Washington State Department of Transportation

The 2016 Corridor Capacity Report

The 15th edition of the annual *Congestion Report*

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Roger Millar, Secretary of Transportation

WSDOT's comprehensive annual analysis of multimodal state highway system performance

Developed in partnership with

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Tracking the health of state commutes

Washington's economic health is improving, but as it does the overall well-being of its transportation system is worsening. Having more and more drivers heading to work is a sure sign of prosperity but it is also causing slow flowing, congested arteries that make it harder and harder for commuters to reach their destinations.

Unclogging commutes on state corridors requires a thorough understanding of congestion and roadway capacity statewide. The Washington State Department of Transportation (WSDOT) communicates this understanding of system performance through the annual *Corridor Capacity Report* specifically to guide decision making by transportation policy makers, planners and engineers as they look to improve multimodal capacity and reduce stop-and-go traffic in Washington.

This report helps start the discussion between WSDOT, the Legislature, external stakeholders, educational and research institutions, the media and the public about congestion levels and capacity constraints on Washington's 86 urban commute corridors and about what can be done to reduce travel times. WSDOT employs Practical Solutions to identify the needs of system performance, develop targets and engage partners to evaluate and implement the multimodal options that provide the most benefit.

The *Corridor Capacity Report* offers a comprehensive picture of state congestion by providing in-depth multimodal system analysis while determining the usable capacity on state highways, transit, passenger rail and ferries. This report not only analyzes congestion's impacts on air quality but also how it affects the amount of green in people's wallets.

This report consists of three parts: this *Corridor Capacity Report*, a data Appendix and the 2nd edition of the *Handbook for Corridor Capacity Evaluation*.

MAP-21: a path to transparency for the federal-aid program

The Moving Ahead for Progress in the 21st Century Act (MAP-21) transformed the federal-aid highway program by establishing new requirements for performance management to ensure the most efficient investment of federal transportation funds. Performance management increases the accountability and transparency of the federal-aid highway program and provides a framework to support improved investment decision making through a focus on performance outcomes for key national transportation goals.

Under MAP-21 and the Fixing America's Surface Transportation Act (MAP-21's successor), several proposed rules have been released—one of which is related to system performance, freight, and congestion mitigation and air quality. WSDOT is considered among the nation's leaders in transportation performance measurement and has an extensive framework for data collection, processing, analysis and reporting through the annual *Corridor Capacity Report* – WSDOT's comprehensive annual analysis of multimodal state highway system performance. WSDOT has a strong history of analyzing and reporting congestion on the state's major urban commute corridors where greenhouse gas emissions is one of the key measures.

For more details on WSDOT's response to the above federal rulemaking, please visit www.wsdot.wa.gov/Accountability/MAP-21.htm.

Interactive maps help visualize data

Readers can explore each corridor's performance data within interactive online maps (marked with the icon above). For an overview of Washington state's transportation capacity, visit bit.ly/CCR16statewidemap.

On the cover: Traffic backs up heading into downtown Spokane (Photo courtesy of Eastern Region Transportation Engineer Mike Bjordahl)

A statewide and regional look at multimodal travel indicators

Washington state saw an increase in drivers on the road in 2015. Passenger vehicle registrations increased 8.3% while licensed drivers increased 4.0% between 2013 and 2015.

- More drivers in 2015 contributed to a 4.3% increase in the number of vehicle miles traveled (VMT) on all public roadways, up from 57.211 billion in 2013 to a new high of 59.653 billion miles.
- More drivers also had a hand in a 5.3% increase in VMT exclusively on state highways, which hit a new high of 33.335 billion in 2015, up from 31.649 billion in 2013.
- Total VMT on the five monitored major corridors in the central Puget Sound region (I-5, I-405, SR 520, I-90 and SR 167) increased by almost 1% between 2013 and 2015.

Higher VMT, likely due to increased population, an improving economy and lower gas prices (see p. 9), led to increased congestion on many major corridors throughout the state. Total congestion on the five monitored freeway corridors in the central Puget Sound region increased by 35.7% between 2013 and 2015, surpassing 2007 pre-recession levels for the second consecutive year. (2015 statewide delay data was unavailable at the time of this publication).

- Of the five monitored freeway corridors in the central Puget Sound region, three (I-5, I-405 and I-90) saw congestion increases (of 59%, 28% and 74%, respectively) compared to 2007 pre-recession levels. Tolling and carpooling brought congestion on SR 520 and SR 167 down to levels 62% and 2% below pre-recession peak levels, respectively. (See table and charts on p. 3 of the appendix document.)
- High occupancy vehicle (HOV) lanes accounted for 38% of person miles traveled on central Puget Sound region freeways in 2015.
- After I-405 express lane tolling began on September 27, 2015, the express lanes in both directions met the legislatively mandated HOV lane speed requirement of 45 mph or faster 90% of the time during the peak travel periods from January through June 2016.

Travel times are faster and person throughput is higher in HOV lanes as opposed to single occupancy vehicle (SOV) lanes (refer to appendix pp. 27-29). An example of this is the HOV lane on I-5 at Northgate where reliable travel times were up to 17 minutes shorter, and the movement of people was nearly three times higher than in the adjacent SOV lanes in 2015.

WSDOT Incident Response teams responded to 16.3% more incidents (50,092 total) in 2015 than in 2013, with the same average clearance time of 12 minutes and 45 seconds in both 2013 and 2015.

- Proactive work by Incident Response teams resulted in $80.2 million in economic benefit in 2015, an 18.1% increase from 2013.

Urban transit on commute corridors

More people are taking transit than before. Transit ridership on urban commute corridors during daily peak periods increased 5.3%, from 90,300 in 2013 to 95,100 in 2015. For example, transit on I-5 between Federal Way and Everett moved 48,730 people during peak periods on average weekdays. Without transit it would require more than four additional SOV lanes to meet the capacity demand on this stretch of I-5.

- The number of miles passengers traveled using transit during daily peak periods increased 6% on urban commute corridors, from 1.16 million miles in 2013 to 1.23 million miles in 2015.
- Daily greenhouse gas emissions avoided during peak periods due to transit ridership improved by 6.7%, from 564,100 pounds avoided in 2013 to 601,900 pounds avoided in 2015.

Ferries

The number of travelers using WSDOT Ferries continues its upward trend as annual ridership increased 6%, up from 22.5 million in 2013 to 23.9 million in 2015. Meanwhile, annual vehicle capacity utilization increased by two percentage points, from 60% in 2013 to 62% in 2015. (See pp. 51-52.)

- Annual ferry trip reliability did not change significantly, at 99.5% in both 2013 and 2015.
- Ferries on-time performance dropped approximately one percentage point from 2013 to 94.4% in 2015.

Amtrak Cascades

Passenger miles traveled on Amtrak Cascades decreased by 3.3% from 110.6 million miles in 2013 to 106.9 million miles in 2015, with ridership declining 3.2% during the same period, from approximately 694,000 to 672,000. Capacity utilization also decreased by three percentage points, from 59.8% in 2013 to 56.8% in 2015. (See p. 53.)

- Amtrak Cascades annual on-time performance fell by 4.6 percentage points, from 77.6% in 2013 to 73% in 2015.

Dashboard of Indicators

2016 *Corridor Capacity Report* Dashboard of Indicators	2011	2012	2013	2014	2015	Difference '13 vs. '15[1]
Demographic and economic indicators						
State population (in millions)	6.77	6.82	6.88	6.97	7.06	2.6%
Gasoline price per gallon (annual average)[2]	$3.92	$3.96	$3.71	$3.56	$2.70	-27.2%
Washington total employment (in thousands of workers)[3]	2,872	2,919	2,986	3,065	3,154	5.6%
Taxable retail sales (in billions of dollars)[2]	$109.3	$112.6	$119.2	$125.0	$135.4	13.5%
Statewide multimodal performance measures						
Drive alone commuting rate[4]	73.3%	72.2%	72.7%	72.4%	72.4%	-0.3%
Carpool commuting rate[4]	10.2%	10.7%	10.1%	10.1%	9.8%	0.3%
Bicycling and walking commuting rate[4]	4.2%	4.5%	4.3%	4.5%	4.7%	0.4%
Public transit commuting rate[4]	5.6%	5.8%	6.3%	6.3%	6.2%	-0.1%
Transit ridership[5] (in millions)	195.1	218.1	221.2	227.2	N/A	N/A
WSDOT Ferries ridership[5] (in millions)	22.3	22.2	22.5	23.2	23.9	6.2%
Amtrak Cascades ridership[6] (in thousands)	742	725	694	700	672	-3.2%
Statewide congestion indicators						
Per person, total vehicle miles traveled on all public roads, state highways only						
All public roads vehicle miles traveled (VMT) (in billions)	56.965	56.607	57.211	58.060	59.653	4.3%
All public roads per person VMT (miles)	8,417	8,303	8,313	8,332	8,448	1.6%
State highways VMT (in billions)	31.455	31.214	31.649	32.177	33.335	5.3%
State highways per person VMT (miles)	4,648	4,578	4,599	4,618	4,721	2.7%
Congestion on state highway system						
Total state highway lane miles	18,642	18,659	18,662	18,680	18,699	0.2%
Percent of state highway system congested[8]	5.4%	5.5%	5.5%	5.8%	N/A	N/A
Per person, total, and cost of delay on state highways						
Annual hours of per person delay on state highways[9]	4.8	4.7	4.7	4.7	N/A	N/A
Total vehicle hours of delay (in millions of hours)[9]	32.0	30.9	32.5	32.3	N/A	N/A
Cost of delay on state highways (in millions)[2,9]	$783	$773	$823	$834	N/A	N/A
Results Washington system performance measures						
Throughput productivity[10]	96.0%	95.7%	95.2%	94.6%	93.4%	-1.8%
Reliability index[10]	1.15	1.17	1.19	1.24	1.26	5.9%
Corridor-specific congestion indicators (84 commutes statewide)[11]						
Annual Maximum Throughput Travel Time Index (MT^3I)	1.26	1.29	1.34	1.37	1.42	6.0%
Number of commute routes with $MT^3I > 1$[12]	60	59	61	62	68	11.5%
WSDOT congestion relief projects (cumulative)						
Number of completed Nickel and Transportation Partnership Account mobility projects as of December 31 each year	82	91	94	98	99	5.3%
Project value (in millions of dollars)	$2,802	$3,851	$3,985	$4,287	$4,669	17.2%

Data sources: Washington State Office of Financial Management, U.S. Energy Information Administration, Bureau of Labor Statistics – Consumer Price Index, Washington State Employment Security Department, Washington State Department of Revenue, WSDOT State Highway Log, U.S. Census Bureau - American Community Survey, National Transit Database, Washington Department of Ecology.

Notes: N/A = Not available. 1 Due to rounding, some percentages are not computable based on numbers in the table. 2 These dollar values are inflation-adjusted using the Consumer Price Index, and are reported in 2015 dollars. 3 Employment only includes non-agricultural workers. 4 Based on 1-year estimates from the American Community Survey, commuting rates are of workers age 16 and older. Totals do not equal 100 because "Worked at home" and "Other" categories not included here. 5 Ridership is the number of boardings, also called unlinked passenger trips. Complete 2015 data was not yet available from the National Transit Database, as some rural transit agency data had not been updated. 6 These figures include riders on Washington segments only. 7 Values for 2013 and 2014 will be published by the Washington Department of Ecology in December 2016. See pp. 11, 15, 21, 25, 29, 36, 40, 43 and 49 for corridor-specific greenhouse gas emissions data. 8 Based on below 70% of posted speed.
9 Based on maximum throughput speed threshold (85% of posted speed). 2015 statewide delay data was unavailable at the time of this publication.
10 See pp. 6-7 for descriptions of these measures. 11 Does not include Tri-Cities data. 12 MT^3I greater than one means the commute route experiences congestion.

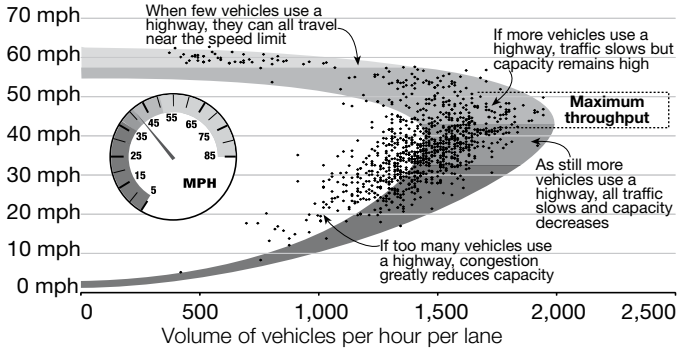
Maximum Throughput and Other Key Concepts

WSDOT prioritizes throughput

WSDOT aims to provide and maintain a system that maximizes capacity, productivity and efficiency. WSDOT uses maximum throughput speed (the speed at which the highest number of vehicles can pass through a roadway segment) as the baseline speed for congestion and capacity performance measurement. Maximum throughput is achieved on freeways when vehicles travel at 70% to 85% of the posted speed limit (42 to 51 mph for a 60 mph speed limit). At this speed, drivers can safely travel with a shorter distance between vehicles than they can at posted speeds, allowing more vehicles to pass through a segment.

Maximum throughput: adapted speed/volume curve

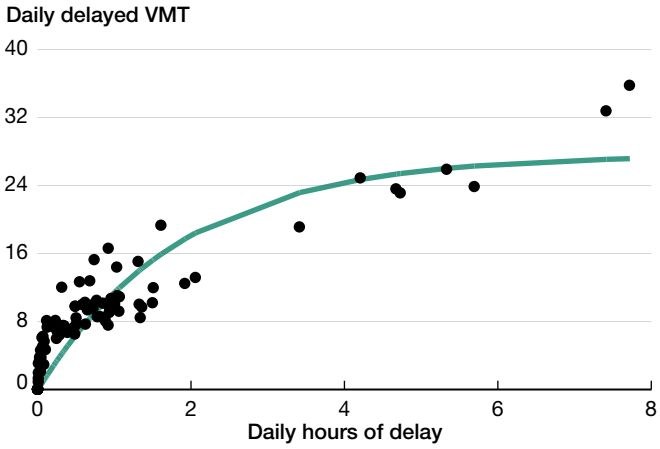
Speed limit 60 mph; Maximum throughput speed ranges between 70%-85% of posted speed



Data source: WSDOT Northwest Region Traffic Office.

I-5 northbound delay increases while delayed vehicle miles traveled[1] levels off

Daily hours of delay and daily delayed VMT in thousands



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: 1 Delayed vehicle miles traveled (VMT) refers to VMT accrued when there is delay on the corridor.

Delay and person miles traveled have unconventional interaction

While vehicle miles traveled (VMT) and delay interact, they do not have a linear relationship. VMT is a continuous measurement, while delay is a threshold-based measure. VMT fluctuates based on growth in driving population, job availability and other economic factors which can put additional stress on the transportation system, lowering speeds and leading to increased delay.

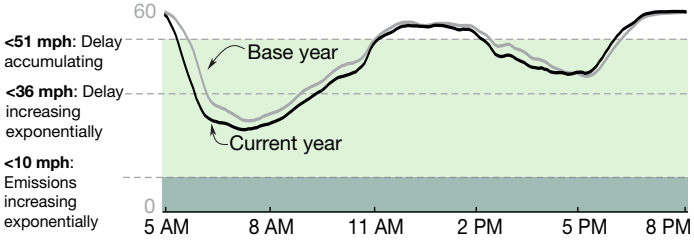
Delay is calculated when speeds are below 50 mph (threshold speed). WSDOT limited VMT to the same threshold speed, creating the measure of delayed VMT. Delayed VMT and vehicle hours of delay increase hand in hand until congestion becomes so severe that even though delay continues to accumulate, delayed VMT begins to level off (see graph at left). Vehicles record no additional VMT while stopped in traffic.

Delay not always a good indicator of emissions

For speeds slower than 10 mph, CO_2e emissions from vehicles quickly escalate. However, there is little variation in emissions per vehicle mile traveled between 35 and 60 mph, the typical range of highway speeds. For this reason, emissions often hold steady even as delay begins to accumulate. In addition, vehicle fuel economy improves each year, negating marginal changes in emissions caused by slower speeds or, on some corridors, leading to decreased emissions. The Puget Sound Regional Council provides WSDOT the emission factors used to calculate the greenhouse gas emissions measures in this report.

Speeds on I-5 from Federal Way to Seattle not low enough to trigger increases in emissions between years[1]

2013 and 2015; Northbound; Speed in miles per hour



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: 1 Average speeds did not drop below 10 mph, the speed at which greenhouse gas emissions start rising exponentially. While emissions begin to rise around 25 mph, this is offset by lower emissions factors in 2015 due to improved efficiency of vehicles on the roadway. At 7:20 a.m. (the 5-minute peak), the average speed in 2015 was 24.6 mph, down from 27.3 mph in 2013.

See the 2nd edition of WSDOT's Handbook for Corridor Capacity Evaluation for details on WSDOT's measurement and analysis approach for these and other system evaluation metrics.

Performance-Based Transportation System Management

Federal law emphasizes system performance

The Moving Ahead for Progress in the 21st Century Act (MAP-21) is a federal law that establishes a new framework for investment in the nation's transportation infrastructure. MAP-21 is intended to make states more accountable and transparent in their investment of federal taxpayer dollars, and to ensure that states invest federal money in transportation projects that make progress toward achieving national transportation goals.

On April 22, 2016, the U.S. Department of Transportation (USDOT) released the 3rd notice of proposed rulemaking for performance measure requirements for states in various areas, including system performance, freight movement, and congestion mitigation and air quality. This proposed rule included detailed measures for each performance area.

MAP-21 proposed system performance measures

Area	Proposed measure
System Performance	Percent of the Interstate System providing for reliable travel times
	Percent of the non-Interstate NHS providing for reliable travel times
	Percent of the Interstate System where peak hour travel times meet expectations
	Percent of the non-Interstate NHS where peak hour travel times meet expectations
Freight Movement	Percent of the Interstate System mileage providing for reliable truck travel times
	Percent of the Interstate System mileage uncongested
Congestion Mitigation	Annual hours of excessive delay per capita
Air Quality	2- and 4-year emission reductions for each applicable criteria pollutant and precursor

The national MAP-21 goals include reducing congestion, improving system reliability, supporting freight movement and economic vitality, and ensuring environmental sustainability.

WSDOT proactively worked with the American Association of State Highway and Transportation Officials and USDOT to propose improvements to MAP-21's proposed performance measures. WSDOT provided these comments to federal docket number FHWA-2013-0054, which can be accessed here: www.wsdot.wa.gov/Accountability/MAP-21.htm. The comment period closed August 20, 2016, and USDOT is currently reviewing all public comments, with an unknown timeline for final rule publication. States will set targets within one year of final rule-making. For more information about the current status of MAP-21, see *Gray Notebook* 62, p. 7.

Results Washington focuses on performance and accountability

Results Washington, the state's performance management system, outlines Gov. Jay Inslee's priorities for the state and focuses on key goals that strive to strengthen the economy, protect the environment, and make Washington an ideal place to live and do business.

WSDOT manages performance measures related to Sustainable, Efficient Infrastructure, which fall within the Prosperous Economy goal. The Results Washington transportation performance measures related to system performance and commute methods include the following:

- **Alternative commute methods:** Increase the percentage of Washingtonian's using alternative commute methods to 29% by 2020.
- **Travel and freight reliability:** Ensure travel and freight reliability (impacted by economic growth) on strategic corridors does not deteriorate beyond 5% from 2012 levels through 2017.
- **System efficiency:** Operate strategic corridors at 90% efficiency or higher through 2017.

Alternative Commute Methods: A transportation system that integrates and supports travel by many different modes can work more efficiently, improve mobility and accessibility and reduce greenhouse gas emissions. Increasing the use of alternative modes helps maximize capacity on the entire transportation system.

In 2015, 27.6% of Washington workers age 16 years and older used an alternative commute method (which includes carpool, vanpool, public transportation, walk, bike, taxicab, motorcycle, or telecommute) to travel to work. This is the same percentage of Washington workers using alternative commute methods as in 2014, but a 0.3 percentage point increase from 27.3% in 2013.

WSDOT uses a variety of strategies to manage demand on the transportation system, which include incorporating

Travel reliability worsens as economy improves

demand management strategies into project design and corridor planning studies, Commute Trip Reduction, and improving bicyclist and pedestrian safety. The Results Washington report for alternative commute methods can be accessed at bit.ly/RW_AlternativeCommute, and uses data from the American Community Survey.

Travel and Freight Reliability: Reliability is an important metric for highway users because it provides information that allows travelers to plan for on-time arrival with a higher degree of certainty. A reliability index greater than 1 indicates that the system is delayed during the daytime travel period (5 a.m. to 8 p.m.); an increase in the index over time indicates worsening delay and less reliable travel times. For more detail on how WSDOT calculates the Results Washington measures, see pp. 53-54 of the 2nd edition of the *Handbook for Corridor Capacity Evaluation*.

In 2015, the reliability index increased by about 7.7% from 2012 levels; therefore, Washington did not meet the goal of maintaining travel and freight reliability to no more than 5% above the 2012 baseline. Travel time reliability has been worsening since 2012 (see table below), which follows the overall trend of economic growth. Reliable travel times are impacted by economic activity because more people and freight movement often means more traffic on the roads.

Reliability and efficiency decline since 2012 baseline
80th percentile reliable travel times for 5 a.m. to 8 p.m.; Throughput productivity averages weighted by average daily volume per lane

Year	Reliability index	Throughput productivity %
2012	1.17	95.7%
2013	1.19	95.2%
2014	1.24	94.6%
2015	1.26	93.4%

WSDOT's strategies for improving travel and freight reliability include implementing Practical Solutions to enable more flexible and sustainable transportation investment decisions, promoting multimodal transportation options, and integrating tolling, high occupancy toll lanes and express toll lanes. The Results Washington report for travel and freight reliability can be accessed at bit.ly/RW_Reliability.

System Efficiency: Commuters value efficiency across all transportation modes because it allows them to make better use of their own time, while shippers and freight carriers require an efficient system to remain competitive. An increase in throughput productivity indicates that system efficiency has improved, meaning more people and/or goods are being moved per corridor mile.

For 2015, Washington met the goal of operating strategic corridors at 90% efficiency or higher (see table at left). However, system efficiency has been worsening overall since 2009, which follows the overall trend of economic growth since the Great Recession. The most recent data shows throughput productivity in 2015 at approximately 93.4%.

WSDOT's strategies for improving system efficiency are the same as the strategies for travel and freight reliability. The Results Washington report for system efficiency can be accessed at bit.ly/RW_Capacity.

WSDOT prioritizes clean transportation

WSDOT also has an interest in the clean transportation measures that fall under the Sustainable Energy and a Clean Environment goal area. These performance measures include reducing transportation-related greenhouse gas (GHG) emissions, reducing average GHG emissions for each vehicle mile traveled in Washington, improving the fuel efficiency of Washington's passenger vehicle and light duty truck fleet, and increasing the number of plug-in electric vehicles registered in the state. Reports for these measures can be accessed at bit.ly/RW_CleanTransportation.

Results WSDOT sets the agency's direction and priorities

Results WSDOT, the agency's strategic plan for 2014-2017, aligns with Results Washington. This plan focuses on maximizing capacity for the entire multimodal system, emphasizes working across all modes, and strives to provide and support safe, reliable and cost-effective transportation options to improve livable communities and economic vitality for people and businesses.

The 2016 *Corridor Capacity Report* is designed to help inform WSDOT policy makers, planners and engineers as they examine opportunities for maximizing multimodal capacity. It supports MAP-21 and Results Washington, as well as Results WSDOT's emphasis on innovation through Practical Solutions and performance-based planning initiatives. For more information on Results WSDOT, see http://www.wsdot.wa.gov/Secretary/ResultsWSDOT.

Statewide Congestion Indicators

Statewide vehicle miles traveled reach new high in 2015

Statewide vehicle miles traveled (VMT) on all Washington state roads reached a new high of 59.653 billion miles in 2015, an increase of 4.3% from 2013 (57.211 billion). Similarly, state highway-only VMT reached a new high at 33.335 billion miles, an increase of 5.3% from 2013 (31.649 billion).

In 2015, compared to 2014, the VMT on all roads and state highways-only saw one-year increases of 2.7% and 3.6%, respectively, which are the highest one-year increases observed since 2000.

Per person vehicle miles traveled resumes ascent after 3-year stall

In 2015, per person (per capita) VMT on all roads was measured at 8,448 miles—about 135 miles (or 1.6%) higher than 2013 (8,313 miles) and 1.4% higher than the 8,332 miles in 2014. This uptick in per person VMT broke a three-year trend of approximately 8,300 miles from 2012 through 2014.

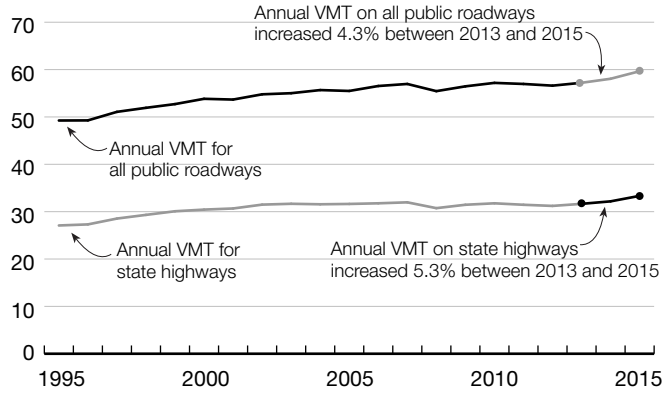
Total vehicle miles traveled (VMT) outpaces population growth in 2015
2011 through 2015; Population in thousands

	Total vehicle miles traveled (billions)		Vehicle miles traveled per person	
Year (population)	All public roads	State highways	All public roads	State highways
2011 (6,768)	56.965	31.455	8,417	4,648
2012 (6,818)	56.607	31.214	8,303	4,578
2013 (6,882)	57.211	31.649	8,313	4,599
2014 (6,968)	58.060	32.177	8,332	4,618
2015 (7,061)	59.653	33.335	8,448	4,721
Δ 2015 vs. 2013	2.442	1.686	135	122
%Δ 2015 vs. 2013	4.3%	5.3%	1.6%	2.7%

Data sources: WSDOT Multimodal Planning Division and Washington State Office of Financial Management.

On all roadways, per person VMT increased by 1.4% in 2015, indicating that VMT increased faster than the state's population. Looking at state highways alone, per person VMT remained around 4,600 between 2011 and 2014, but increased to 4,721 miles per person in 2015. This is about a 122-mile increase (or 2.7%) per Washingtonian compared to 4,599 miles in 2013.

Record high statewide vehicle miles traveled in 2015
1995 through 2015; Miles in billions

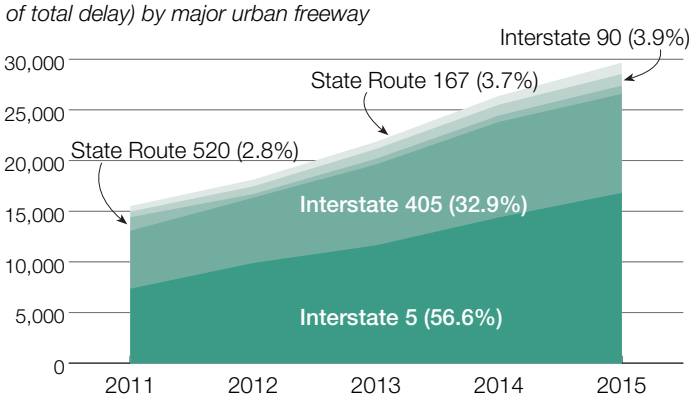


Data sources: WSDOT Multimodal Planning Division.

Central Puget Sound region delay trends upward since 2011

Average daily weekday delay on freeway corridors (Interstate 5, I-405, I-90, State Route 520 and SR 167) in King and Snohomish counties grew roughly 35.7% from 21,855 daily vehicle hours of delay in 2013 to 29,656 hours in 2015. This growth can be partially attributed to growing employment during this period (see pp. 9-10).

Major urban freeways in the Central Puget Sound region see delay increases
2011 through 2015; Vehicle hours of delay per weekday (and percent of total delay) by major urban freeway



Data source: WSDOT Multimodal Planning Division.
Notes: Central Puget Sound includes King and Snohomish counties.

The four-year trend also shows a significant delay increase, at 91.2% more delay in 2015 than in 2011 (which had 15,510 average daily vehicle hours of delay, and was the second year of growth in delay from the low point of 13,058 daily vehicle hours in 2009 during the recession).

Transportation accounts for 46% of Washington emissions

Average daily weekday delay on major Central Puget Sound freeways
2011 through 2015; Vehicle hours of delay per day

Corridor	2011	2012	2013	2014	2015	2013 vs. 2015
I-5	7,354	9,894	11,638	14,389	16,810	**44.4%**
I-405	5,719	6,439	7,978	9,427	9,768	**22.4%**
SR 520	1,335	363	564	633	818	**45.0%**
I-90	565	756	963	1,064	1,149	**19.3%**
SR 167	537	669	712	863	1,111	**56.0%**
Total	**15,510**	**18,121**	**21,855**	**26,376**	**29,656**	**35.7%**

Data source: WSDOT Multimodal Planning Division.
Notes: To make accurate comparisons, the 2013 data was recalculated for this report. To learn why delay and miles traveled do not increase hand in hand, see p. 10 of the 2nd edition of the *Handbook for Corridor Capacity Evaluation*. See the lane mile inventory on p. 4 of the Appendix for delay context.

From 2011 to 2015, I-5 was the central Puget Sound region's most delayed major urban freeway. In 2015, I-5 experienced an average of 16,810 vehicle hours of delay each weekday, or roughly 56.6% of all delay on the major urban freeways in the region. In all years except 2011 it had more delay than the other four monitored freeways combined (see graph at bottom of p. 8).

Emissions on high-demand urban commute corridors down by 2.9%

In 2015, the weekday annual greenhouse gas emissions from vehicles on the high-demand commute corridors in urban areas statewide were estimated to be 2.69 million metric tons (or 5.94 billion pounds) of carbon dioxide equivalents (CO_2e)—2.9% less than in 2013. Even while VMT and delay increased since 2013, emissions continue to decline due to increased efficiency of vehicles and the non-linear relationship between VMT, delay and emissions (see p. 5 of this report, and p. 10 and p. 16 of the 2nd edition of the *Handbook for Corridor Capacity Evaluation*).

According to the Washington State Department of Ecology, transportation-related activities contributed 46.2% of all greenhouse gases released into the atmosphere in 2012 (the most recent year with available data). Washington state generates more clean energy than the national average; as a result, transportation as a percent of statewide emissions is higher compared to the national average of 27%.

Multiple economic factors affect congestion levels in Washington

Increased employment: Maintaining the steady economic recovery, non-farm employment in Washington reached 3.15 million workers in 2015, a 5.6% increase from 2013. Much like congestion on some of Washington's highways, employment now exceeds (by 6.2%) 2007 pre-recession levels. Washington's unemployment rate dropped to 5.7% in 2015, from 7.0% in 2013.

While the statewide unemployment rate is at a seven-year low and continues to approach the pre-recession rate of 4.7%, this can likely be partially attributed to workers leaving the labor force, or young adults delaying entry to the labor force. Washington's labor force participation rate has fallen from 66.2% in 2007 to 62.9% in 2015 because the labor force (the population currently working or actively seeking work) did not increase as quickly as the working age population. Another factor of the economic recovery that must be considered is that average weekly hours worked by all Washington employees increased slightly by 0.3% (about 5.5 minutes) between 2013 and 2015, but remained 2.4% below 2007 pre-recession levels, likely due to a lingering shift toward part-time employment.

In the Seattle-Bellevue-Everett metropolitan area, employment grew 5.9% and the unemployment rate fell to a seven-year low of 4.5%, while the labor force participation rate (69.5%) reached a 10-year low in 2015. Both statewide and the metropolitan area's average hourly wages were higher in 2015 than they were before the recession and

Summary of Washington's economic indicators
2013 and 2015

Indicator	2013	2015	%Δ	Trend: Actual	Trend: Desired
Employment (millions of workers)	2.99	3.15	5.6%	↑	↑
Unemployment rate	7.0%	5.7%	-18.6%	↓	↓
Taxable retail sales[1] (billions of dollars)	$119.2	$135.4	13.5%	↑	↑
Gasoline price per gallon[1]	$3.71	$2.70	-27.2%	↓	N/A
Driving age population (ages 16 and over, in millions)	5.48	5.64	2.9%	↑	N/A
Licensed drivers (millions)[2]	5.21	5.42	4.0%	↑	N/A
Passenger vehicle registrations (millions)	4.44	4.81	8.3%	↑	N/A
Median home price (thousands)[1]	$256.5	$286.3	11.6%	↑	N/A

Data source: Washington State Office of Financial Management, U.S. Bureau of Labor Statistics, Washington State Department of Revenue, U.S. Energy Information Administration, Washington State Department of Licensing.
Note: 1 Adjusted for inflation and reported in 2015 dollars. 2 Does not include licensed military personnel.

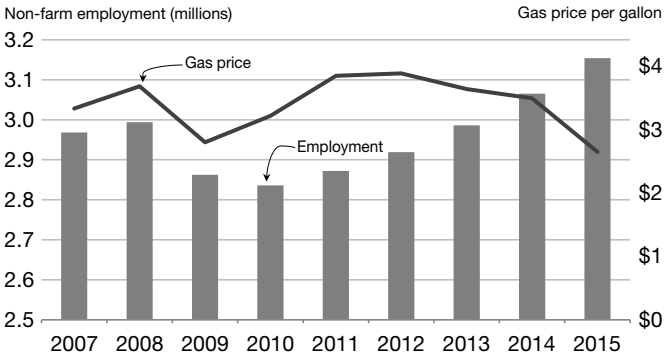
More vehicles on the road and more congestion in 2015

increased by approximately $1.50 an hour from 2013. Seattle-Bellevue-Everett metropolitan area average wages remain about $5.50 an hour higher than statewide.

Washington state retail sales (adjusted for inflation) increased from 2013 to 2015 by 13.5%. This increased consumption is likely related to the growth in employment, and therefore linked to increased commute traffic that leads to congestion. Taxable retail sales can be an indicator of consumers' confidence in the economy and is likely representative of freight truck traffic on Washington roadways, given that retail stores need to be supplied with goods.

Employment trends upward as gas prices fall

2007 through 2015; Gas prices in 2015 dollars



Data sources: U.S. Bureau of Labor Statistics; U.S. Energy Information Administration.

Lower gas prices: Gas prices in Washington fell 27.2% (accounting for inflation) between 2013 and 2015, from an average of $3.71 per gallon in 2013 to $2.70 in 2015. This is the lowest average annual gas price in Washington since 2004, when gas was $2.45 per gallon. Washington's gas prices exceeded the national average by 27 cents in 2015. When gas prices fall, VMT tends to increase (see p. 8) and traffic congestion worsens; when gas prices fall, driving becomes less expensive and people often drive alone (or drive more) rather than using alternative commute modes such as transit or carpools.

More vehicles on the road: Washington's driving age population (age 16 and older) increased 2.9% from 2013 to 2015, from 5.48 million to 5.64 million people. This exceeded the growth rate of total state population, which increased 2.6% from 2013 to 2015. In the frequently congested Seattle-Bellevue-Everett metropolitan area, the driving age population increased by 3.9% between 2013 and 2015, from 2.19 million to 2.27 million people.

There were 5.42 million licensed drivers (all types) in Washington in 2015, up 4.0% from 2013 (see table at bottom of p. 9). This equates to 96% of Washingtonians over the age of 16 holding driver's licenses. In addition, there were 4.81 million registered passenger vehicles in 2015, an 8.3% rise from two years before, indicating additional demand on the transportation system. This translates to about 0.89 passenger vehicles per licensed driver in Washington, up from 0.85 in 2013.

Alternative commutes and home prices: According to the American Community Survey, 72.4% of Washingtonians drove alone to work in 2015 (and 2014), a slight decrease from 72.7% in 2013. Of the remaining Washington workers in 2015, 9.8% carpooled, 6.2% rode public transportation, 5.6% worked from home, 3.7% walked and 1% biked. While this alternative commute rate increase of 0.3% is significant, employment during the same 2013-2015 time period grew at a faster rate of 5.6%, putting additional pressure on the transportation system.

Adding to this pressure, median home prices in Washington rose 11.6% (accounting for inflation) between 2013 and 2015. Often the highest home prices are in high-density urban and job centers, making it unaffordable for people to live near their jobs. This in turn encourages urban sprawl. Without alternative commute options, workers end up driving alone to work more, which uses up roadway capacity and leads to increased congestion.

Major urban highways continue to experience increased delay

Traffic congestion, travel time and delay are influenced by a number of factors, including the availability of public transportation, the rate of drive-alone commuting, and the overall economy. As the economy strengthens and employment levels improve, congestion tends to worsen due to an increased number of commuters, especially when these workers are driving alone.

Urban highways statewide saw significant increases in delay on some commutes in 2015, while changes in VMT were moderate to significant. WSDOT tracks VMT and delay along with other multimodal performance measures on urban commute corridors statewide. See detailed evaluations of each corridor beginning on p. 11, and more statewide indicators data in the Appendix pp. 3-4.

Visit bit.ly/CCR16CentralSoundmap for this article's interactive map.

Interstate 5 Corridor Capacity Analysis

Annual SOV person miles traveled
2013 vs. 2015
2,466 vs. 2,503
in millions of miles
▲ 1.5%

Annual SOV vehicle delay[1]
2013 vs. 2015
3,038 vs. 4,387
in thousands of hours
▲ 44%

Annual SOV GHG emissions
2013 vs. 2015
2,046 vs. 2,010
in millions of pounds of CO_2 equivalents
▼ 1.8%

Annual passenger miles traveled on transit
2013 vs. 2015
186.2 vs. 199.3
in millions of miles
▲ 7%

Capacity savings due to transit
2013 vs. 2015
4.1 vs. 4.2
in number of lanes
▲ 2.4%

Percent transit seats occupied
2013 vs. 2015
67% vs. 73%
on average during peak periods
▲ 6%

Percent park and ride spaces occupied
2013 vs. 2015
89% vs. 92%
on average during peak periods
▲ 3%

Commute travel times

2013 and 2015 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for single occupant vehicle (SOV), high occupancy vehicle (HOV) and transit[3] trips.

Average SOV | Average HOV | Average transit
Reliable SOV | Reliable HOV | Reliable transit

Everett to Seattle
Morning; 7:15 a.m.; Trip length 24 miles

		Average	Reliable
SOV	2013	50	80
	2015	56	92
HOV	2013	39	61
	2015	47	75
Transit	2013	38	53
	2015	43	66

Seattle to Everett
Evening; 4:25 p.m.; Trip length 23 miles

		Average	Reliable
SOV	2013	39	57
	2015	47	67
HOV	2013	35	48
	2015	42	58
Transit	2013	31	40
	2015	36	45

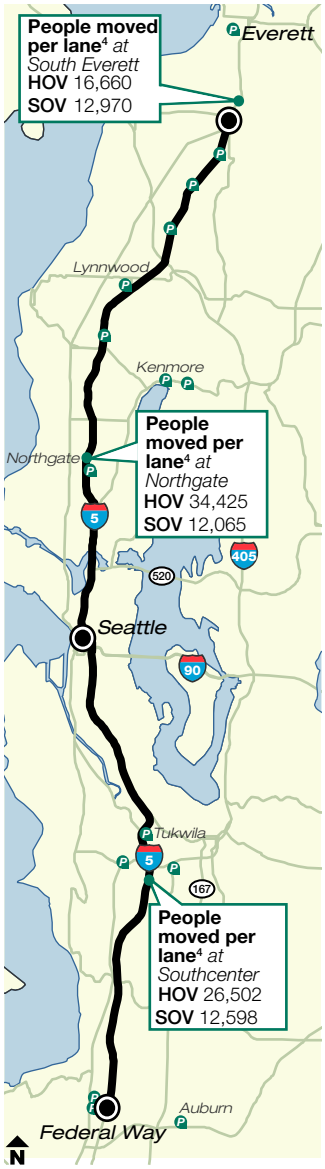
Federal Way to Seattle
Morning; 7:20 a.m.; Trip length 22 miles

		Average	Reliable
SOV	2013	49	69
	2015	54	69
HOV	2013	36	49
	2015	43	61
Transit	2013	38	47
	2015	41	50

Seattle to Federal Way
Evening; 4:10 p.m.; Trip length 22 miles

		Average	Reliable
SOV	2013	32	48
	2015	37	53
HOV	2013	29	41
	2015	33	44
Transit	2013	39	51
	2015	47	61

See Appendix pp. 5-21 for more commute routes



Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2013	2015	2013	2015
Everett to Seattle	10,464	10,941	68%	71%
Federal Way to Seattle *Includes Tacoma to Seattle transit routes	6,328	6,562	69%	71%
SeaTac to Seattle	5,181	5,734	80%	92%
Evening (3-6 p.m.)				
Seattle to Everett	10,265	10,713	65%	68%
Seattle to Federal Way *Includes Seattle to Tacoma transit routes	5,058	5,390	63%	65%
Seattle to SeaTac	5,869	6,622	85%	103%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Everett-Seattle commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Ash Way (1,022)	100%	106%
Kenmore area (693)	100%	101%
Lynnwood Transit Ctr. (1,370)	100%	100%
S. Everett Freeway Station (397)	100%	100%
Northgate area (1,024)	99%	100%
Mountlake Terrace (877)	100%	99%
Mariner (644)	75%	74%
Everett Station (1,107)	35%	65%

Federal Way-Seattle commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Sumner train station (302)	100%	101%
Auburn area (633)	100%	100%
Tukwila area (855)	99%	99%
Kent area (996)	97%	98%
Tacoma Dome (2,273)	96%	95%
Puyallup area (583)	94%	98%
Lakewood area (1,093)	84%	87%
Federal Way area (2,067)	73%	74%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for the I-5 corridor between Everett and Federal Way for SOV trips only. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). 3 Transit travel times by bus and Link light rail may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel to stops. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 4 Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic.

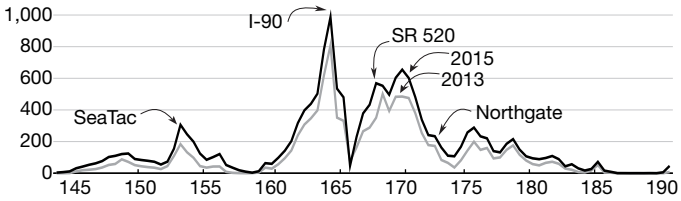
Corridor delay and person miles traveled on the rise

Interstate 5 (I-5) is one of the key commute and economic corridors in the central Puget Sound region. More than 2.5 billion person miles were traveled between Federal Way and Everett in 2015, a 1.5% increase over 2013. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; parts of the I-5 corridor in the central Puget Sound region are served by Link light rail, Sounder commuter rail, and high occupancy vehicle (HOV) lanes. The HOV lane at Northgate on this corridor moved nearly three times as many people as each adjacent single occupancy vehicle (SOV) lane. This speaks to the efficiencies of the HOV network and transit options on the corridor in moving more people.

Despite these efficiencies, traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing severe congestion on a daily basis. Delay increased 44% on I-5 between Federal Way and Everett. To learn why delay and miles traveled do not increase hand in hand, see p. 5. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington, as trucks accounted for over 7% of the total daily traffic volume on the corridor in 2015.

One tell-tale sign of a booming economy is increasing traffic congestion. The congestion along the I-5 corridor has increased as Seattle's economy, fueled by technology sector workers, recovered from the Great Recession. In addition, many people have relocated to areas outside of the greater Seattle area to find more affordable housing, which means more drivers are using the highway to commute to work. It is also important to note that many of the highways that I-5 crosses also face significant congestion during the peak commute periods. Congestion on nearby corridors such as SR 520, I-90, I-405 and major city off-ramps often create backups that overflow onto I-5 and create congestion on a regular basis.

Delay along the I-5 corridor by milepost
2013 and 2015; Northbound and southbound combined; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

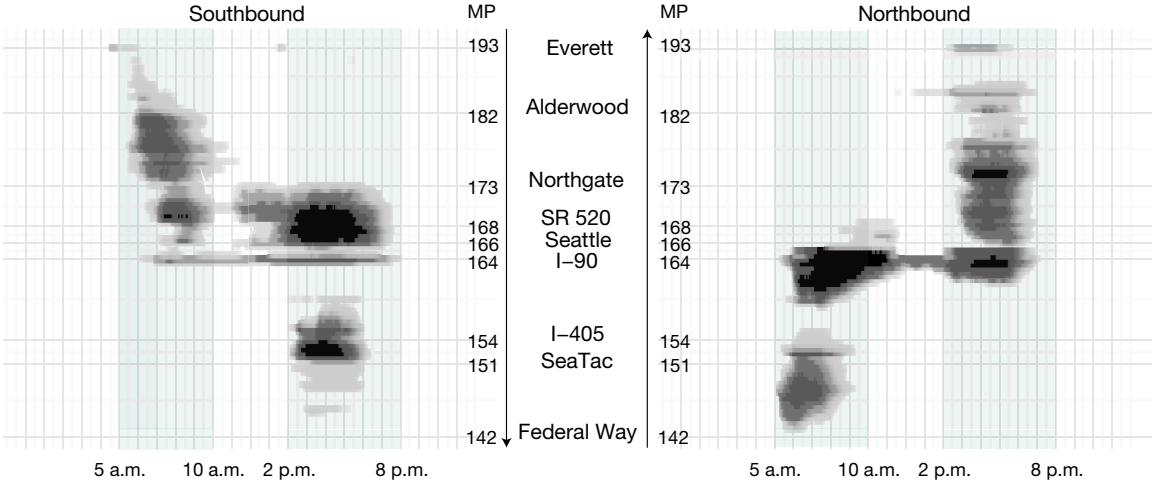
Greenhouse gas (GHG) emissions declined by 1.8% between 2013 and 2015. For more information on the relationship between GHG emissions and delay, see p. 5.

Corridor delay: In 2015, the I-5 corridor in the central Puget Sound region between Federal Way and Everett experienced vehicle delay northbound around the I-90 interchange and between Northgate and downtown Seattle, as well as southbound at SeaTac and the SR 520 interchange. Vehicle delay along the I-5 corridor was consistently equal to or higher in 2015 than in 2013; the magnitude of the difference varied depending on the location and direction of travel (see graphs above and below).

The amount of delay significantly increased between 2013 and 2015 at specific locations on the I-5 corridor including: southbound at SeaTac (up 105%), northbound at the I-90 interchange (up 33%), and in both directions near Northgate

I-5 delay between Federal Way and Everett
2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

For both travel directions in 2015, delay was prevalent around the Seattle area throughout the entire day. Delay on northbound I-5 was most intense from 6-11 a.m. approaching Seattle; evening delay extended from the I-90 interchange to Everett. During the morning commute, delay on southbound I-5 extended from Everett past Seattle. Delay was most intense from 2-6 p.m., with pockets of delay from Northgate to Federal Way.



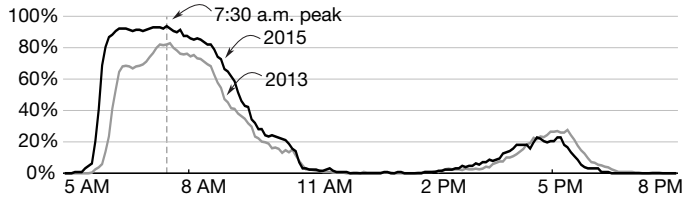
Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Nearly 68% of I-5 peak direction miles routinely congested

(up 25%). Delay would have been worse without transit. Data shows that even with conservative assumptions, transit ridership along the I-5 corridor translates to a capacity savings equivalent to more than four additional lanes of traffic during peak commute periods (See p. 14 for more information on transit ridership). Improvements at key congestion areas, such as the transit access ramps from I-90 to downtown Seattle that bypass the I-5 interchange, provide significant benefits in capacity and reducing travel delay. The heatmap graph below shows the intensity of delay by time of the day and location in 2015.

Severe congestion on the Federal Way to Seattle commute

2013 and 2015; Northbound; Percent of days the average speed was slower than 36 mph



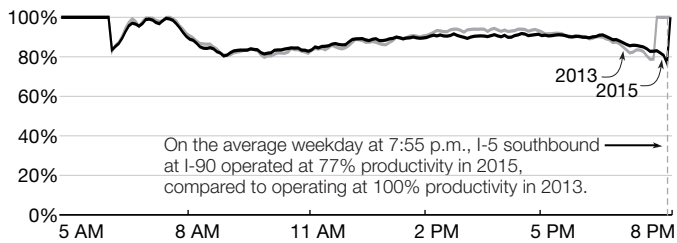
Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: The percent of days the Federal Way to Seattle commute operated in severely congested (36 mph or below) condition worsened between 2013 and 2015 (see severe congestion chart below). For example, at around 7:30 a.m. during the morning commute from Federal Way to Seattle, the percent of days speeds were below 36 mph worsened from 82% in 2013 to 94% in 2015.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-5 in the central Puget Sound region, WSDOT analyzed vehicle throughput at three locations: near South 188th Street, near Northeast 103rd Street and at the I-90 interchange. In 2013 and 2015, productivity at these locations ranged

Throughput productivity on southbound I-5 at I-90 interchange

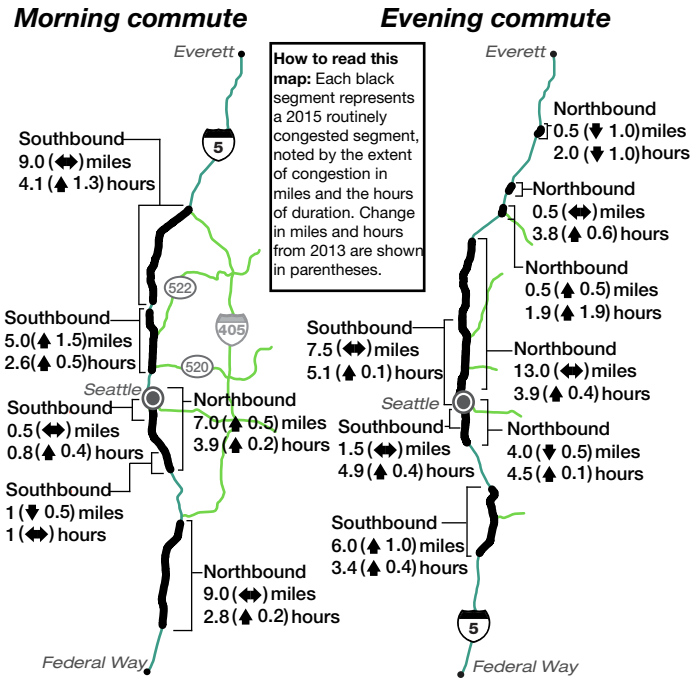
2013 and 2015; Based on the highest observed 5-minute flow rate; Southbound = 1,730 vehicles per hour per lane = 100%



Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments of I-5

2015; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

from 68% to 84% at their most congested. Throughput productivity varies by direction of travel, location and time of day. For example, at the I-90 interchange, nearly 25% of the freeway's capacity was unavailable due to congestion during part of the evening peak period (see graph below).

Routinely congested segments: Of the 91-mile I-5 corridor between Federal Way and Everett (both directions), the segments leading to downtown Seattle experienced significant routine congestion. Overall, the locations where routine congestion occurred increased by 2.5 miles between 2013 (64 miles total) and 2015 (66.5 miles total), while the amount of time of routine congestion increased by 8% (see map above).

Sixteen miles of the 22-mile morning commute route between Federal Way and Seattle and 15.5 miles of the 24-mile Everett to Seattle morning commute route experienced routine congestion in 2015.

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: Capacity constraints impacted both the Federal Way to Seattle northbound

Transit saves four extra lanes of highway capacity on I-5

commute near the I-90 interchange and the Northgate area for the Everett to Seattle southbound commute. This resulted in increased average and reliable travel times during the morning peak period (5-10 a.m.) for some commutes. The average travel time for the Federal Way to Seattle commute increased to 54 minutes in 2015, up five minutes (10%) compared to 2013, while reliable travel time remained flat at 69 minutes for both years. Similarly, the average morning travel time from Everett to Seattle increased to 56 minutes in 2015, up six minutes (12%) compared to 2013, while reliable travel time increased by 12 minutes (15%). Similar trends in increased average and reliable travel times were observed for evening commutes from Seattle.

The SeaTac to Seattle morning commute, a subcommute of the Federal Way to Seattle morning commute, has the highest maximum throughput travel time index (MT^3I) of the 12 I-5 commutes tracked in the central Puget Sound region. The route's MT^3I of 2.31 means the commute takes more than twice as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes.

Transit trip travel times: On I-5, light rail, commuter rail, and managed lanes such as HOV or transit-only lanes allow people to bypass highway capacity constraints in the corridor's SOV lanes. For example, in 2015 the average and reliable transit travel times for the I-5 commute from Federal Way to Seattle in the morning were 41 and 50 minutes, respectively. This is three minutes slower than the average (38 minutes) and reliable (47 minutes) transit travel times in 2013. Transit travel in 2015 proved to be faster than the respective SOV average and reliable travel times by 13 and 19 minutes. See p. 11 for a comparison of transit trips to SOV and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved roughly 48,730 riders on the I-5 corridor during the peak periods on an average weekday in 2015, a 4% increase over 2013 (about 46,820 riders). This corresponds with an approximate 7% increase in transit passenger miles traveled.

Transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the I-5 corridor in the central Puget Sound region was equal to more than four extra lanes of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Transit on I-5 commutes during the morning and evening peak periods operated between 50% and 103% of total seating capacity in 2015. Of the 937 daily peak period transit trips, 195 were over 90% of seating capacity on a typical weekday. Transit use during peak periods avoided roughly 371,500 pounds of GHG emissions per day on the I-5 central Puget Sound corridor in 2015, an 11% improvement compared to 2013 (334,900 pounds).

Why are some transit travel times faster than HOV?
On the I-5 corridor map on p. 11, three commutes have transit travel times which are faster than the corresponding HOV travel times. This is due to the transit routes being slightly shorter than the HOV commute.

For example, on the Everett to Seattle morning commute the transit trip is about two miles shorter than the HOV trips cutting out some of the worst congestion. The Sound Transit 510 bus uses the express lanes to travel between the South Everett Freeway Station park and ride and the Stewart Street and Yale Avenue intersection in downtown Seattle.

Park and ride: Along the I-5 corridor in the central Puget Sound region in 2015, park and ride (P&R) utilization rates ranged from 65% to 106% depending on the location, with 13 out of 16 having utilization rates above 85%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Commuters making roundtrips between Everett and Seattle, Federal Way and Seattle, and SeaTac and Seattle on I-5 experienced costs due to congestion in the central Puget Sound region. For example, the 47-mile roundtrip between Everett and Seattle claimed the highest cost due to congestion (measured in wasted time and gas for travel below maximum throughput speed), about $2,900 per passenger vehicle annually in 2015, while the 44-mile roundtrip between Federal Way and Seattle cost commuters over $2,300.

Visit bit.ly/CCR16CentralSoundmap for this article's interactive map.

Interstate 405 Corridor Capacity Analysis

Annual SOV person miles traveled

2013 vs. 2015
1,147 vs. 1,137
in millions of miles
0.9% ↓

Annual SOV vehicle delay[1]

2013 vs. 2015
2,082 vs. 2,549
in thousands of hours
22% ↑

Annual SOV GHG emissions

2013 vs. 2015
961.8 vs. 919.1
in millions of pounds of CO_2 equivalents
4.4% ↓

Annual passenger miles traveled on transit

2013 vs. 2015
18.1 vs. 19.7
in millions of miles
8.8% ↑

Capacity savings due to transit

2013 vs. 2015
0.4 vs. 0.5
in number of lanes
25% ↑

Percent transit seats occupied

2013 vs. 2015
67% vs. 66%
on average during peak periods
1% ↓

Percent park and ride spaces occupied

2013 vs. 2015
93% vs. 101%
on average during peak periods
8% ↑

Corridor summaries provided in the *Corridor Capacity Report* examine calendar year data from January to December of 2013 and 2015. The I-405 express toll lane before and after analysis on pp. 19-20 examines more recent data available for the tolled section of I-405 through June 2016.

The I-405 corridor saw a 22% increase in annual delay for SOV drivers between 2013 and 2015. Much like I-5, congestion on this corridor began to see an increase as the region's economy rebounded and more people moved outside of major urban centers to find affordable housing. Much of the delay on this corridor can be attributed to a lack of capacity, as there are now more drivers traveling on I-405 at the same time.

The largest delays occur on the south end of the I-405 corridor near interchanges with SR 167, SR 169 and I-90 (see graph on p. 16). Traffic waiting to merge onto these heavily congested intersecting highways often backs up onto I-405, resulting in increased delays for all drivers.

Are the express toll lanes a contributing factor for the 22% delay increase?

The 22% increase refers to the entire I-405 corridor, stretching between Tukwila and Lynnwood. Delay is calculated using traffic data from the SOV lanes on I-405 from all weekdays in 2013 and 2015. WSDOT activated new express toll lane systems between Bellevue and Lynnwood on September 27, 2015. While there are still delays on I-405 between Bellevue and Lynnwood, this area is not the sole contributing factor for the increase in delay for the entire I-405 corridor.

See Appendix pp. 5-21 for more commute routes

Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[2] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2013	2015	2013	2015
Everett to Bellevue	662	745	82%	95%
Lynnwood to Bellevue	847	1,018	77%	72%
Tukwila to Bellevue	818	780	72%	66%
Evening (3-6 p.m.)				
Bellevue to Everett	681	735	79%	88%
Bellevue to Lynnwood	666	888	71%	69%
Bellevue to Tukwila	811	737	70%	65%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Lynnwood-Bellevue commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Kingsgate (502)	106%	107%
Ash Way (1,022)	100%	106%
Kenmore area (693)	100%	101%
Canyon Park (302)	99%	99%
Bothell (220)	99%	98%
South Kirkland (783)	75%	98%
Brickyard (443)	82%	95%

Tukwila-Bellevue commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
South Bellevue (519)	100%	106%
Wilburton (186)	87%	99%
Renton Munipical[4] (150)	87%	99%
Renton (150)	96%	97%
Newport Hills (275)	84%	84%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for SOV trips only on the I-405 corridor between Tukwila and Lynnwood. See travel time information on p. 17. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Transit travel times by bus may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel to stops. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 3 Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic. 4 The Renton Municipal park and ride was reduced from 200 to 150 spaces on January 1, 2015.

I-405 facilitates over 1.1 billion miles traveled in 2015

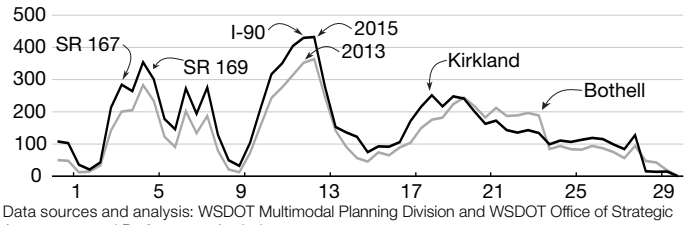
Interstate 405 (I-405) is one of the key commute and economic corridors in the central Puget Sound region and runs parallel to I-5 between Tukwila and Lynnwood. Over 1.1 billion person miles were traveled in 2015, a 0.9% decrease from 2013. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; the I-405 corridor in the central Puget Sound region is served by high occupancy vehicle (HOV) lanes, transit and, as of September 27, 2015, express toll lanes. The HOV lane at Newcastle on this corridor moved nearly two times as many people as each adjacent single occupancy vehicle (SOV) lane.

Despite these efficiencies, traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing severe congestion on a daily basis. Delay increased 22% on I-405 between Tukwila and Lynnwood. To learn why delay and miles traveled do not increase hand in hand, see p. 5. Corridor segments near State Route (SR) 169 in Renton, the I-90 interchange and the Kirkland area contributed to the significant delay increases in 2015 compared to 2013. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington, as trucks accounted for 5% of the total daily traffic volume on the corridor in 2015. The greenhouse gas (GHG) emissions on I-405 decreased by 4.4% in 2015 compared to 2013.

Corridor delay: In 2015, the I-405 corridor in the central Puget Sound region between Tukwila and Lynnwood experienced vehicle delay northbound near SR 169 (in Renton) and southbound at the I-90 interchange, while the Kirkland-Bothell area experienced congestion in both directions. Vehicle delay along the I-405 corridor was higher at most locations in 2015 than in 2013; the magnitude of the difference varied depending on the location and direction of travel (see graphs below). The amount of delay significantly increased between 2013 and 2015 at specific locations on the I-405 corridor including: northbound at the SR 167 interchange in Renton (up 38%), southbound at the I-90 interchange (up 23%), and in both directions in the Kirkland-Bothell area (up 2%). Closer observation of the line graph below shows the shift in location and change in magnitude of the delay that occurred in the Kirkland-Bothell area. The heatmap graph at the bottom of the page shows the intensity of delay by the time of day and location in 2015.

Delay along the I-405 corridor by milepost

2013 and 2015; Northbound and southbound combined; Average daily vehicle hours of delay



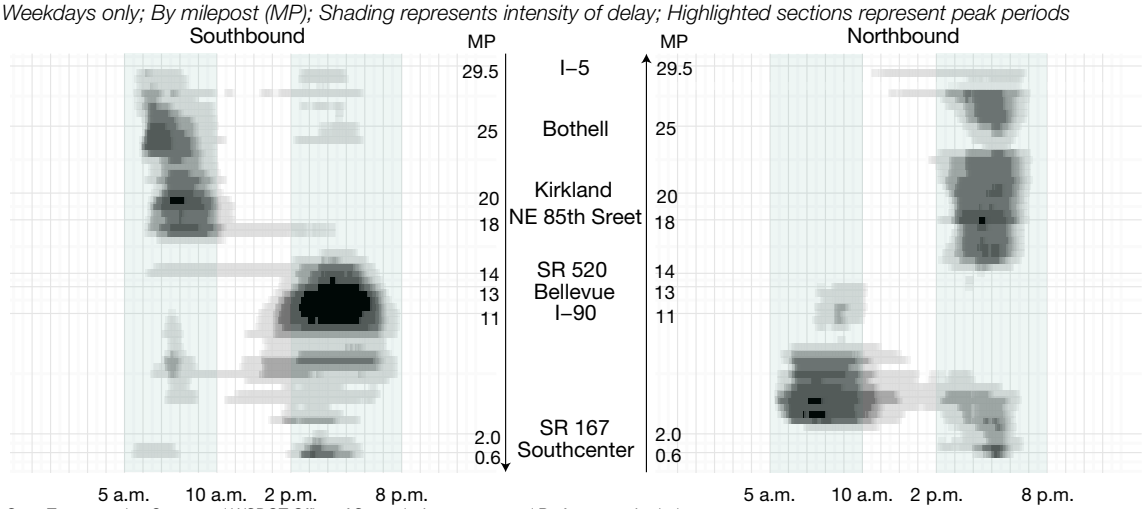
Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: The percent of days the Bellevue to Tukwila commute operated in severely congested (36 mph or below) condition worsened between 2013 and 2015 (see severe congestion chart at top of p. 17). For example, at 3:15 p.m. during the evening commute, the percent of days speeds were below 36 mph worsened from 89% in 2013 to 97% in 2015.

I-405 delay between Tukwila and the Lynnwood I-5/I-405 interchange

2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on northbound I-405, the most delay occurred during the morning peak period north of the SR 167 interchange. There were pockets of delay from SR 520 to I-5 during the evening commute. On southbound I-405, the most delay extended from SR 520 past I-90, and lasted from 3-6:30 p.m. There was also delay during the morning commute from I-5 past Kirkland. For both directions on I-405, at certain locations delay lasted for most of the peak periods.

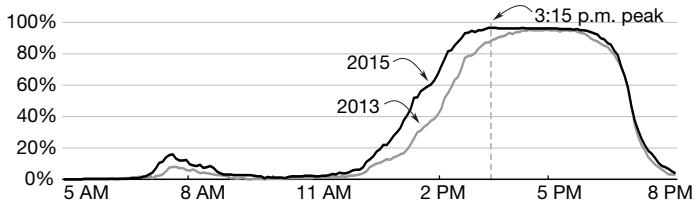


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Commutes into Bellevue experience routine congestion

Severe congestion on the Bellevue to Tukwila commute

2013 and 2015; Southbound; Percent of days the average speed was slower than 36 mph

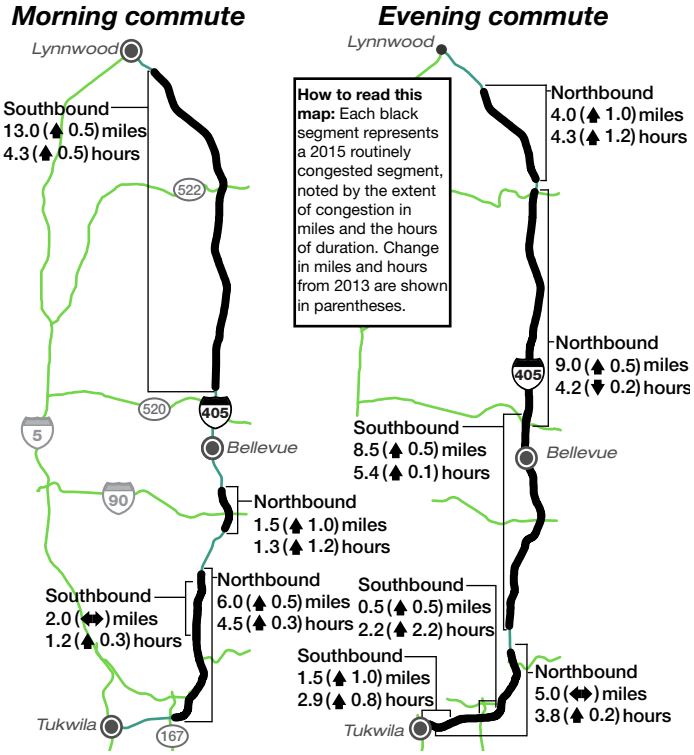


Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-405 in the central Puget Sound region, WSDOT analyzed vehicle throughput at two locations: near SR 169 in Renton, and at NE 160th Street in Kirkland. In 2013 and 2015, productivity at these locations ranged from 36% to 87% at their most congested. The graph above right shows how productivity varies in Renton by direction of travel, location and time of day.

Routinely congested segments of I-405

2015; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013).

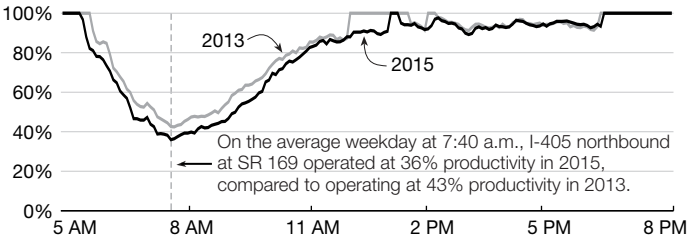


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

Throughput productivity on northbound I-405 at SR 169 near Renton

2013 and 2015; Based on the highest observed 5-minute flow rate; Northbound = 1,670 vehicles per hour per lane = 100%

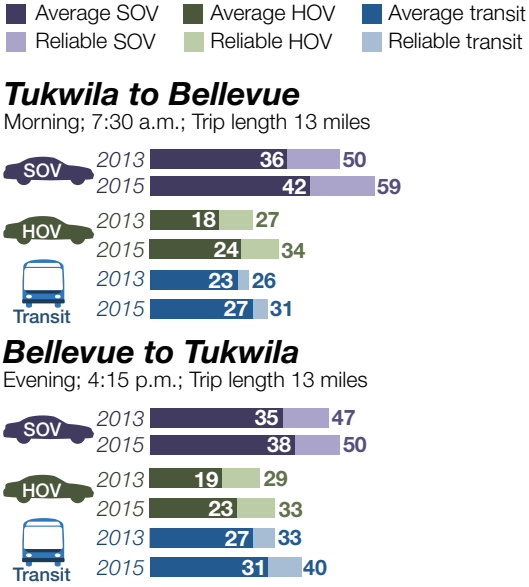


Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments: Of the 58-mile I-405 corridor between Tukwila and Lynnwood, the segments leading to Bellevue (in both directions) experienced significant routine congestion. Overall, the locations where routine congestion occurred increased by 5.5 miles between 2013 (46.5 miles) and 2015 (52 miles), while the amount of time of routine congestion increased by 20% (see map below left).

Commute travel times

2013 and 2015 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[1] travel times for single occupant vehicle (SOV), high occupancy vehicle (HOV) and transit[2] trips.



Data sources and analysis: Washington State Transportation Center, Sound Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: In the fall of 2015, WSDOT deployed express toll lanes on I-405 between Bellevue and Lynnwood. Please see the special report on pp. 19-20. For detailed quarterly reports, see www.wsdot.wa.gov/tolling/405/library.htm. 1 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). 2 Transit travel times by bus may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel to stops. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV.

More than 90% of I-405 park and ride lots are at capacity

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: Capacity constraints impacted the entire I-405 corridor between Tukwila and Lynnwood, but specifically near SR 169 in Renton and the I-90 interchange. This resulted in slower average and reliable travel times during the morning and evening peak periods. The average travel time for I-405 commutes between Tukwila and Bellevue increased by up to six minutes (from 36 minutes to 42 minutes for the morning Tukwila to Bellevue commute) in 2015 compared to 2013. The largest increase in reliable travel time was also on the morning Tukwila to Bellevue commute, an increase of nine minutes (18%). For travel time information on the commutes between Lynnwood and Bellevue, where the new express toll lanes were implemented mid-2015, see pp. 19-20 or quarterly performance reports at www.wsdot.wa.gov/tolling/405/library.htm.

The morning Tukwila to Bellevue commute has the highest maximum throughput travel time index (MT^3I) of the commutes tracked on I-405. The route's MT^3I of 2.60 means the commute takes more than two and a half times as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes.

Transit trip travel times: On I-405, transit and managed lanes such as the new express toll lanes (which opened in September 2015) and HOV lanes allow people to bypass highway capacity constraints in the corridor's SOV lanes. For the 2015 morning commute from Tukwila to Bellevue, the average and reliable transit travel times were 27 and 31 minutes, respectively. This is four minutes slower than the average (23 minutes) and five minutes slower than the reliable (26 minutes) transit travel times in 2013. The reliable transit travel time was 28 minutes faster than the reliable SOV travel time (59 minutes) and the average transit travel time was 15 minutes faster than the SOV average (42 minutes). See p. 15 for a comparison of transit trips to SOV and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved approximately 5,310 riders during the peak periods on an average weekday in 2015, an 11% increase from 2013 (about 4,780 riders). Transit passenger miles traveled increased by about 8.8% in the same time period.

Why did ridership go up and utilization go down?

On the I-405 corridor map on p. 15, ridership grew on two commutes while the percent of seats occupied decreased. This occurred because new bus trips were added between 2013 and 2015.

For example, six trips were added on the Lynnwood to Bellevue morning commute, increasing total seating from 1,096 to 1,408 while ridership grew from 847 to 1,018. As a result, utilization decreased from 77.3% to 72.3%.

Transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the I-405 corridor in the central Puget Sound region was equal to approximately half of an extra lane of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Transit on I-405 commutes during the morning and evening peak periods in 2015 operated between 29% and 95% of seating capacity. Of the 169 daily transit trips during the peak periods, 30 were over 90% of seating capacity on a typical weekday. Transit use during peak periods avoided roughly 37,000 pounds of GHG emissions per day on the I-405 central Puget Sound corridor in 2015, an 11% improvement compared to 2013 (33,200 pounds).

Park and ride: Along the I-405 corridor in the central Puget Sound region in 2015, park and ride (P&R) utilization rates ranged from 84% to 107% depending on the location, with 11 out of 12 having utilization rates at or above 95%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Commuters making roundtrips between Tukwila and Bellevue on I-405 experienced costs due to congestion in the central Puget Sound region. For example, the 27-mile roundtrip between Tukwila and Bellevue cost commuters over $2,750 in 2015 due to congestion (measured in wasted time and gas for travel below maximum throughput speed).

Before and After Analysis of I-405 Express Toll Lanes

Express toll lanes open in September 2015

WSDOT opened the Interstate 405 (I-405) express toll lanes (ETLs) on September 27, 2015, between Bellevue and Lynnwood. The ETLs provide a more reliable trip for transit, vanpools and carpools while providing a choice for solo drivers to pay a toll for a faster trip. This creates a more sustainable solution for moving people and goods on the I-405 corridor.

The ETLs on I-405 span over 17 miles between Northeast 6th Street in Bellevue and I-5 in Lynnwood. There are two ETLs in each direction between Bellevue and Bothell, and one ETL in each direction between Bothell and I-5 in Lynnwood (see graphic at top of p. 20).

Tolling on I-405 is in effect on weekdays from 5 a.m. to 7 p.m. WSDOT defines the peak periods for the I-405 ETLs as 5-9 a.m. and 3-7 p.m., as this is when there is the greatest strain on the corridor's capacity. The legislatively defined performance measures for the ETLs in RCW 47.56.880 require a review of peak period performance. This before and after analysis looks at the most recent quarter's data, spring (April to June) 2016, and compares it to the spring quarter of 2015.

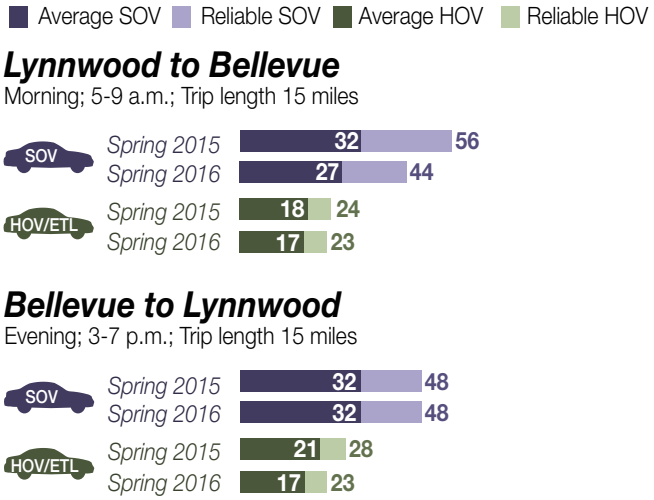
I-405 express toll lanes provide faster, more predictable trips

Once implemented, ETLs improved the average speed and reliability of the high occupancy vehicle (HOV) lanes along with most areas of the single occupancy vehicle (SOV, or general purpose) lanes. SOV lane average travel times improved by five minutes in the morning from Lynnwood to Bellevue when comparing spring 2015 to spring 2016, while reliable travel times improved by 12 minutes. Average and reliable travel times for the reverse SOV commute in the evening from Bellevue to Lynnwood remained approximately the same after express lane tolling began, mostly due to a pre-existing lack of capacity at this location where five lanes narrow to three lanes near Bothell.

Average travel times in the ETLs improved for both the morning and evening peak commutes after tolling began. Morning commuters in the southbound I-405 ETLs saved one minute in spring 2016 compared to spring 2015, while reliable travel times improved by one minute. Evening commuters in the northbound ETLs saw a time savings of four minutes on average, along with a five minute improvement in reliable travel time after tolling began.

Commute travel times

Spring 2015 and spring 2016 during the morning (5-9 a.m.) and evening (3-7 p.m.) peak periods; Weekday travel times in minutes including average and reliable travel times for SOV & HOV/ETL trips. The full length of the ETL corridor is 17 miles; the length of the measured trip is indicated below.



Volumes consistently higher post-tolling

Along with improved travel times, corridor-wide throughput has increased since ETL implementation. Traffic volumes were measured at four locations in both the northbound and southbound directions for all lanes of traffic. Every location saw a combined increase in peak period volumes between spring 2015 and spring 2016. The increase in peak period volumes ranged from 1% to 20%, as shown in the table below. Although the improvement in the two-lane section (see p. 20 graphic) can be partially attributed to added capacity, the performance improvement in the

I-405 volumes increase overall after tolling

Volume percentage changes during peak periods (5-9 a.m. and 3-7 p.m.) from spring 2015 to spring 2016

	SB morning peak period			NB evening peak period		
I-405 location	**SOV**	**HOV**	**Total**	**SOV**	**HOV**	**Total**
SR 527	1%	35%	7%	-3%	14%	1%
SR 522	1%	34%	10%	-7%	35%	4%
NE 100th	-7%	117%	16%	-10%	143%	17%
NE 53rd	-3%	132%	20%	-6%	127%	17%

Data source: WSDOT Tolling Division.
Note: See locations in the graphic on p. 20.

Express toll lanes continue to show improvement

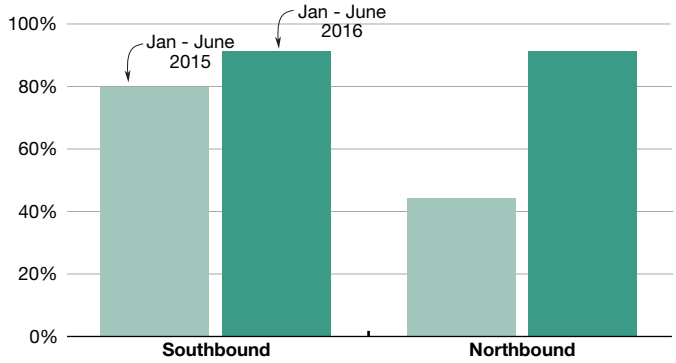
single lane section (SR 527 and SR 522) indicates the overall system is functioning better than before tolling.

Express toll lanes meeting 45 mph performance standard as of June 2016

Prior to introducing ETLs, the HOV lanes on I-405 were not meeting the legislatively mandated HOV lane speed requirements of 45 mph or faster 90% of the time during the peak travel periods. During the first six months of 2015, prior to the introduction of ETLs, the HOV lanes were moving at 45 mph or more for about 80% of the time southbound and 44% of the time northbound during the peak periods. After nine months of operation, the express toll lane speeds met or exceeded 45 mph 90% of the time in both directions when measured corridor-wide and averaged over six months as the Federal Highway Administration directs (see graph below).

ETL performance improves since fall 2015 introduction

January through June 2015 and January through June 2016 ; Percent of peak period when ETL speeds are greater than 45 mph

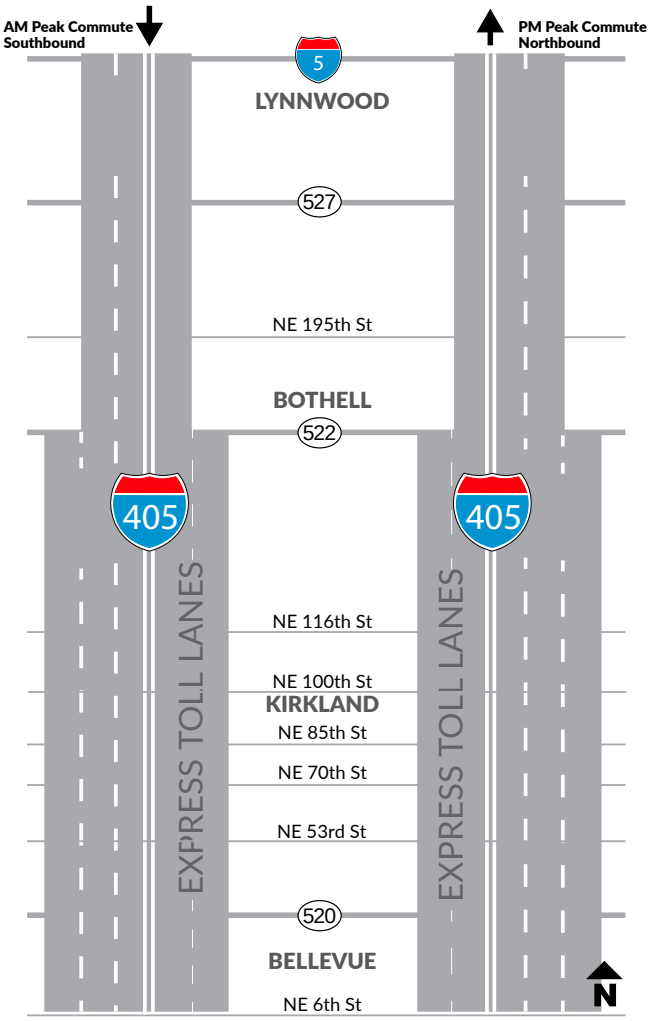


Data source: WSDOT Tolling Division.

Note: This performance measure is compiled for six-month periods per the Federal Highway Administration's direction.

At the same time, more drivers are choosing to use the express toll lanes. This causes toll rates to reach the $10 maximum more often and for longer durations. Frequently speeds drop below 45 mph at the maximum toll rate if drivers continue to enter the lane (paying the maximum rate). WSDOT will continue to monitor this trend and make adjustments as necessary.

Overall, SOV peak period speeds on I-405 increased by 6 mph in the southbound and no change in the northbound direction, when compared to spring 2015 speeds. ETL speeds increased by 3 mph in the morning peak direction and 10 mph in the evening.



Operational enhancements ongoing to further improve I-405

WSDOT has listened to and acted upon driver feedback by making over a dozen operational improvements to the ETLs, including longer access points, additional signage and pavement markings, tolling algorithm changes to improve system reliability, and opening the lanes to all motorists during nights and weekends. As of March 18, 2016, tolling hours are 5 a.m. to 7 p.m. on weekdays only.

The I-405 Master Plan calls for two-lane express toll lanes extending the length of the corridor, but currently funding is unavailable for that project. Alternative short-term solutions are being implemented to help alleviate traffic at that point, including using the shoulder as a lane during peak periods. This will be the first project funded through I-405 ETL toll revenue, projected to start by early 2017. See www.wsdot.wa.gov/Projects/I405 for more information.

Visit bit.ly/CCR16CentralSoundmap for this article's interactive map.

State Route 520 Corridor Capacity Analysis

Annual SOV person miles traveled
2013 vs. 2015: 238.8 vs. 248.9 in millions of miles — ▲ 4.2%

Annual SOV vehicle delay[1]
2013 vs. 2015: 147.2 vs. 213.5 in thousands of hours — ▲ 45%

Annual SOV GHG emissions
2013 vs. 2015: 218.9 vs. 221.3 in millions of pounds of CO_2 equivalents — ▲ 1.1%

Annual passenger miles traveled on transit
2013 vs. 2015: 37.9 vs. 40.7 in millions of miles — ▲ 7.4%

Capacity savings due to transit
2013 vs. 2015: 1.4 vs. 1.5 in number of lanes — ▲ 7.1%

Percent transit seats occupied
2013 vs. 2015: 57% vs. 68% on average during peak periods — ▲ 11%

Percent park and ride spaces occupied
2013 vs. 2015: 86% vs. 94% on average during peak periods — ▲ 8%

Commute travel times

See Appendix pp. 5-21 for more commute routes

2013 and 2015 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for single occupant vehicle (SOV), high occupancy vehicle (HOV) and transit[3] trips.

Average SOV · Reliable SOV · Average HOV · Reliable HOV · Average transit · Reliable transit

Bellevue to Seattle
Morning; 8:35 a.m.; Trip length 10 miles

	2013	2015
SOV	15 / 21	19 / 28
HOV	14 / 18	16 / 22
Transit	20 / 23	20 / 26

Seattle to Bellevue
Evening; 5:05 p.m.; Trip length 10 miles

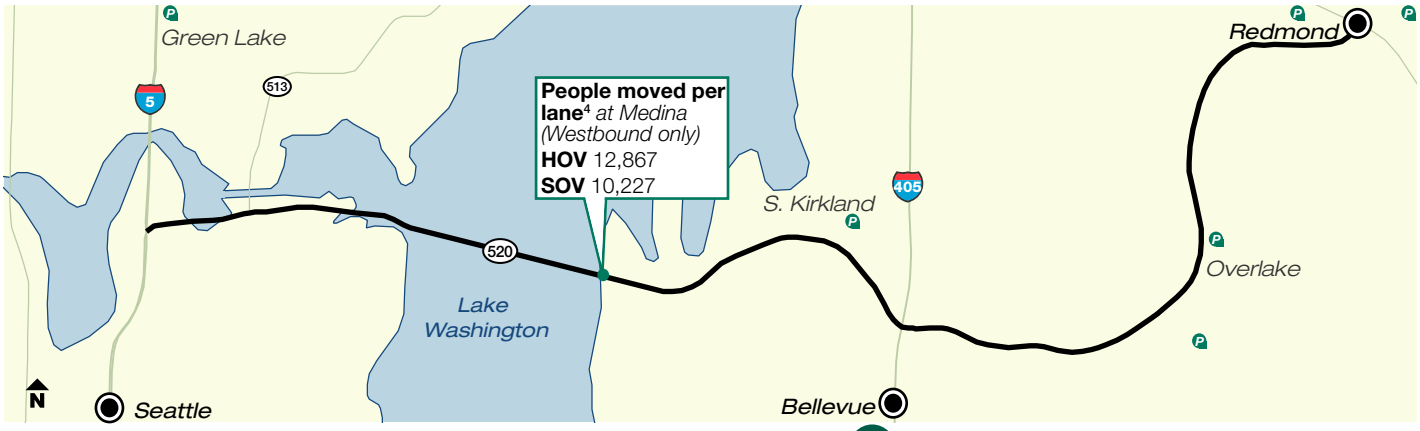
	2013	2015
SOV	18 / 25	18 / 26
HOV		N/A
Transit	20 / 25	18 / 25

Redmond to Seattle
Morning; 8:30 a.m.; Trip length 13 miles

	2013	2015
SOV	18 / 25	22 / 33
HOV	18 / 23	20 / 26
Transit	28 / 33	29 / 35

Seattle to Redmond
Evening; 5:35 p.m.; Trip length 13 miles

	2013	2015
SOV	18 / 24	18 / 25
HOV	17 / 22	17 / 22
Transit	28 / 33	29 / 37



Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2013	2015	2013	2015
Redmond to Seattle	4,413	4,703	68%	87%
Seattle to Redmond	1,930	2,037	54%	57%
Bellevue to Seattle	973	1,038	60%	63%
Evening (3-6 p.m.)				
Seattle to Redmond	4,142	4,387	61%	80%
Redmond to Seattle	1,706	1,932	53%	63%
Seattle to Bellevue	1,106	904	61%	60%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Seattle-Bellevue commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Greenlake (411)	100%	102%
South Kirkland (783)	75%	98%

Redmond-Bellevue commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Overlake Transit Center (222)	100%	103%
Redmond (377)	100%	100%
Bear Creek (283)	100%	98%
Overlake (203)	42%	35%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for SOV trips only on the SR 520 corridor between Seattle and Redmond. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). 3 Transit travel times by bus may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 4 Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic.

Severe congestion starts early on evening trip into Seattle

State Route 520 (SR 520) is one of the key commute and economic corridors connecting I-5 and I-405 in the central Puget Sound region and runs parallel to I-90 across Lake Washington. Almost 249 million person miles were traveled on the corridor in 2015, a 4.2% increase over 2013, while greenhouse gas emissions increased by slightly over 1%. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; parts of the SR 520 corridor were served by transit and high occupancy vehicle (HOV) lanes in 2013 and 2015, although HOV lanes did not span the entire corridor. In 2015, HOV lanes in both directions between the floating bridge and I-405 were on the left side of the roadway in the direction of travel, while the HOV lanes east of I-405 were on the right side of the road, often interrupted by traffic merging onto SR 520. The SR 520 Evergreen Point Floating Bridge portion was tolled in both directions from 5 a.m. to 11 p.m. Tolling on the SR 520 bridge was implemented to fund the new floating bridge, which opened with an HOV lane in each direction in spring 2016. The westbound HOV lane at Medina on this corridor moved 26% more people in 2015 than each adjacent single occupancy vehicle (SOV) lane.

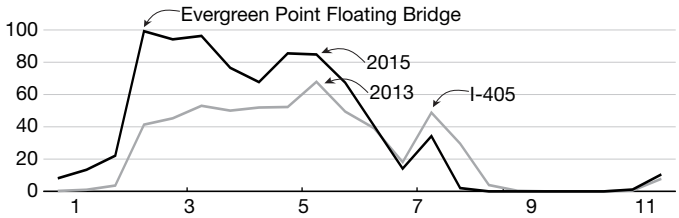
Despite this efficiency, traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing moderate to severe congestion on a daily basis. Delay increased by 45% on SR 520 between Seattle and Redmond. Corridor segments on the Evergreen Point Floating Bridge contributed to the significant delay increases in 2015 compared to 2013. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington as trucks accounted for 4% of the total daily traffic volume on the corridor in 2015.

Increases in delay on SR 520 can be attributed to the booming regional economy. SR 520 has two major destination points: I-5 and I-405, both of which are typically congested during the peak commute periods. Thus, traffic is slow to enter I-5 or I-405, which in turn increases delay on SR 520. Ongoing construction to replace the SR 520 bridge is also a factor, and affects the westbound evening commute in particular. WSDOT has completed construction on the new floating bridge and on SR 520 between Bellevue and Medina. This stretch of highway now includes two SOV lanes and one 3+ HOV lane in each direction. However, WSDOT has yet to replace SR 520 between the floating bridge and I-5. This stretch of highway only has two SOV lanes.

When traveling on westbound SR 520, drivers are forced to merge out of the 3+ HOV lane as they reach the end of the new floating bridge. This merge is the cause of congestion that affects westbound traffic during the evening commute. Delays on westbound SR 520 are further exacerbated as congestion on I-5 and Montlake increases, which slows the rate at which vehicles can exit SR 520.

Corridor delay: The SR 520 corridor in the central Puget Sound region between Seattle and Redmond experienced vehicle delay in 2015 at varying magnitudes depending on the location and direction of travel compared to 2013 (see graphs below). The amount of delay significantly increased between 2013 and 2015 in both directions on the Evergreen

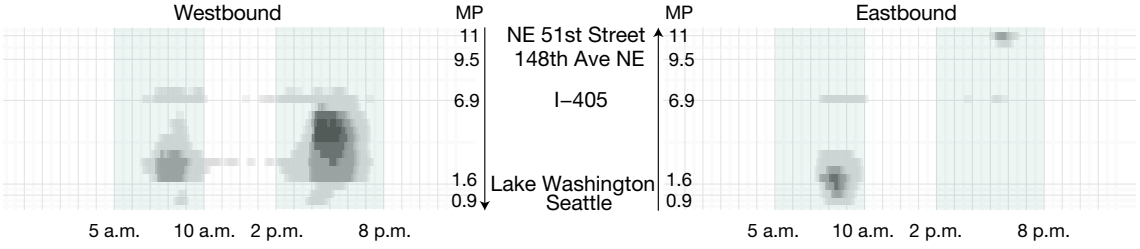
Delay along the SR 520 corridor by milepost
2013 and 2015; Eastbound and westbound combined; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

SR 520 delay between Seattle and Redmond
2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on eastbound SR 520, morning delay lasted from 7-10 a.m. On westbound SR 520, delay extended from the I-405 interchange to Seattle during the evening commute, with the most intense delay occuring from 4-6:30 p.m.



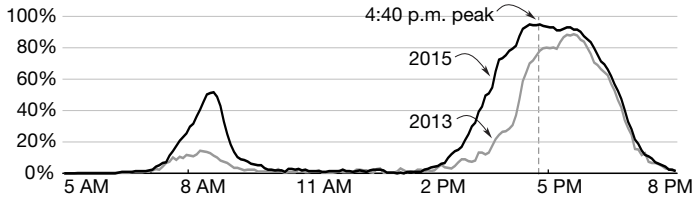
Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Westbound SR 520 sees daily congestion in 2015

Point Floating Bridge (up 64%), while delay decreased in the westbound direction near the I-405 interchange (down 51%). The heatmap graph at the bottom of p. 22 shows westbound delay between Lake Washington and I-405 increased both in intensity and duration. For a detailed 2013 and 2015 comparison see Appendix p. 14.

Severe congestion on the SR 520 Bellevue to Seattle commute

2013 and 2015; Westbound; Percent of days the average speed was slower than 36 mph

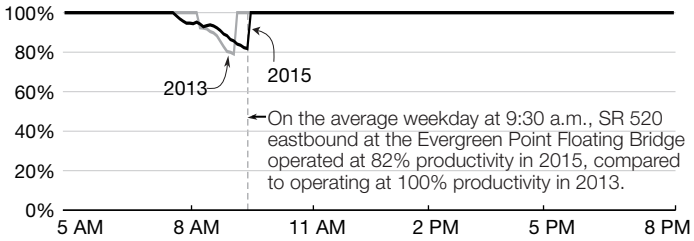


Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: Commuters driving between Bellevue and Seattle drove in severely congested conditions (36 mph or less) more often in 2015 than in 2013. Although severe westbound congestion ended around the same time in both 2013 and 2015, it started an hour earlier during the evening peak period in 2015. Between 3 p.m. and 6 p.m., most weekday commuters experienced speeds below 36 mph (see graph on the left). For example, at 4:40 p.m. during the evening commute from Bellevue to Seattle, the percent of days speeds were below 36 mph worsened from 78% in 2013 to 95% in 2015.

Throughput productivity on eastbound SR 520 at the Evergreen Point Floating Bridge

2013 and 2015; Based on the highest observed 5-minute flow rate; Eastbound = 1,630 vehicles per hour per lane = 100%

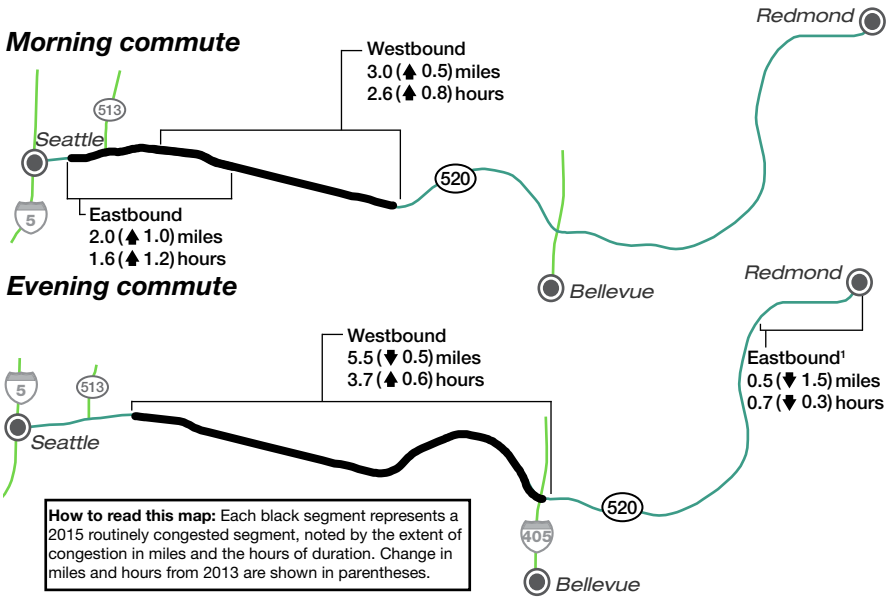


Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on SR 520 in the central Puget Sound region, WSDOT analyzed vehicle throughput at the Evergreen Point Floating Bridge across Lake Washington. In 2013 and 2015, productivity at this location ranged from 79% to 100% at its most congested (see graph above).

Routinely congested segments of SR 520

2015; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data. 1 Routinely congested segments that dropped below 50 minutes in duration in 2015 from 2013 are noted with text on the map, but are not shown with the bold segment lines.

Routinely congested segments: Of the approximately 26-mile SR 520 corridor between Seattle and Redmond (both directions), the segments on SR 520 between the I-5 and I-405 interchanges contributed to the most routine congestion. Overall, the locations where routine congestion occurred decreased by half a mile between 2013 (11.5 miles) and 2015 (11 miles), while the amount of time of routine congestion increased by 36%.

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: Capacity constraints impacted the SR 520 corridor between Seattle and Redmond specifically between the I-5 interchange in west Seattle and the I-405 interchange in Bellevue. This resulted in longer average and reliable travel times during the morning and evening

One fifth of daily SR 520 peak transit trips were full

peak periods. The average travel time for the morning SR 520 commute from Bellevue to Seattle increased by four minutes (up 27%) in 2015 compared to 2013 while reliable travel time increased by seven minutes (up 33%).

The Redmond to Seattle evening commute has the highest maximum throughput travel time index (MT^3I) of the 12 commutes tracked on SR 520 between Seattle, Bellevue and Redmond. The route's MT^3I of 2.43 means the commute takes more than twice as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes.

Why are some transit travel times slower than HOV?

On the SR 520 corridor map on p. 21, two commutes have average transit travel times which are nine to 12 minutes slower than HOV times. This is partially caused by buses pulling off the highway to multiple stops along their routes.

For example, on the Redmond to Seattle morning commute the Sound Transit 545 bus has five stops before it reaches downtown Seattle from Redmond.

Transit trip travel times: On SR 520, transit and managed lanes such as HOV lanes allow people to bypass highway capacity constraints in the corridor's SOV lanes. While the SR 520 corridor was served by HOV lanes for parts of its length, there were no HOV lanes on SR 520 across Lake Washington until the new bridge opened in 2016, minimizing benefits to transit at a key location on the corridor. For example, in 2015 the average and reliable transit travel times for the SR 520 commute from Redmond to Seattle in the morning were 29 and 35 minutes, respectively. This is one and two minutes slower than the average (28 minutes) and reliable (33 minutes) transit travel times in 2013. Average and reliable transit travel times were seven and two minutes slower than SOV average (22 minutes) and reliable (33 minutes) travel times for 2015. See p. 21 for a comparison of transit trips to SOV and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved roughly 17,450 riders during the morning and evening peak periods on an average weekday in 2015, a 7% increase from 2013 (16,340 riders). Similarly, daily transit passenger miles traveled increased by about 7.4% in 2015 (156,000 miles) compared to 2013 (145,200 miles). This increase in ridership occurred even while the number of transit trips during the peak period decreased. There were a total of 499 peak period transit trips during a typical weekday in 2015, down 56 from 2013. Restructures in transit service like this occurred throughout the central Puget Sound region between 2013 and 2015.

Transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the SR 520 corridor in central Puget Sound was equal to roughly 1.5 extra lanes of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Transit on SR 520 commutes during the morning and evening peak periods operated between 16% and 87% of total seating capacity in 2015. Of the 499 daily transit trips during the peak periods, 125 were over 90% of seating capacity on a typical weekday. Transit use during peak periods avoided approximately 74,300 pounds of GHG emissions per day on the SR 520 central Puget Sound corridor in 2015, a 12% increase compared to 2013 (66,600 pounds), corresponding to the increase in passenger miles traveled.

Park and ride: Along the SR 520 corridor in the central Puget Sound region in 2015, park and ride (P&R) utilization rates ranged between 35% and 103% depending on the location, with five out of six having utilization rates above 95%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Single occupant vehicle commuters making trips between Seattle and Redmond paid tolls to speed up the portion of the roundtrip across the Evergreen Point Floating Bridge. For the remaining 12-mile roundtrip east of the bridge (between Bellevue and Redmond), the additional cost due to congestion (measured in wasted time and gas for travel below maximum throughput speed) was $500 or less per passenger vehicle annually in 2015, depending on the direction of travel.

Visit bit.ly/CCR16CentralSoundmap for this article's interactive map.

Interstate 90 Corridor Capacity Analysis

Annual SOV person miles traveled

2013 vs. 2015: 500.7 vs. 499.7 in millions of miles — ▼ 0.2%

Annual SOV vehicle delay[1]

2013 vs. 2015: 251.3 vs. 299.9 in thousands of hours — ▲ 19%

Annual SOV GHG emissions

2013 vs. 2015: 614.1 vs. 591.1 in millions of pounds of CO_2 equivalents — ▼ 3.7%

Annual passenger miles traveled on transit

2013 vs. 2015: 36.9 vs. 39.2 in millions of miles — ▲ 6.2%

Capacity savings due to transit

2013 vs. 2015: 1.2 vs. 1.3 in number of lanes — ▲ 8.3%

Percent transit seats occupied

2013 vs. 2015: 79% vs. 92% on average during peak periods — ▲ 13%

Percent park and ride spaces occupied

2013 vs. 2015: 99% vs. 100% on average during peak periods — ▲ 1%

Commute travel times

See Appendix pp. 5-21 for more commute routes

2013 and 2015 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for single occupant vehicle (SOV), high occupancy vehicle (HOV) and transit[3] trips.

Average SOV | Reliable SOV | Average HOV | Reliable HOV | Average transit | Reliable transit

Bellevue to Seattle

Morning; 8:20 a.m.; Trip length 10 miles

	2013	2015
SOV	18 / 26	19 / 28
HOV	14 / 18	15 / 21
Transit	28 / 30	29 / 34

Seattle to Bellevue

Evening; 5:25 p.m.; Trip length 11 miles

	2013	2015
SOV	17 / 28	15 / 22
HOV	12 / 18	11 / 17
Transit	26 / 30	26 / 30

Issaquah to Seattle

Morning; 7:55 a.m.; Trip length 15 miles

	2013	2015
SOV	29 / 41	29 / 43
HOV	18 / 22	20 / 26
Transit	26 / 27	26 / 31

Seattle to Issaquah

Evening; 5:30 p.m.; Trip length 16 miles

	2013	2015
SOV	23 / 34	22 / 32
HOV	17 / 22	15 / 20
Transit	27 / 30	25 / 28

Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2013	2015	2013	2015
Issaquah to Seattle	3,475	3,495	82%	105%
Bellevue to Seattle	2,182	2,512	85%	97%
Issaquah to Bellevue	282	331	69%	71%
Evening (3-6 p.m.)				
Seattle to Issaquah	3,002	3,129	78%	97%
Seattle to Bellevue	2,280	2,437	84%	94%
Bellevue to Seattle	876	990	84%	90%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Seattle-Bellevue commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
South Bellevue (519)	100%	106%
Mercer Island (447)	100%	100%

Issaquah-Bellevue commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Eastgate (1,614)	99%	100%
Issaquah Transit Center (819)	99%	99%
Issaquah Highlands (1,010)	98%	99%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for the I-90 corridor between Seattle and Issaquah for SOV trips only. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). 3 Transit travel times by bus may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 4 Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic.

Westbound delay on the rise on I-90 floating bridge

Interstate 90 (I-90) is one of the key commute and economic corridors connecting I-5 and I-405 in the central Puget Sound region and runs parallel to SR 520 across Lake Washington. The I-90 floating bridge is the non-tolled alternative to SR 520 across Lake Washington. Around 500 million person miles were traveled on the corridor in 2015 and 2013. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; parts of the I-90 corridor are served by high occupancy vehicle (HOV) lanes and transit. The HOV lanes on the floating bridge west of Mercer Island and in Issaquah move 8% and 39% more people than each adjacent single occupancy vehicle (SOV) lane.

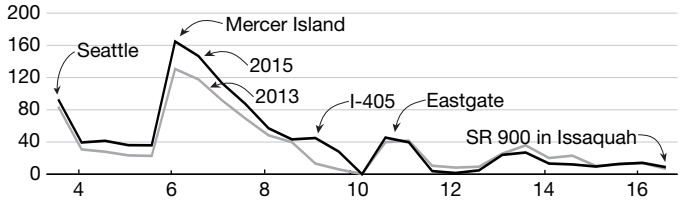
Despite this efficiency, traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing moderate to severe congestion on a daily basis. Delay increased by 19% on I-90 between Seattle and Issaquah, also affected by the region's economic boom. Much like SR 520, traffic on this corridor is heavily influenced by congestion on the major north/south routes: I-5 and I-405. These routes are primary destinations for a large number of drivers. If I-5 and I-405 are congested, traffic will back up onto I-90 resulting in delays for through traffic. Westbound corridor segments on Mercer Island and eastbound segments near I-405 contributed to the delay increases in 2015 compared to 2013. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington as trucks accounted for 6% of the total daily traffic volume on the corridor in 2015. The corridor-wide greenhouse gas (GHG) emissions decreased by approximately 3.7% in 2015 compared to 2013.

Corridor delay: The I-90 corridor in the central Puget Sound region between Seattle and Issaquah experienced vehicle delay in 2015 at varying magnitudes compared to 2013 depending on the location and direction of travel (see graph above and at bottom of page). The amount of delay significantly increased between 2013 and 2015 at specific locations on the westbound I-90 corridor including: Eastgate (up 1%), Mercer Island (up 27%) and the floating bridge (up 53%). The amount of delay in 2015 on eastbound I-90 approaching I-405 increased significantly compared to 2013, but this was due to speeds being just below the delay threshold of 50 mph. The heatmap graph at the bottom of the page shows that eastbound delay is less intense than in the westbound direction.

A focus on hot spots: Commuters driving between Bellevue and Seattle via I-90 drove in severely

Delay along the I-90 corridor by milepost

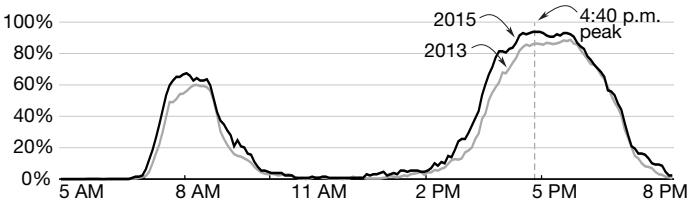
2013 and 2015; Eastbound and westbound combined; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

Severe congestion on the I-90 Bellevue to Seattle commute

2013 and 2015; Westbound; Percent of days the average speed was slower than 36 mph

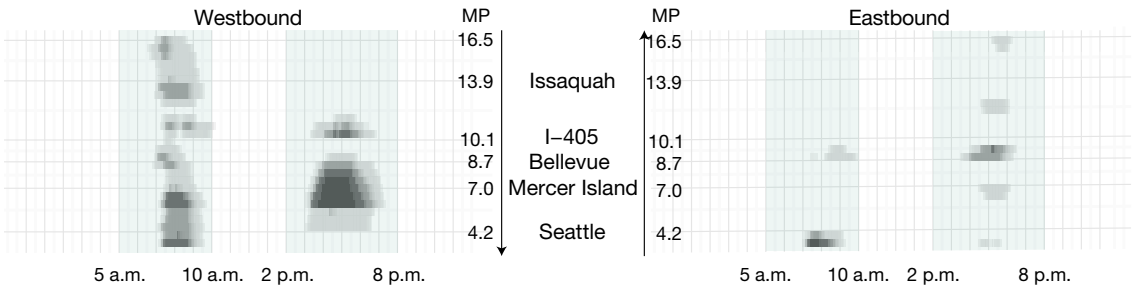


Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

I-90 delay between Seattle and Issaquah

2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on eastbound I-90, there were pockets of delay during both peak periods from Seattle to Issaquah. On westbound I-90, morning delay extended along the entire corridor. Delay during the evening commute extended from the I-405 interchange to Seattle, with the most intense delay occurring from 3-6 p.m.



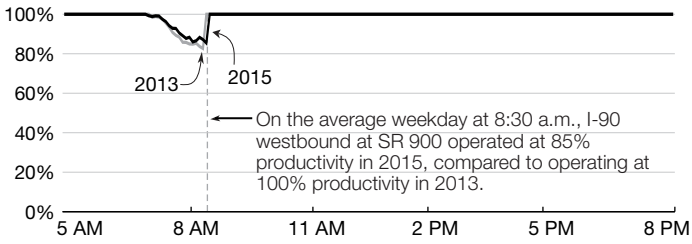
Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

I-90 capacity more constrained in westbound direction

congested conditions (36 mph or less) more often in 2015 than in 2013. Between 3-6 p.m., most weekday commuters experienced speeds below 36 mph (see congestion graph on p. 26). For example, at around 4:40 p.m. during the evening commute from Bellevue to Seattle, the percent of days speeds were below 36 mph worsened from 86% in 2013 to 94% in 2015.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-90 in the central Puget Sound region, WSDOT analyzed vehicle throughput at SR 900 near Issaquah. In 2013 and 2015, productivity at this location ranged from 83% to 100% at its most congested (see throughput graph below left).

Throughput productivity on westbound I-90 at SR 900
2013 and 2015; Based on the highest observed 5-minute flow rate; Westbound = 1,570 vehicles per hour per lane = 100%



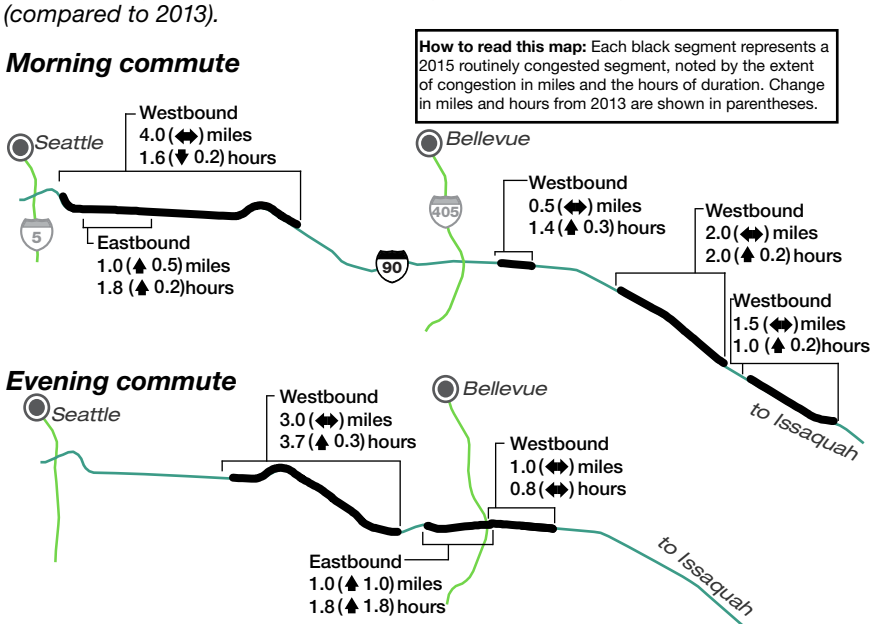
Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments: Of the approximately 30-mile I-90 corridor between Seattle and Issaquah (both directions), the segments on the I-90 floating bridge, Mercer Island and in the Eastgate area contribute to the most routine congestion. Overall, the locations where routine congestion occurred remained the same at 15 miles for 2013 and 2015, while the amount of time of routine congestion increased by 17%.

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: Capacity constraints impacted the I-90 corridor between Seattle and Issaquah specifically in the westbound direction near Mercer Island and the Eastgate area. This resulted in increased average and reliable travel times during the morning and evening peak periods. The average travel time for the morning I-90 commute from Bellevue to Seattle increased by one minute (up 6%) in 2015 compared to 2013 while reliable travel time increased by two minutes (up 8%). On the other hand, the average travel time for the evening commute from Seattle to Bellevue improved by two minutes (down 12%) in 2015 compared to 2013 while reliable travel time improved by six minutes (down 21%).

Routinely congested segments of I-90
2015; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.
Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

Transit trip travel times: On I-90, transit and managed lanes—such as the reversible express lane or HOV lanes—allow people

The Bellevue to Seattle evening commute has the highest maximum throughput travel time index (MT^{3}I) of the 12 commutes tracked on I-90 between Seattle, Bellevue and Issaquah. The route's MT^{3}I of 2.49 means the commute takes nearly two and a half times as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes. In contrast, the Issaquah to Seattle morning commute and the reverse evening commute take 59% and 16% longer than they should.

I-90 park and rides experience frequent spillovers

to bypass highway capacity constraints in the corridor's SOV lanes. However, the I-90 corridor does not have HOV lanes for its full length, including part of the floating bridge, which minimizes benefits of taking transit at a key location on the corridor. For example, in 2015 the average and reliable transit travel times for the I-90 commute from Issaquah to Seattle in the morning were 26 and 31 minutes, respectively. This is the same average transit travel time as in 2013, while the reliable transit travel time slowed by four minutes. In 2015, average and reliable transit travel times proved to be faster than corresponding SOV travel times by 3 and 12 minutes, respectively. See p. 25 for a comparison of transit trips to SOV and HOV trips.

Why are some transit travel times slower than HOV?

On the I-90 corridor map on p. 25, three commutes have average transit travel times 10 to 15 minutes slower than HOV times. This is largely caused by buses pulling off the highway to multiple stops along their routes.

For example, on the Seattle to Bellevue evening commute the Sound Transit 550 bus exits I-90 onto Bellevue Way SE, a major arterial, rather than I-405 to reach seven stops before Bellevue Transit Center.

Transit ridership and GHG emissions avoided: Transit moved roughly 15,060 riders on the I-90 corridor during the morning and evening peak periods on an average weekday in 2015, a 7% increase from 2013 (about 14,090 riders). Similarly, daily transit passenger miles traveled increased by approximately 6.2% in 2015 (150,140 miles) compared to 2013 (141,410 miles).

Increased transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the I-90 corridor in the central Puget Sound region was equal to more than one extra lane's worth of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Transit on I-90 commutes during the morning and evening peak periods operated between 59% and 105% of total seating capacity in 2015. Overall utilization of transit capacity increased 13 percentage points between 2013 and 2015. This is partially due to increases in ridership but also because seating capacity decreased on several routes at the same time. The decrease in seating capacity occurred because of a service restructure which reduced the number of bus trips on the I-90 corridor between 2013 and 2015. For example, on the Issaquah to Seattle morning commute ridership increased from 3,475 to 3,495 (less than 1%) while available seating decreased from 4,258 to 3,320 (down 22%). This resulted in an increase in the percent of seats used from 82% to 105%. Of the 284 daily transit trips during the peak periods, more than half were over 90% of seating capacity on a typical weekday.

Transit use during peak periods avoided roughly 76,100 pounds of GHG emissions per day on the I-90 central Puget Sound corridor in 2015, an 11% improvement compared to 2013 (68,600 pounds).

Park and ride: Along the I-90 corridor in the central Puget Sound region in 2015, park and ride (P&R) utilization rates ranged between 99% and 106% depending on the location. Any P&R lot that has 85% or more utilization is identified as operating at capacity. By this measure, all five P&R lots are operating at close to (or above) 100% of the existing capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Commuters making roundtrips on I-90 between Seattle and Bellevue, and Seattle and Issaquah experienced costs due to congestion. Each passenger vehicle making roundtrips between Seattle and Bellevue using I-90, the non-tolled, cross-lake alternative to SR 520, paid approximately $1,200 annually in 2015 due to congestion (measured in wasted time and gas for travel below maximum throughput speed).

Visit bit.ly/CCR16CentralSoundmap for this article's interactive map.

State Route 167 Corridor Capacity Analysis

Annual SOV person miles traveled
2013 vs. 2015: 301.3 vs. 305.7 in millions of miles — ▲ 1.5%

Annual SOV vehicle delay[1]
2013 vs. 2015: 185.8 vs. 290.0 in thousands of hours — ▲ 56%

Annual SOV GHG emissions
2013 vs. 2015: 260.8 vs. 259.4 in millions of pounds of CO_2 equivalents — ▼ 0.5%

Annual passenger miles traveled on transit
2013 vs. 2015: 13.4 vs. 14.3 in millions of miles — ▲ 6.7%

Capacity savings due to transit
2013 vs. 2015: 0.5 vs. 0.5 in number of lanes — ▬ 0%

Percent transit seats occupied
2013 vs. 2015: 58% vs. 56% on average during peak periods — ▼ 2%

Percent park and ride spaces occupied
2013 vs. 2015: 80% vs. 80% on average during peak periods — ▬ 0%

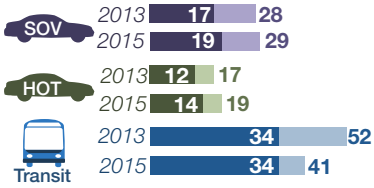
Commute travel times

2013 and 2015 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for single occupant vehicle (SOV), high occupancy vehicle (HOT) and transit[3] trips.

Average SOV | Average HOT | Average transit
Reliable SOV | Reliable HOT | Reliable transit

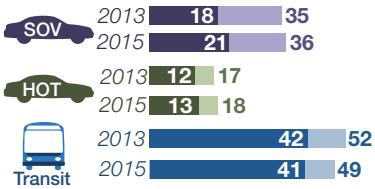
Auburn to Renton

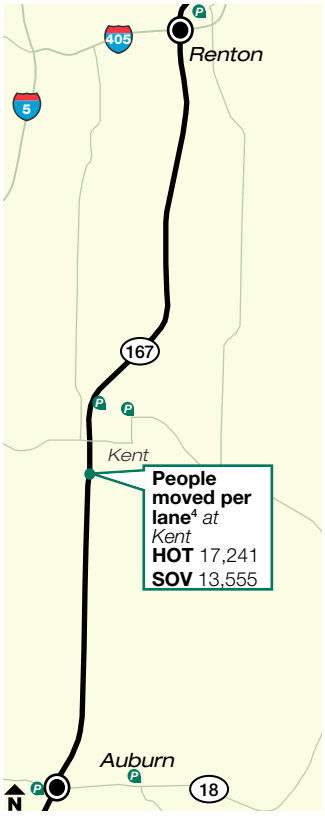
Morning; 7:20 a.m.; Trip length 10 miles



Renton to Auburn

Evening; 3:15 p.m.; Trip length 10 miles





Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	**2013**	**2015**	**2013**	**2015**
Auburn to Renton	2,435	2,892	53%	52%
Evening (3-6 p.m.)				
Renton to Auburn	2,840	2,945	62%	61%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations)

Auburn-Renton commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Auburn Station (633)	100%	100%
South Renton (373)	100%	100%
Kent area (996)	97%	98%
Renton (150)	96%	97%
Peasley Canyon (54)	93%	95%
Renton Municipal[5] (150)	87%	76%
Auburn (244)	67%	69%
Kent/James Street (713)	27%	28%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for SOV trips only on the SR 167 corridor between Auburn and Renton. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). 3 Transit travel times by bus may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 4 Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic. 5 Renton Municipal park and ride had 50 fewer spaces in 2015 than 2013.

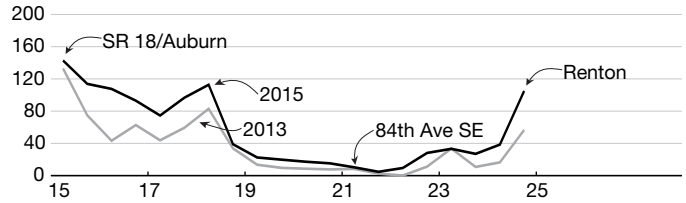
State Route 167 (SR 167) is one of the key commute and economic corridors in the central Puget Sound region and a virtual extension to Interstate 405 (I-405) south of the Tukwila/Renton area. More than 305 million person miles were traveled between Renton and Auburn in 2015, a 1.5% increase over 2013. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; the SR 167 corridor is served by Sounder commuter rail, transit buses, and high occupancy toll (HOT) lanes. The HOT lane (a high occupancy vehicle lane open to solo drivers who choose to pay a toll) at Kent on this corridor moves over 27% more people than each adjacent single occupancy vehicle (SOV) lane. Carpools of two or more, vanpools and buses use the HOT lanes toll-free. Toll rates adjust to ensure traffic in the HOT lane is free flowing even when the regular lanes are congested.

Despite these efficiencies, traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and

SR 167 experiences increased delay near Auburn and Renton

evening weekday commutes experiencing severe congestion on a daily basis. Delay increased 56% on SR 167 between Auburn and Renton. Corridor segments near the corridor endpoints in the two cities contributed to the significant delay increases in 2015 compared to 2013. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington as trucks accounted for 11% of the total daily traffic volume on the corridor in 2015. The greenhouse gas (GHG) emissions decreased by approximately 0.5% in 2015 compared to 2013.

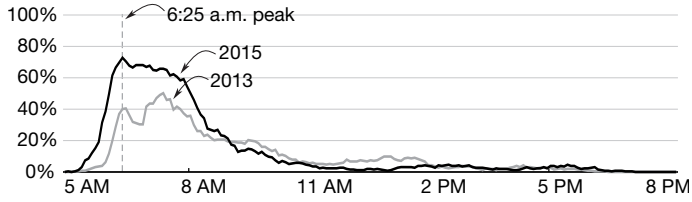
Delay along the SR 167 corridor by milepost
2013 and 2015; Northbound and southbound combined; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

Corridor delay: In 2015, the SR 167 corridor in the central Puget Sound region between Auburn and Renton experienced vehicle delay in both directions of travel in Auburn near SR 18 and northbound in Renton. Vehicle delay on the SR 167 corridor was higher in 2015 than in 2013 at varying magnitudes depending on the location and direction of travel (see graph above and below). This area of the central Puget Sound region has also seen delay increases as the region's economy has grown. More people are moving to this area to find more affordable housing, which results in more commuters using the highway. Traffic delays on SR 167 are influenced by delays on I-405 as well. The amount of delay increased between 2013 and 2015 at specific locations on the SR 167 corridor including: northbound in Renton near the I-405 interchange (up 102%), and in both directions near the SR 18 interchange in Auburn (up 51%). The heatmap graph at the bottom of the page shows the intensity of delay by the time of day and location in 2015.

Severe congestion on the SR 167 Auburn to Renton commute
2013 and 2015; Northbound; Percent of days the average speed was slower than 36 mph

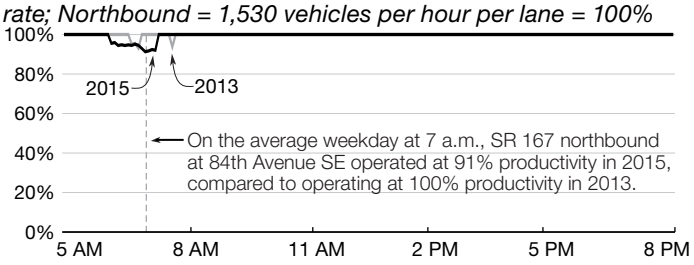


Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: Commuters driving on SR 167 drove in severely congested conditions (36 mph or less) more often in 2015 than in 2013. For example, at around 6:25 a.m. during the morning commute from Auburn to Renton, the percent of days speeds were below 36 mph worsened from 40% in 2013 to 73% in 2015. The chart above also shows that severe congestion peaked an hour earlier in 2015 compared to 2013.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads

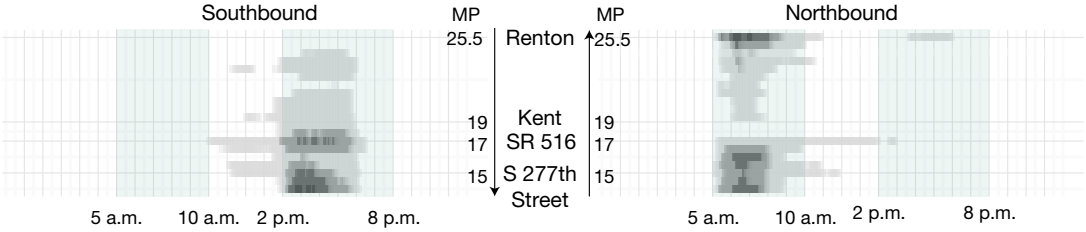
Throughput productivity on northbound SR 167 at 84th Avenue SE
2013 and 2015; Based on the highest observed 5-minute flow rate; Northbound = 1,530 vehicles per hour per lane = 100%



Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

SR 167 delay between Auburn and Renton
2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on northbound SR 167, delay lasted for the entire morning commute, with the most intense delay occurring between South 277th Streeth and SR 516. On southbound SR 167, delay extended along the entire corridor, with the most intense delay occuring from 2-4:30 p.m.



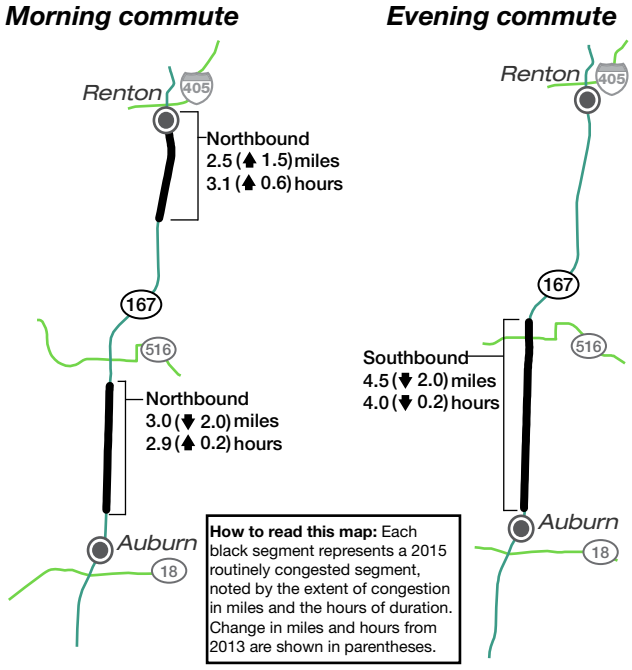
Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routine congestion near Kent decreases by three miles

carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on SR 167 in the central Puget Sound region, WSDOT analyzed vehicle throughput at 84th Avenue SE in Kent. In 2013 and 2015, productivity at this location at its most congested ranged between 93% and 84% in the northbound and southbound directions (see throughput graph on p. 30). This high yield in throughput on SR 167 indicates that HOT lanes as an operational strategy relieve congestion and make traffic flow better for all users on the corridor.

Routinely congested segments: Of the 20-mile SR 167 corridor between Auburn and Renton (both directions), the segment between SR 516 and SR 18 in both directions and the northbound segment near the SR 167/I-405 interchange experienced significant routine congestion. Overall, the locations where routine congestion occurred decreased by three miles between 2013 and 2015, and the amount of time of routine congestion increased by 5% (see map below).

Routinely congested segments of SR 167
2015; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.
Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: Capacity constraints impacted the SR 167 corridor between Auburn and Renton specifically near the SR 18 interchange in Auburn and on the northbound segment leading up to the SR 167/I-405 interchange. This resulted in longer average and reliable travel times during the morning and evening peak periods. In 2015 compared to 2013, the average travel time for the Auburn to Renton morning commute slowed by two minutes (12%), while the return commute in the evening saw a three minute increase (up 17%). Reliable travel times for both portions of this roundtrip commute were one minute longer in 2015 than in 2013.

The Renton to Auburn evening commute has the highest maximum throughput travel time index (MT^3I) of the four commutes tracked on SR 167 between Auburn and Renton. The route's MT^3I of 1.81 means the commute takes more than one and a half times as long as it would if traffic was moving at maximum throughput speed (50 mph). Similarly, the morning Auburn to Renton commute has an MT^3I of 1.63. WSDOT uses this index to compare the severity of congestion across commutes.

Transit trip travel times: On SR 167, Sounder commuter rail, bus transit and HOT lanes allow people to bypass highway capacity constraints in the corridor's SOV lanes. HOT lanes reduce travel times for carpoolers, transit riders, and solo drivers who pay a toll to use the lanes. However, transit and SOV travel times are not easily comparable for the SR 167 corridor due to the frequent stops made by buses. For example, in 2015 the average and reliable transit travel times for the SR 167 commute

Why are some transit travel times slower than HOT?
On the SR 167 corridor map on p. 29, the two commutes have average transit travel times which are 20 and 28 minutes slower than HOT lane travel times. This is caused by buses needing to use the SOV lanes to exit the highway to reach stops along their routes as there are no HOT direct access ramps on the corridor. Off-highway travel to stops also increases transit travel times.

For example, on the Renton to Auburn evening commute, the Sound Transit 566 exits the highway at Kent and makes three stops before re-entering the highway.

Five of eight park and ride utilization rates above 95%

from Auburn to Renton in the morning were 34 and 41 minutes, respectively. This is the same average travel time and 11 minutes faster than the reliable (52 minutes) transit travel times in 2013. However, transit travel times in 2015 were slower than the corresponding SOV average and reliable travel times by 15 and 12 minutes. See p. 29 for a comparison of transit trips to SOV and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved approximately 5,840 riders during the morning and evening peak periods on an average weekday in 2015, an 11% increase from 2013 (5,280 riders). Similarly, daily transit passenger miles traveled increased by roughly 6.7% in 2015 (54,630 miles) compared to 2013 (51,180 miles).

Increased transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the SR 167 corridor in the central Puget Sound region was equal to approximately half of an extra lane of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Transit on SR 167 commutes during the morning and evening peak periods operated between 52% and 61% of total seating capacity in 2015. Transit use during peak periods avoided about 30,700 pounds of GHG emissions per day on the SR 167 central Puget Sound corridor in 2015, a 6% uptick compared to 2013 (28,900 pounds).

Park and ride: Along the SR 167 corridor in the central Puget Sound region in 2015, park and ride (P&R) utilization rates ranged from 28% to 100% depending on the location, with five out of eight having utilization rates at or above 95%. The Renton Municipal P&R decreased in size by 50 spaces in January 2015, while also experiencing an 11 percentage point drop in utilization in 2015 compared to 2013. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the central Puget Sound region.

Commuters and freight move along SR 167 smoothly. Vehicles on SR 167 with more than one person in them can use the high occupancy toll lane for free with a Good to Go! pass.

How much is congestion costing you?

Commuters making roundtrips between Auburn and Renton on SR 167 experienced costs due to congestion (measured in wasted time and gas for travel below maximum throughput speed), of nearly $1,100 per passenger vehicle annually in 2015.

High Occupancy Vehicle Trip Analysis

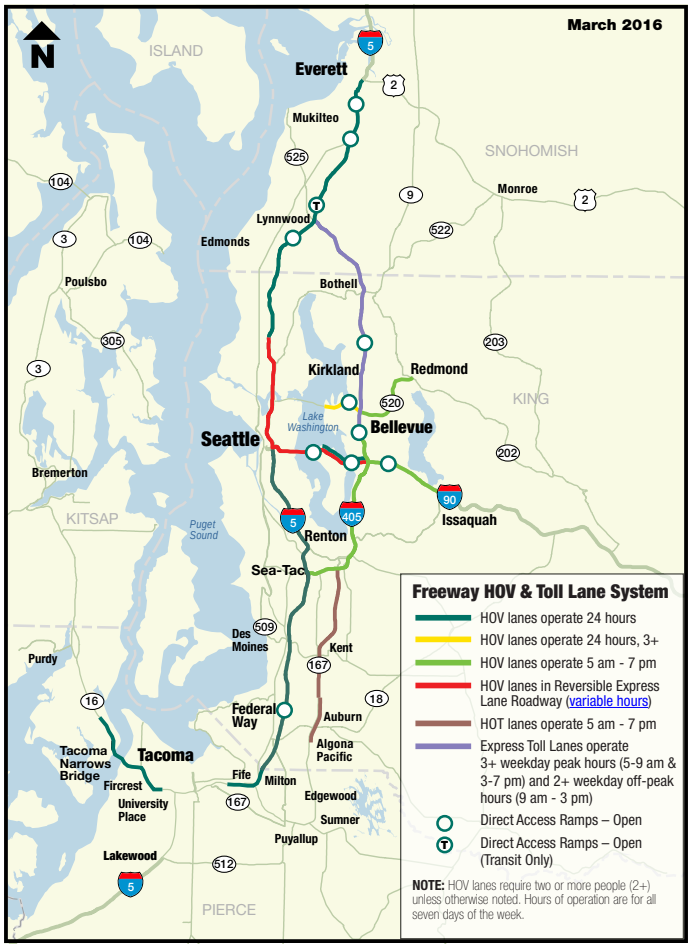
High occupancy vehicle (HOV) lanes are reserved for carpools, vanpools, buses, motorcycles or any vehicle carrying two or more people. The central Puget Sound region freeway network includes a system of HOV lanes designed to provide faster and more reliable options for travelers. This system also enhances the efficient operation of the freeway network by moving more people in fewer vehicles than adjacent single occupant vehicle (SOV) lanes. About 244 lane-miles of the planned 369-mile Puget Sound region HOV network have been completed. These figures reflect the HOV freeway system and exclude ramps and arterials; the planned freeway lane-miles have been updated based on new projects funded through Connecting Washington and additional HOV options such as high occupancy toll lanes and express toll lanes. More information about the HOV lane network can be found at http://www.wsdot.wa.gov/hov/.

WSDOT monitors three aspects of Puget Sound region HOV lane performance: 1) the person-carrying performance of HOV lanes as compared to the adjacent SOV lanes, 2) travel time performance for HOV lane users, and 3) overall travel performance and reliability on freeway HOV corridors.

HOV lanes outperform SOV lanes for person throughput

One of the key metrics of HOV lane performance is the ability of the HOV network to efficiently move more travelers. WSDOT estimates the number of vehicles and travelers at 10 locations on the major freeway corridors in the central Puget Sound region to evaluate HOV network performance.

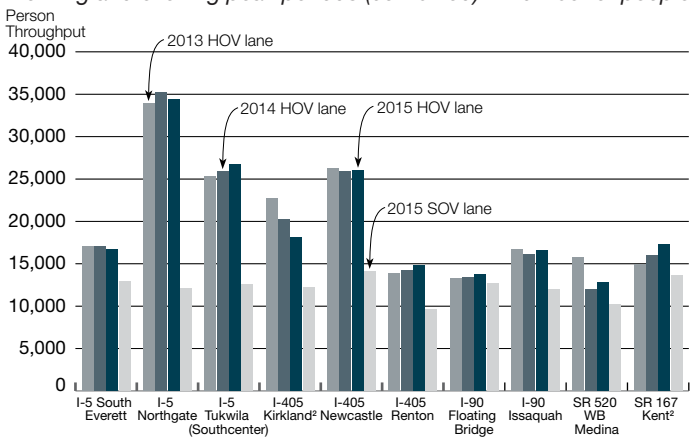
In 2015, changes in person volume varied by location, with six of the 10 monitored locations showing higher person throughput compared to 2013. The magnitude of HOV person volume in 2015 across the entire central Puget Sound HOV network increased by about 1% when compared to 2013 while the single occupant vehicle (adjacent to HOV network) person volume decreased by about 4.5%. The person volume estimates are based on a point location and are not a reflection of the vehicle miles traveled on the central Puget Sound region freeway network as a whole. Across all the point monitoring locations, an average of 38% of the people using the freeway during the peak periods at these locations use the HOV lanes. These values have been generally consistent from year to year.



Approximately 244 lane-miles of a planned 369-mile freeway system of HOV-type lanes have been built in the Puget Sound region since 1970. In addition to the freeway mainline system, approximately 75 miles of transit or HOV lanes exist on state highway arterials and freeway ramps.

Person throughput[1] higher in HOV than SOV lanes

2013 through 2015; Average daily person throughput volumes for morning and evening peak periods (combined) in number of people



Data source: Washington State Transportation Center.

Notes: 1 Person volume estimates are based on most recent 2013-2015 transit ridership and other data. The SOV lane volumes are the estimated person volumes for the average SOV lane at each location. 2 Single occupant vehicles may pay a toll to use the high occupancy toll lane on SR 167 and express toll lanes on I-405 between Lynnwood and Bellevue.

Puget Sound HOV lanes account for 38% of miles traveled

The number of people using the HOV lane varies by location and time of day. The most successful examples of HOV system use occur when the HOV lane offers a clear person throughput and travel time benefit for users combined with strong transit service. SOV lanes at all 10 monitored locations saw a reduction in person throughput volumes while most of the adjacent HOV lanes showed an increase. This shows persistent demand for HOV lanes in the central Puget Sound region.

The Northgate area on I-5 north of downtown Seattle is a good example of a freeway segment with high person throughput, as it is in a heavily traveled freeway corridor served by a number of transit routes. In previous years, this location has consistently shown HOV lane travel time benefits and significant usage. In 2015, during the average morning peak period, the southbound I-5 HOV lane at Northgate carried more than 48% (15,700) of all travelers toward downtown Seattle in 22% (4,200) of the vehicles. The HOV lane at this location carried an average of 3.8 persons per vehicle, or nearly three times the number of persons per vehicle as the adjacent SOV lanes. Ridesharing travelers and high levels of transit service and ridership are major contributing factors to the person throughput on I-5 and the HOV system overall.

Puget Sound region HOV network reaches 6.9 million person miles traveled daily

2013 and 2015; Average daily person miles traveled in thousands

Highway	2013	2015	% change
Interstate 5	3,378	3,744	10.8%
Interstate 405	1,756	1,815	3.4%
State Route 520	391	489	25.1%
Interstate 90	405	416	2.7%
State Route 167	382	444	16.1%
Total	**6,312**	**6,908**	**9.4%**

Data source: WSDOT Office of Strategic Assessment and Performance Analysis.

Roughly 6.9 million person miles were traveled on the central Puget Sound region freeway HOV network on an average weekday in 2015, 9.4% more than in 2013. Approximately 38.4% of all freeway person miles traveled in the central Puget Sound region were on the HOV network in 2015, compared to HOV comprising approximately 24% of total lane miles on the tracked corridors (see Appendix p. 4). I-5 carried more than half of the region's HOV person miles traveled (3.7 million miles). SR 520 saw the biggest two-year increase in the region (25.1%), due to more HOV lane miles added in that time frame.

Carpool, transit and vanpool critical to higher HOV person throughput

Bus riders make up a significant portion of HOV network users. In the central Puget Sound region, King County Metro (KCM), Sound Transit (ST) and Community Transit all showed noticeable annual ridership growth in 2015, continuing the trend from recent years. KCM's 2015 transit boardings were up 0.7% from 2014, which was itself a record-setting year (with ridership of 121 million). KCM experienced significant ridership growth on routes that benefited from new investments from the voter-approved Seattle Proposition 1, which provides additional funding for bus routes that primarily serve the city of Seattle.

The ST Express regional bus service reported a 4% increase in boardings—2015 saw 18.3 million boardings, which was the highest number of commuter bus boardings in the nation. Commuter bus service typically uses freeway HOV lanes, and is defined as service connecting suburban and other areas with a central city with at least five miles of continuous, limited-stop service. Community Transit fixed-route bus ridership grew by 2% in 2015, primarily due to the restoration of Sunday and holiday service that was cut during the recession. WSDOT will continue to track bus ridership trends and levels of transit service as part of its ongoing HOV performance monitoring efforts.

According to the National Transit Database, the Puget Sound region is considered the vanpool capital of the nation, with vanpool boardings per capita almost three times higher than the next closest region (Los Angeles). Puget Sound region vanpools logged nearly 30 million miles in 2015, and made up 80% of the vanpools statewide (2,340 of 2,920).

HOV lanes continue to provide speed and reliability benefits for travelers

WSDOT monitors the benefits for HOV lane users by tracking the travel times and reliability of HOV trips that parallel each of WSDOT's 40 high-demand commute corridors. On I-5 and I-90, alternate HOV routes are provided in the reversible lanes.

Of the 42 HOV trips analyzed for 2015, 31 had average travel times more than two minutes faster than the associated SOV trip (during times of peak congestion). The other 11 trips showed no significant average travel time difference between the SOV and

Three of 12 HOV corridors met reliability standards in 2015

HOV route options. Overall, the 2015 HOV travel time results are similar to those seen in previous years.

In 2015, 37 of the 42 HOV trips had reliable travel times that were more than two minutes faster than those of their SOV counterparts, indicating that HOV lanes were the more dependable option. The other five trips showed little or no difference between HOV and SOV reliable travel times.

See Appendix pp. 22-29 for the travel time and reliability performance of each monitored HOV and SOV lane.

SR 520 HOV performance improves in 2015 compared to 2013

The performance and reliability standard for freeway HOV lanes that was adopted by WSDOT and the Puget Sound Regional Council in 1991 states that travelers in the HOV lane should be able to maintain an average speed of at least 45 mph 90% of the time during the peak hour of travel.

Three of the 12 monitored HOV peak-direction corridors met the state performance standard in 2015 (one in the morning and two in the evening); four corridors met the standard in 2013. I-90 commutes between Issaquah and Seattle, as well as the southbound evening commute from Renton to Auburn met the standard. The degree of compliance with the performance standard held steady or worsened for 10 of the 12 monitored locations in 2015 compared to 2014.

Even during congested periods when HOV performance is reduced, HOV lanes still generally provide speed and reliability benefits compared to adjacent SOV lanes. During the off-peak times of day, all HOV corridors generally meet the standard.

See the table below for a summary of the degree to which each HOV corridor met the state performance standards in recent years in the peak direction of travel. For more detailed performance on I-405 see www.wsdot.wa.gov/tolling/405/library.htm.

I-405 express toll lanes now meeting standard

WSDOT opened 17 miles of express toll lanes (ETLs) between Lynnwood and Bellevue in September 2015, which are expected to better manage demand and ease congestion.

The legislature mandates in RCW 47.56.880 that the I-405 express toll lanes must maintain average vehicle speeds above 45 miles per hour at least 90% of the time during peak periods. WSDOT defines the peak periods for the I-405 ETLs as 5-9 a.m. and 3-7 p.m., as this is when the 3+ occupancy requirement is in effect and when there is the greatest strain on the corridor's capacity.

In 2015 prior to the introduction of ETLs, the HOV lanes were moving at 45 mph or more for about 78% of the time southbound and 43% of the time northbound during the peak periods. By the end of six months of operation, in March 2016, the ETLs exceeded 90% in both directions. See the special I-405 tolling report on pp. 19-20 for more information.

High occupancy vehicle lane speed and reliability performance on major central Puget Sound corridors
2011 through 2015; Goal is to maintain 45 mph for 90% of peak hour; Percent of peak hour goal was met

Commute routes	2011	2012	2013	2014	2015	Commute routes	2011	2012	2013	2014	2015
Morning commutes						**Evening commutes**					
I-5, Everett to Seattle SB	64%	54%	42%	28%	**26%**	I-5, Everett to Seattle NB	76%	68%	66%	46%	**36%**
I-5, Federal Way to Seattle NB	72%	51%	43%	30%	**18%**	I-5, Seattle to Federal Way SB	82%	63%	53%	40%	**32%**
I-405, Tukwila to Bellevue NB	98%	93%	65%	35%	**26%**	I-405, Bellevue to Tukwila SB	60%	43%	41%	26%	**21%**
I-90, Issaquah to Seattle WB	100%	100%	100%	98%	**98%**	I-90, Seattle to Issaquah EB	99%	100%	99%	100%	**99%**
SR 520, Redmond to Bellevue WB	97%	51%	50%	44%	**63%**	SR 520, Redmond to Bellevue WB	70%	54%	52%	52%	**73%**
SR 167, Auburn to Renton NB[1]	99%	96%	94%	86%	**66%**	SR 167, Renton to Auburn SB[1]	99%	98%	98%	98%	**95%**

Data source: Washington State Transportation Center.
Notes: The above HOV reliability performance standards are based on the peak hour, when average travel time is slowest. To meet the standard, a speed of 45 mph must be maintained for 90% of the peak hour. Numbers represent the percentage of the peak hour when speeds are faster than 45 mph. The Washington State Transportation Center analyzes performance data for all complete segments of HOV lanes that have a loop detector. In some cases, like southbound SR 167, data cannot be analyzed for the very beginning and ends of the lanes because there are no detectors at these locations. I-405 commutes between Lynnwood and Bellevue are no longer listed above, as they now have different legislatively mandated speed and reliability performance measures per RCW 47.56.880. For performance information, see www.wsdot.wa.gov/tolling/405/library.htm.
1 High occupancy toll lanes replaced regular HOV lanes May 3, 2008.

South Puget Sound I-5 Corridor Capacity Analysis

Visit bit.ly/CCR16SouthSoundmap for this article's interactive map.

Annual person miles traveled
2013 vs. 2015: 1,579 vs. 1,602 in millions of miles — ▲ 1.5%

Annual vehicle delay[1]
2013 vs. 2015: 803.8 vs. 1,513.6 in thousands of hours — ▲ 88%

Annual GHG emissions
2013 vs. 2015: 1,397 vs. 1,362 in millions of pounds of CO_2 equivalents — ▼ 2.5%

Annual passenger miles traveled on transit
2013 vs. 2015: 28.8 vs. 30.5 in millions of miles — ▲ 5.9%

Capacity savings due to transit
2013 vs. 2015: 0.8 vs. 0.9 in number of lanes — ▲ 13%

Percent transit seats occupied
2013 vs. 2015: 45% vs. 49% on average during peak periods — ▲ 4%

Percent park and ride spaces occupied
2013 vs. 2015: 81% vs. 84% on average during peak periods — ▲ 3%

Commute travel times

2013 and 2015 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for single occupant vehicle (SOV) and transit[3] trips.

Average SOV · Average transit · Reliable SOV · Reliable transit

See Appendix pp. 30-36 for more commute routes

Olympia to Tacoma
Morning; 7:30 a.m.; Trip length 26 miles

		Average	Reliable
SOV	2013	30	37
	2015	32	46
Transit	2013	45	53
	2015	41	52

Tacoma to Federal Way
Morning; 5:35 a.m.; Trip length 12 miles

		Average	Reliable
SOV	2013	16	28
	2015	22	31
Transit	2013	15	16
	2015	16	21

Tacoma to Olympia
Evening; 4:50 p.m.; Trip length 26 miles

		Average	Reliable
SOV	2013	43	68
	2015	41	61
Transit	2013	46	65
	2015	46	65

Federal Way to Tacoma
Evening; 5:15 p.m.; Trip length 12 miles

		Average	Reliable
SOV	2013	27	39
	2015	33	44
Transit	2013	24	34
	2015	31	48

Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	**2013**	**2015**	**2013**	**2015**
Olympia to Tacoma	282	260	24%	22%
Tacoma to Federal Way[4]	3,493	3,684	61%	67%
Evening (3-6 p.m.)				
Tacoma to Olympia[5]	455	425	34%	35%
Federal Way to Tacoma[4]	2,896	3,356	56%	61%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations)

Olympia-Federal Way commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
SR 512 Lakewood (493)	98%	98%
Tacoma Dome (2,273)	96%	95%
Lakewood Station (600)	74%	78%
DuPont (126)	70%	74%
Martin Way (318)	40%	48%
Hawks Prairie (332)	15%	39%

Data sources and analysis: Washington State Transportation Center, Sound Transit, Pierce Transit, Intercity Transit, WSDOT Olympic Region and WSDOT Office of Strategic Assessment and Performance Analysis.
Notes: Measures at the top of the page are for SOV trips only on the I-5 corridor between Olympia and Federal Way. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). 3 Transit travel times by bus may not be directly comparable to SOV/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 4 Includes transit trips between Olympia/Tacoma and Seattle. 5 Transit routes on this trip were adjusted, shifting some trips outside the 3-6 p.m. peak period which decreased daily peak period riders. For more detail on transit utilization, refer to Appendix p. 36.

South Puget Sound congestion sees significant increases

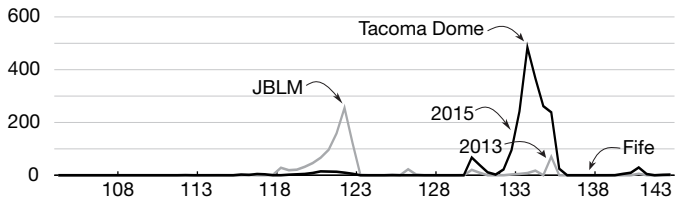
Interstate 5 (I-5) is the key commute and economic corridor connecting the south and central Puget Sound regions. More than 1.6 billion person miles were traveled between Olympia and Federal Way in 2015, a 1.5% increase over 2013.

Traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing moderate to heavy congestion on a daily basis. Delay increased 88% on the corridor, with the Tacoma Dome and Fife areas contributing to the significant increase from 2013 to 2015 (see chart below). To learn why delay and miles traveled do not increase hand in hand, see p. 5. In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington as trucks accounted for 7% of the total daily traffic volume on the corridor in 2015.

Corridor delay: The I-5 corridor in the south Puget Sound region between Olympia and Federal Way experiences a significant amount of vehicle delay on a daily basis. From 2013 to 2015, the Tacoma Dome and Fife areas experienced significant increases in delay—about 375% and 140%, respectively. Construction and temporary lane re-configurations on I-5 in this area led to higher than normal traffic friction in 2015, which contributed to the delay increases. Delay was also influenced by population growth—the population of the Puget Sound Regional Council area grew by 3.1% between 2013 and 2015. Employment in the Seattle-Tacoma-Bellevue metropolitan area also increased significantly (by 5.9%) between 2013 and 2015. Despite these growth challenges to the north, the Joint Base Lewis McChord (JBLM) area saw an approximate 80% decrease in congestion compared to 2013. This can partially be attributed to the implementation of 18 new ramp meters through the JBLM corridor in May 2015. The delay graphs above indicate a potential correlation between reduction in congestion at JBLM and increase in congestion at the Tacoma Dome area, mostly in the northbound direction. The majority of the Fife area congestion is in the southbound direction, which is likely due to the relocation of a bottleneck, along with the end of HOV lane restrictions.

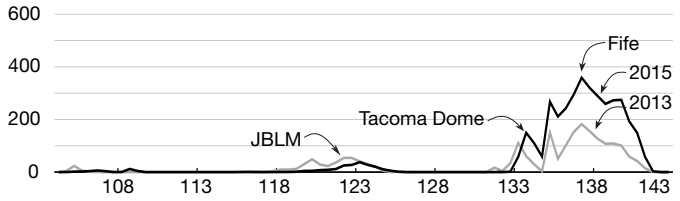
A focus on hot spots: The percent of days the Federal Way to Tacoma commute operated in severely congested (36 mph or below) condition significantly

Northbound delay along the I-5 corridor by milepost
2013 and 2015; Northbound; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Olympic Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

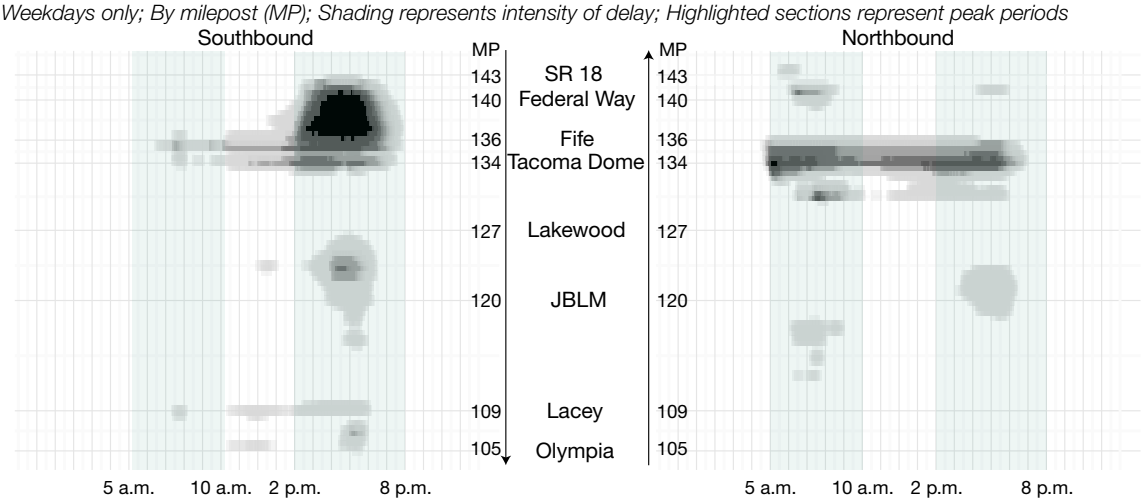
Southbound delay along the I-5 corridor by milepost
2013 and 2015; Southbound; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Olympic Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

I-5 delay between Olympia and Federal Way
2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on northbound I-5, delay lasted from 5 a.m. to 7 p.m. around the Tacoma Dome, with the most intense delay occurring during the morning commute. On southbound I-5, delay was most intense during the evening commute, extending from SR 18 past the Tacoma Dome and lasting between 2 p.m. and 8 p.m.

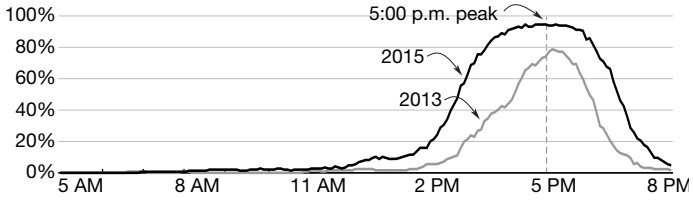


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Capacity constraints evident at Tacoma Dome and Fife

Severe congestion on the Federal Way to Tacoma commute

2013 and 2015; Southbound; Percent of days the average speed was slower than 36 mph



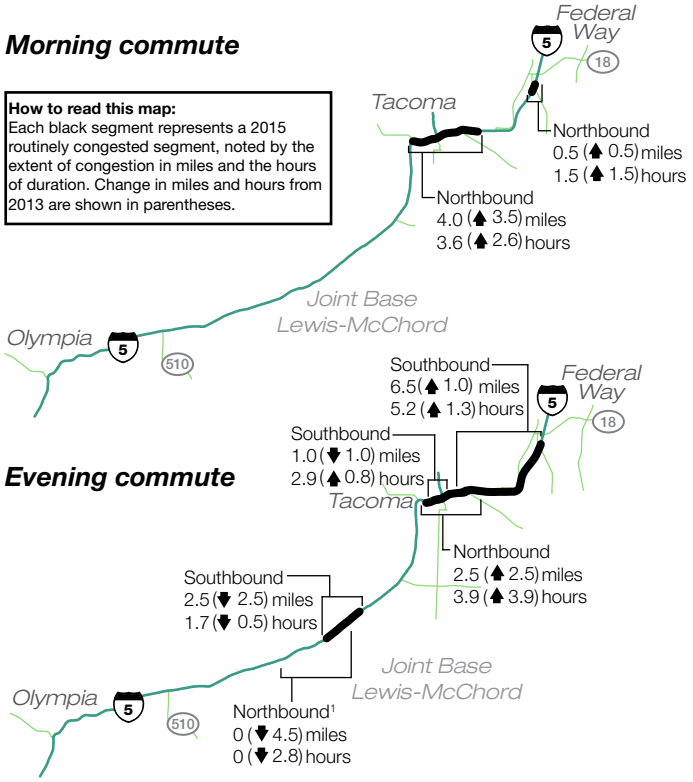
Data sources and analysis: WSDOT Olympic Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

worsened between 2013 and 2015. The graph above shows that between 2-8 p.m., most weekday commutes experienced speeds well below 36 mph. For example, at 5 p.m., the percent of days experiencing severe congestion increased from 77% in 2013 to 94% in 2015.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry

Routinely congested segments of I-5

2015; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013).

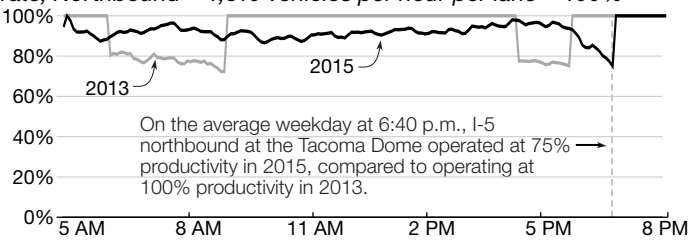


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: See p. 33 in the Appendix for all south Puget Sound region routinely congested segment data. 1 Routinely congested segments that dropped below 50 minutes in duration in 2015 from 2013 are noted with text on the map, but are not shown with the bold segment lines.

Throughput productivity on northbound I-5 at the Tacoma Dome

2013 and 2015; Based on the highest observed 5-minute flow rate; Northbound = 1,810 vehicles per hour per lane = 100%



Data sources and analysis: WSDOT Olympic Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-5 in the south Puget Sound region, vehicle throughput was analyzed at five locations: near 14th Avenue in Olympia, near JBLM, south and north of the Tacoma Dome, and near SR 18. In 2013 and 2015, productivity at these locations ranged from 66% to 100% at their most congested. The graph above shows how productivity varies by direction of travel, location and time of day near Tacoma Dome. The graph shows that throughput productivity loss in the northbound direction during morning and evening peak hours during 2013 changed to an all-day productivity loss in 2015. This might be explained by the significant reduction in congestion in the northbound direction near JBLM, which previously acted as a meter restricting the volume of vehicles to the Tacoma Dome area. Similarly, the loss in throughput productivity at the Tacoma Dome in the southbound direction increased from approximately 4.5 hours (between 2 p.m. and 6:30 p.m.) in 2013 to roughly 8.5 hours in 2015 (between 10:30 a.m. and 6:55 p.m.).

Routinely congested segments: Of the 38-mile I-5 corridor between Olympia and Federal Way (both directions), the segment between JBLM and SR 18 experienced routine congestion, with hot spots at the Tacoma Dome and Fife areas. While the locations were similar in 2013 and 2015, the amount of time of routine congestion increased by 60%.

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: In 2015, the Tacoma to Federal Way northbound commute was more severely impacted by capacity constraints near the Tacoma Dome than it was in 2013. Average travel times during the morning peak period (5-10 a.m.) were six minutes (38%)

Transit ridership saves nearly one lane of I-5 capacity

longer in 2015 than in 2013, and during the evening peak period (2-8 p.m.), three minutes (20%) longer. Similarly, reliable travel times increased by three minutes (11%) and five minutes (25%) for the morning and evening commutes on this route. This 12-mile commute is routinely congested and saw a significant increase in the duration of congestion. While in 2013 average speeds did not dip below 45 mph, in 2015 speeds were below 45 mph for over four hours (for both morning and evening). The cause for the delay increase in the Tacoma Dome area might be the significant reduction in congestion at the JBLM area in the northbound direction, further evidenced by the improved travel times on the 17-mile Lacey to Lakewood evening commute. Average travel time improved by 8 minutes (25%) and reliable travel time by 13 minutes (25%).

The Federal Way to Tacoma southbound reverse commute was impacted by capacity constraints near the Fife area. This resulted in increased average and reliable travel times during the evening peak period (2-8 p.m.). The average travel time for this route increased by six minutes (up 22%) from 2013 to 2015, while the reliable travel time increased by five minutes (up 13%). This 12-mile commute is routinely congested, with a significant increase in the duration of congestion along this route. Speeds on this segment of the corridor were below 45 mph on the evening commute for three hours and 50 minutes in 2013, and five hours and 25 minutes in 2015 – an increase of one hour and 35 minutes.

The maximum throughput travel time index (MT^3I) WSDOT uses to compare severity of congestion across commutes shows that the Federal Way to Tacoma evening commute has the highest MT^3I—2.23—of the 20 commute routes tracked in the south Puget Sound region.

Transit trip travel times: The transit route from Olympia to Tacoma saw improved travel times since September 2013. This is primarily due to express buses run by Intercity Transit and Sound Transit made possible by a Regional Mobility Grant funded by WSDOT under RCW 47.66.030. However, the Federal Way to Tacoma southbound transit trip saw severe congestion similar to the single occupancy vehicle trips, possibly due to the Fife area capacity constraint. In 2015, the trip took seven minutes longer in the evening than it did in 2013, while the morning trip remained the same.

Transit ridership and GHG emissions avoided: On an average weekday in 2015, transit moved 9,277 people during the morning and evening peak periods. Transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. Peak period transit ridership on the south Puget Sound I-5 corridor was equal to 86% of one extra lane of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

The evening Federal Way to Tacoma transit route saw ridership increase by 16% from 2013 to 2015. This corresponds to an increase in transit passenger miles traveled of 16%. The GHG emissions avoided by south Sound I-5 transit trips during peak periods improved 6% from 2013 to 2015. The GHG emissions avoided for the morning Tacoma to Federal Way commute and for the evening Federal Way to Tacoma commute improved by 8% and 19%, respectively. These two popular transit routes are operating at 67% and 61% of their seating capacity during the morning and evening peak periods.

Park and ride: Along the I-5 corridor in the south Puget Sound region in 2015, park and ride (P&R) utilization rates ranged from 39% to 98% depending on location. The SR 512 Lakewood P&R and the Tacoma Dome Station saw utilization rates of 98% and 95%, respectively. Any P&R lot that has 85% or more utilization is identified as operating at capacity. Lakewood Station and the DuPont P&R have utilization rates of 78% and 74%, respectively, which are considered to be nearing capacity.

P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the south Puget Sound region.

How much is congestion costing you?

The southbound evening commute along I-5 from Federal Way to Tacoma experienced the most congestion of the south Puget Sound area commutes. This 12-mile trip claimed the highest cost due to congestion (compared to maximum throughput speed), making the round-trip congestion cost about $2,000 per passenger vehicle annually in 2015.

Spokane Region I-90 Corridor Capacity Analysis

Visit bit.ly/CCR16Spokanemap for this article's interactive map.

Annual person miles traveled
2013 vs. 2015: 230.9 vs. 235.3 in millions of miles — 1.9%

Annual vehicle delay[1]
2013 vs. 2015: 40.6 vs. 80.6 in thousands of hours — 99%

Annual GHG emissions
2013 vs. 2015: 186.9 vs. 190.7 in millions of pounds of CO_2 equivalents — 2.0%

Annual passenger miles traveled on transit
2013 vs. 2015: 1.7 vs. 1.8 in millions of miles — 2.3%

Capacity savings due to transit
2013 vs. 2015: 0.09 vs. 0.08 in number of lanes — 11%

Percent transit seats occupied
2013 vs. 2015: 61% vs. 57% on average during peak periods — 4%

Percent park and ride spaces occupied
2013 vs. 2015: 84% vs. 68% on average during peak periods — 16%[2]

Commute travel times

2013 and 2015 during the morning (7-10 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[3] travel times for single occupant vehicle (SOV) and planned, average and reliable transit[4] travel times.

Average SOV · Average transit · Reliable SOV · Reliable transit · Planned transit

Argonne Rd. to Division St.

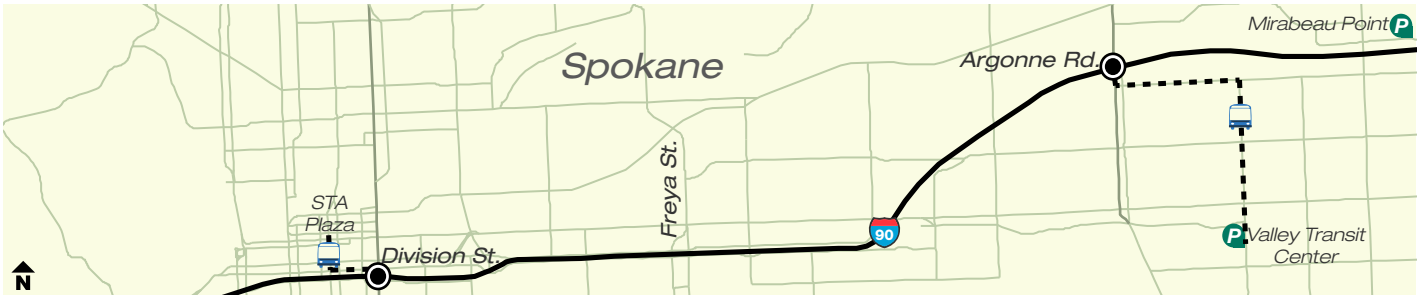
Morning; 7:50 a.m.; Trip length 7.5 miles

SOV	2013	9	12
	2015	10	12
Transit	2013[4]		20
	2015	17	19

Division St. to Argonne Rd.

Evening; 5:20 p.m.; Trip length 7.5 miles

SOV	2013	10	13
	2015	10	15
Transit	2013[4]		24
	2015	17	20



Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[4] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
	2013	2015	2013	2015
Morning (6-9 a.m.)				
Argonne to Division	617	585	58%	56%
Evening (3-6 p.m.)				
Division to Argonne	456	400	64%	56%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations)[5]

Argonne-Division commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Mirabeau Point (198)	84%	75%
Liberty Lake[2] (204)	100%	74%
Valley Transit Center (236)	69%	56%

See Appendix pp. 37-39 for more commute routes

Data sources and analysis: WSDOT Eastern Region Planning Office, Spokane Transit Authority and WSDOT Office of Strategic Assessment and Performance Analysis.
Notes: Measures at the top of the page are for SOV trips only on the I-90 corridor in the Spokane area. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Liberty Lake park and ride added 39 new spaces in October 2014, partly contributing to the 16% decline in overall utilization. 3 Reliable travel time will get a commuter to their destination on time or early 19 out of 20 weekdays (95% of the time). 4 Transit travel times by bus for 2013 in the Spokane region include some off-highway travel past the Division St. and Argonne Rd. exits on I-90 (see dotted lines on map) and thus are not directly comparable to SOV times which are highway only. 5 Liberty Lake park and ride not shown in map extent.

Interstate 90 (I-90) in the Spokane region is one of the area's key commute and economic corridors. Approximately 235.3 million person miles were traveled on I-90 between Division Street and Argonne Road in 2015, an increase of 1.9% since 2013.

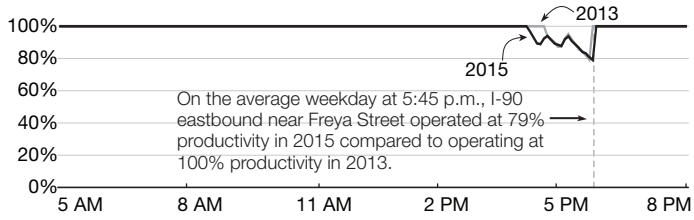
Traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing light to moderate congestion on a daily basis. Delay increased 99% on the corridor between 2013 and 2015, mostly due to increased traffic volumes on a corridor that was already nearing capacity in the peak periods. For example, the average daily traffic at the interchange at Sprague Avenue experienced a 5% increase of 6,000 vehicles per day from 112,000 to 118,000.

Spokane routine congestion expands by three miles

Also contributing to delay were crashes in the corridor, which increased from approximately 190 in 2013 to about 225 in 2015. In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington as trucks accounted for roughly 8% of the total daily traffic volume on the corridor in 2015.

Throughput productivity on eastbound I-90 near Freya Street

2013 and 2015; Based on the highest observed 5-minute flow rate; Eastbound = 1,740 vehicles per hour per lane = 100%



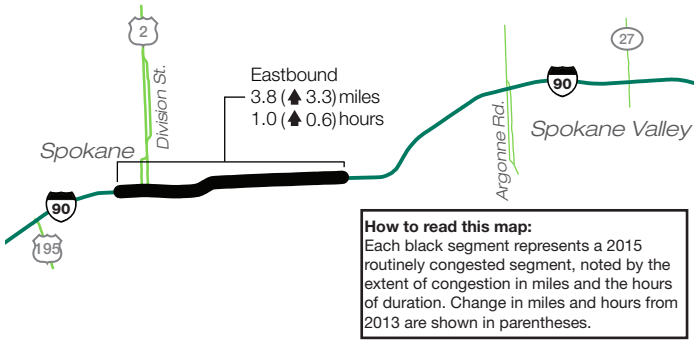
Data sources and analysis: WSDOT Eastern Region Planning Office and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-90 in the Spokane region, WSDOT analyzed vehicle throughput at several locations between Division Street and Argonne Road. In 2013 and 2015, productivity at these locations ranged from 79% to 100% at their most congested. The graph above shows how productivity varies by direction of travel, location and time of day near Freya Street. For example, at 5:45 p.m., 21% of the corridor's capacity was unavailable due to congestion on eastbound I-90 near Freya Street.

Routinely congested segments of I-90

2015; For weekday evening peak period (3-6 p.m.); Length of backup in miles; Daily duration of congestion in hours (compared to 2013).

Evening commute



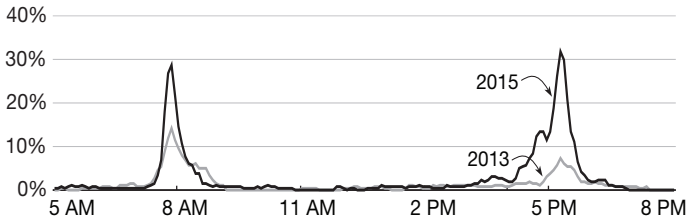
Data sources and analysis: WSDOT Eastern Region Planning Office and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: There was no routine morning congestion over the 50-minute threshold. See p. 38 in the Appendix for all Spokane region routinely congested segment data.

Routinely congested segments: In 2015, the eastbound I-90 evening commute experienced nearly four miles of congestion lasting about an hour between Division Street and Custer Road. This is a significant increase in routine congestion over 2013 in terms of both length (3.3 miles longer) and duration (35 minutes longer). The morning routine congestion on westbound I-90 expanded by a mile, while the duration increased by 10 minutes from 2013 to 2015.

Congestion on the Spokane I-90 commute

2013 and 2015; Westbound; Percent of days the average speed was slower than 45 mph



Data sources and analysis: WSDOT Eastern Region Planning Office and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: The commute routes on I-90 through the Spokane region did experience congestion occasionally. On the westbound commute there was up to a 32% chance of experiencing congestion during peak commute periods on an average weekday. For eastbound commutes, there was up to a 44% chance of experiencing congestion during peak commute periods. The Spokane region experiences some severe congestion (average speeds slower than 36 mph) as well, ranging from a 5% chance in the westbound direction to a nearly 20% chance in the eastbound direction.

What does congestion mean for travel times on the corridor?

Between 2013 and 2015, average travel times changed by no more than a minute, and are no more than a minute higher than the maximum throughput travel time during the peak periods. In 2015, average and reliable transit travel times were 17 and 19 minutes, respectively, for the highway portion of the morning westbound commute. Similarly, the average and

Lower fuel prices lead to drop in transit ridership on I-90

reliable transit travel times are 17 and 20 minutes, respectively, for the eastbound evening commute.

Transit ridership and GHG emissions avoided: Transit moved nearly 1,000 people on the corridor during the morning and evening peak periods on an average weekday in 2015. Transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. Peak period transit ridership on the Spokane region I-90 corridor was equal to about a tenth of an extra lane of capacity in 2015 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Transit routes on the I-90 corridor are operating at 56% of their seating capacity during the morning and evening peak periods. Combined morning and evening ridership declined by approximately 8% since 2013, and the amount of greenhouse gas emissions avoided declined by approximately 3% in 2015. Transit use during peak periods avoided roughly 2,900 pounds of GHG emissions per day on the I-90 Spokane region corridor in 2015.

Spokane Transit Authority has received grant funding to coordinate with WSDOT and regional partners to begin designing improved connections with routes outside of the corridor, upgrade passenger amenities, enhance operations, improve reliability and expand park and ride (P&R) facilities. These improvements will encourage additional ridership and accommodate growth in demand for P&R spaces.

Park and ride: Along the I-90 corridor in the Spokane region in 2015, P&R utilization rates ranged from 56% to 75% depending on location. The Mirabeau Point P&R, east of Argonne Road, saw an average utilization rate of 75%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. Spokane Transit Authority has seen transit use around Spokane slightly decline with the sustained drop in fuel prices (see pp. 9-10), which appears to have affected P&R utilization at a higher rate than overall ridership. Also contributing to the utilization decrease was an addition of 39 spaces to the frequently full Liberty Lake P&R in late 2014, decreasing the utilization percentages. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates.

Visit bit.ly/CCR16Vancouvermap for this article's interactive map.

Vancouver Region I-5 and I-205 Corridor Capacity Analysis

Annual person miles traveled[1]

2013	vs.	2015	
527.3		551.1	▲ 4.5%

in millions of miles

Annual vehicle delay[2]

2013	vs.	2015	
205.7		264.1	▲ 28%

in thousands of hours

Annual GHG emissions

2013	vs.	2015	
429.8		434.0	▲ 1.0%

in millions of pounds of CO_2 equivalents

Annual passenger miles traveled on transit

2013	vs.	2015	
2.1		1.9	▼ 9.5%

in millions of miles

Capacity savings due to transit

2013	vs.	2015	
0.2		0.2	◆ 0%

in number of lanes

Percent transit seats occupied

2013	vs.	2015	
46%		41%	▼ 5%

on average during peak periods

Percent park and ride spaces occupied

2013	vs.	2015	
63%		65%	▲ 2%

on average during peak periods

Commute travel times

2013 and 2015 during the morning (6-9 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times[3] in minutes at the 5-minute peak including average and reliable[4] travel times for single occupant vehicle (SOV) travel times.

Average SOV
Reliable SOV

Interstate 5 commutes

I-205 to I-5 bridge

Morning; 6:40 a.m.; Trip length 8 miles

SOV
2013 19 30
2015 22 34

I-5 bridge to I-205

Evening; 5:15 p.m.; Trip length 8 miles

SOV
2013 8 9
2015 8 9

Interstate 205 commutes

I-5 to I-205 bridge

Morning; 7:45 a.m.; Trip length 10 miles

SOV
2013 13 21
2015 15 24

I-205 bridge to I-5

Evening; 5:20 p.m.; Trip length 10 miles

SOV
2013 12 16
2015 13 18

See Appendix pp. 40-45 for more commute routes

Transit system use

2013 and 2015; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[5] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2013	2015	2013	2015
I-5: I-205 to I-5 bridge	694	628	53%	49%
I-205: SR 500 to I-205 bridge	424	385	52%	50%
Evening (3-6 p.m.)				
I-5: I-5 bridge to I-205	483	436	41%	34%
I-5: I-5 bridge to SR 500	377	259	38%	32%

Park and ride capacity

2013 and 2015; Average percent occupied for select park and rides (see map for locations)[6]

Interstate 5 commute route

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Andresen (100)	52%	94%
99th Street Transit Ctr. (609)	65%	65%
Salmon Creek (472)	61%	57%

Interstate 205 commute route

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Fisher's Landing Transit Ctr. (563)	90%	90%
Evergreen Transit Ctr. (267)	10%	13%

Data sources and analysis: WSDOT Southwest Region Planning Office, Southwest Washington Regional Transportation Council, C-TRAN, National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

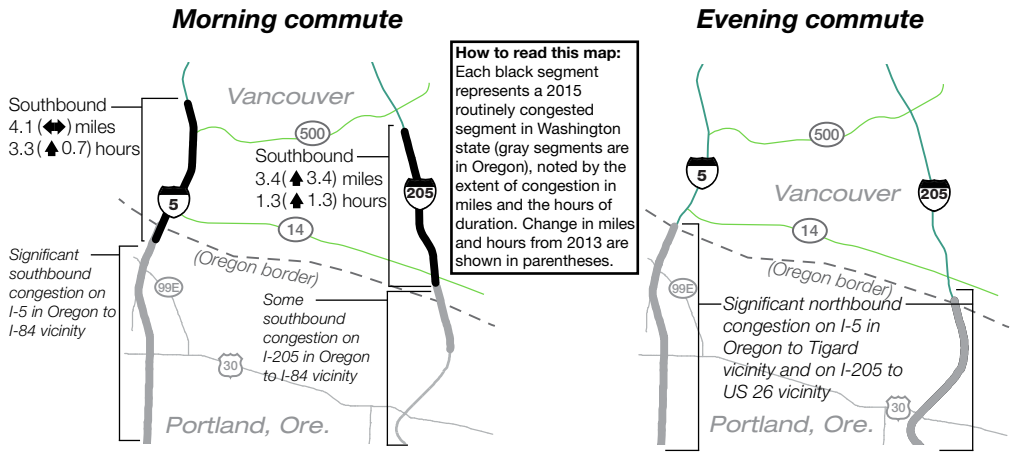
Notes: Measures at the top of the page are for SOV trips only on the I-5 and I-205 corridors in the Vancouver area. 1 Due to limited data availability, measurements for annual person miles traveled are not comparable to previous editions of the *Corridor Capacity Report*. WSDOT recommends that the percent change be used as an indicator of a general trend for the region. 2 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. This measure now has a better data source (provided by the Federal Highway Administration), so trends might not line up with previous years. 3 Due to constraints with sample size, transit travel time data for I-5 and I-205 were not published for 2013 and 2015. 4 Reliable travel time will get a commuter to their destination on time or early 19 out of 20 weekdays (95% of the time). 5 WSDOT attempts to match transit trips as closely as is practical to SOV/HOV. 6 The BPA park and ride was shut down before 2015 and not included in this edition of the report.

I-5 bridge squeeze in Vancouver snarls traffic

Interstate 5 (I-5) and I-205 in the Vancouver region are two of the region's key commute and economic corridors. General trends for the corridors combined indicate a 4.5% increase between 2013 and 2015 in annual person miles traveled. The I-5 and I-205 corridors are analyzed for the Vancouver urban area from the I-5/I-205 split near the Clark County fairgrounds to the respective bridges that cross the Washington/Oregon border.

Routinely congested segments of I-5 and I-205 in the Vancouver area

2015; For weekday morning (6-9 a.m.) and evening (3-6 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2013)

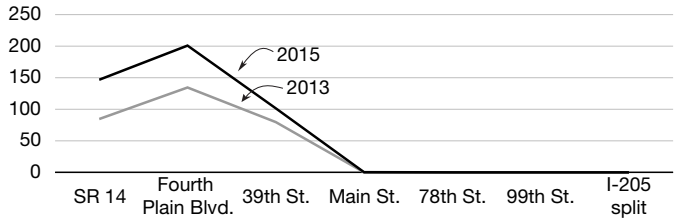


Data sources and analysis: National Performance Measurement Research Data Set, WSDOT Southwest Region Planning Office, WSDOT Office of Strategic Assessment and Performance Analysis, and endorsed by Oregon Department of Transportation.
Note: See pp. 43-45 in the Appendix for all Vancouver and Portland region routinely congested segment data. Generalized Portland routinely congested segments are shown in the map above in light gray.

Traffic at specific locations on the corridors worsened from 2013 to 2015, with morning and evening weekday commutes experiencing moderate to heavy congestion on a daily basis. Delay increased 28% throughout the corridors between 2013 and 2015. However, southbound delay was 99% of the total in 2015. (See heatmap graphs for I-5 and I-205 on p. 46). In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington as trucks accounted for 7% of the total daily traffic volume on I-5 and 6% on I-205 in 2015.

Delay along the I-5 corridor by milepost

2013 and 2015; Northbound and southbound combined; Average daily vehicle hours of delay

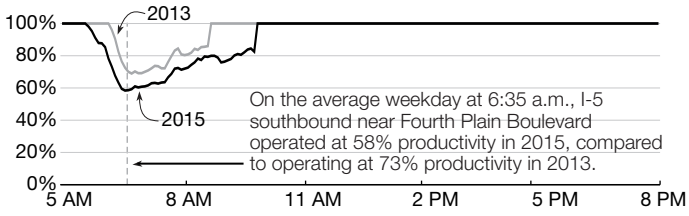


Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-5 and I-205 in the Vancouver region, WSDOT analyzed vehicle throughput at two locations: near Fourth Plain Boulevard on I-5 and near 10th Street on I-205. In 2013 and 2015, productivity at these locations at their most congested ranged from 58% to 87% in the southbound direction while no loss of productivity occurred in the northbound direction. Throughput productivity varies by direction of travel, location and time of day. For example, on southbound I-5 near Fourth Plain Boulevard, nearly one-half of the corridor's capacity was unavailable due to congestion during part of the morning peak period. The graph below shows that productivity loss increased in both duration and intensity between 2013 and 2015.

Throughput productivity on southbound I-5 near Fourth Plain Boulevard

2013 and 2015; Based on the highest observed 5-minute flow rate; Southbound = 1,490 vehicles per hour per lane = 100%



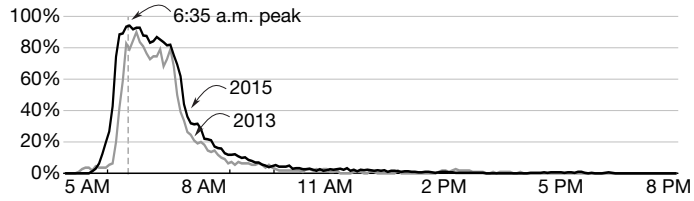
Data sources and analysis: WSDOT Southwest Region Planning Office and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments: Of the 36 miles on the I-5 and I-205 corridors between the split near the Clark County fairgrounds to the respective bridges that cross the Washington state line (both directions), the segments between SR 500 and the state line in the southbound direction experienced the most routine congestion, mostly during the morning commute. I-5 morning congestion often extends to 78th Street in Vancouver. Combined routine congestion on both the I-5 and I-205 corridors increased

I-5 morning commute into Oregon severely congested

by 88% in 2015. I-5 saw a 25% increase in daily congestion in 2015 (three hours and 20 minutes) compared to 2013 (two hours and 40 minutes). Additionally, I-205 experienced daily morning congestion for one hour and 40 minutes approaching the Glenn Jackson Bridge in 2015 that was non-existent in 2013. As shown in the maps on p. 44, significant congestion occurred in the Portland area on the I-5 and I-205 corridors heading into Washington during the evening commute. Refer to Appendix pp. 44-45 for more details on Portland-area congestion.

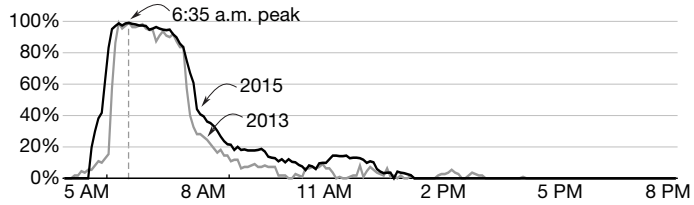
Severe congestion on the I-5 Vancouver to Portland commute (I-205 interchange to I-5 bridge)
2013 and 2015; Southbound; Percent of days the average speed was slower than 36 mph



Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: Morning commuters driving on I-5 between the I-205 interchange and the I-5 bridge at the state line drove in severely congested conditions (36 mph or less) slightly more often in 2015 than in 2013. During the morning peak period, a significant portion of weekday commutes experienced speeds below 36 mph (see graph above). For example, at 6:35 a.m. on the southbound I-5 commute, 94% of the weekday commutes experienced severe congestion. Similarly, the sub-commute on I-5 from SR 500 to the I-5 bridge experienced severe congestion almost all weekdays (see graph below). For example, at around 6:35 a.m. the percent of days speeds were below 36 mph remained at 99% for both 2013 and 2015. The graphs show that severe congestion on southbound I-5 during the morning commute lasted longer.

Severe congestion on the I-5 Vancouver to Portland commute (SR 500 to I-5 bridge)
2013 and 2015; Southbound; Percent of days the average speed was slower than 36 mph



Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

What does severe congestion mean for travel times on the corridor?

Single occupancy vehicle trips: Between 2013 and 2015, average travel times for I-5 commutes in the Vancouver region increased by three minutes or less, while the reliable travel times increased by no more than four minutes. On I-205 commutes average travel times increased by no more than two minutes, while the reliable travel time increased by no more than three minutes.

Seven out of eight Vancouver commutes on I-5 and I-205 had a maximum throughput travel time index (MT^3I) of greater than one in 2015. The southbound I-5 morning commute from SR 500 to the I-5 bridge exhibited the highest MT^3I (4.09), which means the trip took over four times longer than it ideally should. Peak period speeds on this commute were 13 mph on average. This two-mile segment of stop-and-go traffic up to the Washington state line is the state's most congested segment based on MT^3I.

Morning southbound congestion to cross the Oregon border is prevalent approaching the I-5 bridge in Vancouver (pictured in background).

Transit ridership and GHG emissions avoided:
On an average weekday in 2015, transit moved 1,850 people on both the corridors during the morning and evening peak periods, a 14% decrease over 2013 (2,150 riders). This decrease in transit ridership might be due to dropping gas prices and better economic conditions (see pp. 9-10). Ideally, transit ridership translates to fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. In 2015, peak period transit ridership on the I-5 and I-205 Vancouver region corridors was equal to 16% of an extra lane of capacity (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Transit routes in the peak direction during peak periods on the I-5 and I-205 corridors combined operated on average at 41% of their seating capacity, a five percentage

Fisher's Landing P&R nearing capacity, expanding in 2016

point reduction from 2013. Transit use during peak periods avoided 2,700 pounds of greenhouse gas emissions per day on the I-5 and I-205 corridors in 2015, a 12% reduction compared to 2013 (3,100 pounds).

Park and ride: Along the I-5 corridor in the Vancouver region in 2015, park and ride (P&R) utilization rates ranged between 57% and 94% depending on the location, with the Andresen P&R showcasing the highest average utilization rate of 94%. This high utilization was likely due to the nearby BPA P&R shutting down before 2015, shifting users to the Andresen P&R. Additionally, in 2015, P&R utilization rates on I-205 at the two monitored locations were 13% at Evergreen Transit Center and 90% at Fisher's Landing Transit Center. Parking capacity at Fisher's Landing will be expanded by nearly 200 spaces in 2016. Any P&R lot that has 85% or more utilization is identified as operating at capacity.

P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. One of the primary focuses of C-TRAN, the Vancouver region's main transit provider, is improving ridership; C-TRAN uses strategies ranging from increased public outreach to changes in service routes. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address regional highway capacity issues.

How much is congestion costing you?

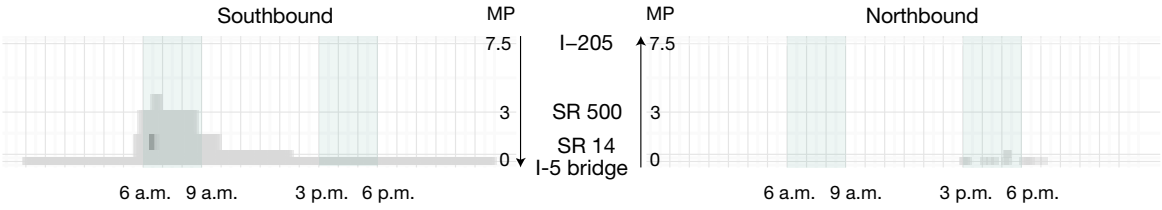
Drivers on the 7.5-mile southbound morning commute on I-5 from the split near the Clark County fairgrounds to the I-5 bridge experienced the highest cost due to congestion (measured in wasted time and gas for travel below maximum throughput speed), about $760 per passenger vehicle annually in 2015. The return trip congestion is on the Oregon side of the bridge, and is not accounted for in this report's cost calculations.

Vancouver area commuters regularly experience delays on State Route (SR) 14, SR 500, and I-205 between SR 500 and Padden Parkway. Because data collection infrastructure is not in place to reliably quantify the congestion, information for these corridors is not provided in this report. For additional information on five-year Clark County traffic trends, refer to Southwest Washington Regional Transportation Council's 2015 Congestion Management Process Summary Report at bit.ly/RTC2015CongestionSummary.

I-5 delay between the I-5 bridge and the I-205 interchange

2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on northbound I-5, delay lasted from 2:30 to 7:30 p.m. around the I-5 bridge. On southbound I-5, morning delay extended from before State Route 500 to the I-5 bridge. Delay around the I-5 bridge lasted all day.

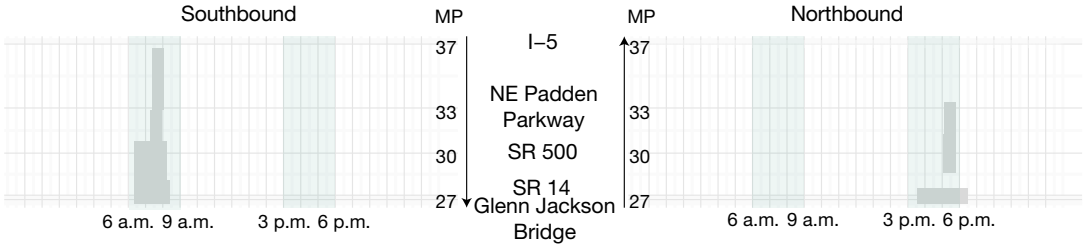


Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

I-205 delay between Glenn Jackson Bridge and the I-5 interchange

2015; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2015 on northbound I-205, delay occurred during the evening peak period, with pockets of delay from the Glenn Jackson Bridge to Northeast Padden Parkway. On I-205 southbound, delay lasted from 6-8:30 a.m., and extended from the I-5 interchange to the Glenn Jackson Bridge.



Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

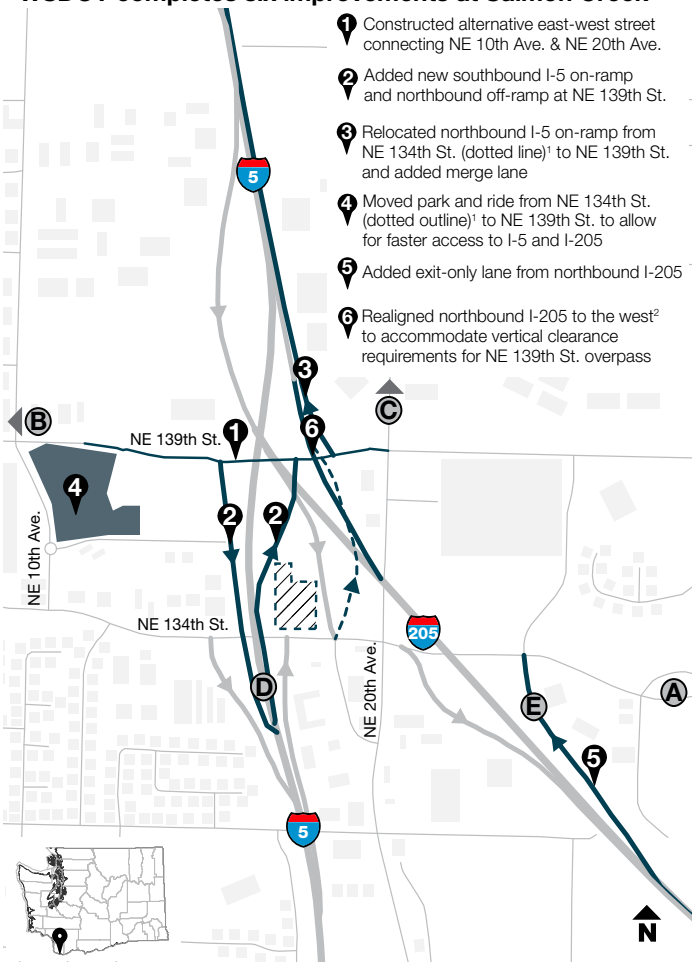
Before and After Analysis of Vancouver Capacity Expansion Projects

New capacity reduces congestion in Salmon Creek

WSDOT completed a series of improvements in September 2014 to reduce traffic congestion and improve safety on I-5, I-205 and local roads in the fast-growing Salmon Creek area near Vancouver, Washington (see map below). WSDOT's evaluation shows the redesigned interchanges, along with additional capacity on NE 139th St. (done in collaboration with Clark County), reduced travel times for commuters and local traffic around Salmon Creek while allowing higher vehicle throughput on I-5, I-205 and local roads.

The cost for all improvements combined was $122 million ($11 million under budget), of which 69% was funded by the 2003 Nickel transportation package and 31% by the Clark County Public Works Department. Baseline volume and travel time data was collected in April 2010 and compared with data from April 2015. The After data collection was delayed by a few months to account for seasonal factors along with allowing time for drivers to adjust to the roadway re-configurations. The Before and After travel time data for this project was collected using test vehicles during the region's peak commute hours (6-9 a.m. and 3-6 p.m.).

WSDOT completes six improvements at Salmon Creek



Notes: The dark lines represent the sections of roadway improved by the Salmon Creek project. Letter symbols are route origin and destination points. 1 Dotted lines are a ramp and park and ride that were moved as part of the project. 2 Realignment was too slight to see on map at this scale.

1 An alternative east-west through street

With I-5 and I-205 running almost parallel through Salmon Creek, the on-ramp entrances and off-ramp exits are close together. Prior to this project, NE 134th St. was the only east-west through street connecting neighborhoods on either side of the interchange, causing congestion as local traffic competed with commuters using the street to enter and exit the highways. After WSDOT constructed an alternative thoroughfare—NE 139th St.—traffic in this area is now split between the two east-west corridors. Before the improvements, the 1.4-mile evening trip between points A and B via NE 134th St. (see map at left) took between 10 and 30 minutes in the westbound direction. After the improvements, the same trip took less than half the time—between five and 10 minutes—and was more accessible to pedestrians due to the sidewalk installed on NE 139th St.

2 A new interchange at NE 139th St.

With the addition of the new east-west through street (NE 139th St.), WSDOT was able to add a new interchange, giving commuters more options for entering and exiting I-5. The new southbound on-ramp and northbound off-ramp provide additional access for the peak direction morning and evening commutes, respectively. The redistribution of traffic flow has helped ease the bottleneck that existed on NE 134th St. prior to the improvements.

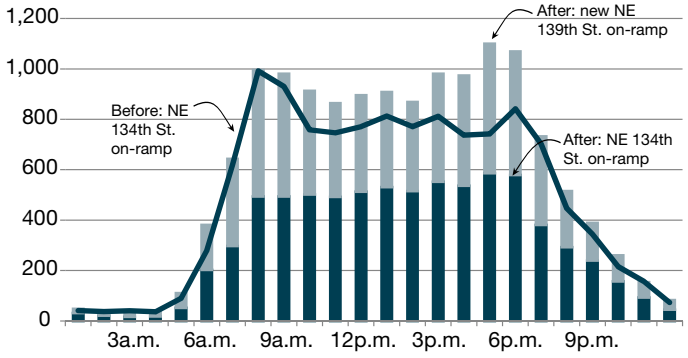
Analysis showed that commuters coming to and from the north or east of the study area were more likely to use the new NE 139th St. corridor to enter and exit from the highways due to fewer signals and intersections. This new option of entering the highway sooner in commuters' trips reduced morning travel time between points C and D (see map) by 44%. Average speed on this segment increased from 18 mph to 32 mph (approximately 78%) during the morning peak after the improvement. As shown in the graph at the top of p. 48, this successfully split

Park and ride relocation allows for better transit access

southbound traffic almost 50-50 between two on-ramps instead of one, allowing more vehicles than before to pass through these interchanges to access I-5.

Southbound I-5 on-ramps see greater volumes

April 2010 average vehicles per hour (before) compared to April 2015 volumes for new and existing off-ramps combined (after)

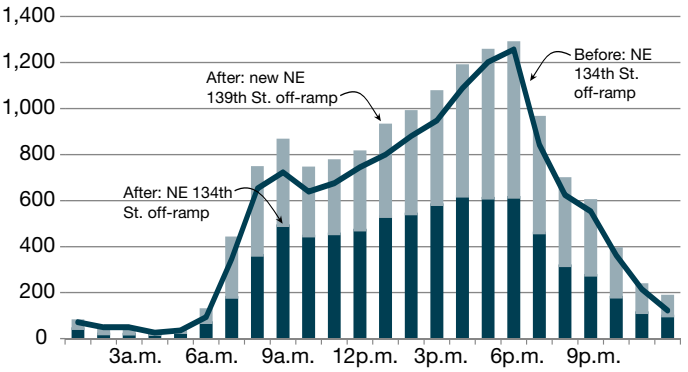


Data source: WSDOT Multimodal Planning Division.

The graph below shows that the northbound off-ramps most frequently used in evening commutes also saw an equal traffic volume split, improving safety by eliminating occasional backups from the off-ramp onto mainline I-5. Further, as shown in the graph below where the light bars extend above the dark 2010 "Before" line, total volumes during the morning and evening peak periods were 3% greater than before construction—2,620 more vehicles in the morning peak and 3,656 more vehicles in the evening peak. However, Salmon Creek is a fast growing region and some volume increases can be attributed to population growth.

Northbound I-5 off-ramps see greater volumes

April 2010 average vehicles per hour (before) compared to April 2015 volumes for new and existing off-ramps combined (after)



Data source: WSDOT Multimodal Planning Division.

❸ Relocation of a northbound I-5 on-ramp

To further disperse the traffic around Salmon Creek, WSDOT moved the northbound I-5 on-ramp from NE 134th St. (see dotted line on the map on p. 47) to NE 139th St. A new lane on part of northbound I-5 helps those merging onto the highway from the new on-ramp.

❹ Relocation of a park and ride for better access

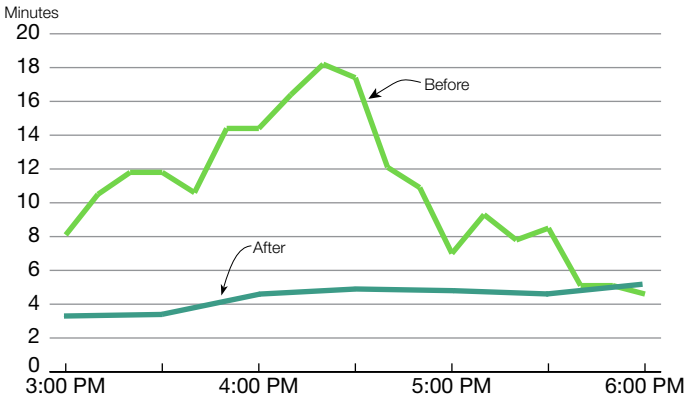
The C-TRAN park and ride, formerly located between I-5 and I-205 ramps on NE 134th St. (see dotted outline on map on p. 47, was expanded and moved to the corner of NE 139th St. and NE 10th Ave. to ease the bottleneck that existed on NE 134th St. The new location creates better transit access to I-5 via a designated transit connection point on NE 139th St., and easy connections to both NE 134th St. and NE 139th St. access ramps for general users. Additionally, WSDOT widened a connection to the new park and ride location and constructed a roundabout at a nearby busy NE 10th Avenue intersection to help with traffic flow.

❺ Addition of I-205 exit-only lane for NE 134th St.

The Salmon Creek improvements also included adding an exit-only lane where commuters exit northbound I-205. Before the project, evening commuters' travel times ranged up to 18 minutes between points E and B via NE 134th St. (see map on p. 47) due to frequent backups on the I-205 off-ramp. With the addition of an extra off-ramp lane (and other area improvements discussed), users now experience less variable evening travel times of three to six minutes, as shown below.

Northbound evening commute times stabilize

April 2010 (before) and April 2015 (after); Northbound travel times from I-205 off-ramp[1] to NE 139th St.[2]



Data source: WSDOT Multimodal Planning Division.
Notes: 1 Point E on the map. 2 Point B on the map.

❻ Realignment of I-205 for vertical clearance

The project also realigned northbound I-205 to the west at NE 139th St. to accommodate vertical clearance requirements for an overpass. All of the above project improvements have compounded to make the entire system in the Salmon Creek area work better for all travelers.

Tri-Cities US 395 Corridor Capacity Analysis

Annual person miles traveled

2013	vs.	2015	
68.1		72.3	6.2%

in millions of miles

Annual vehicle delay[1,2]

2013	vs.	2015	
17.2		18.5	7.6%

in thousands of hours

Annual GHG emissions

2013	vs.	2015	
141.1		144.8	2.6%

in millions of pounds of CO_2 equivalents

Commute travel times

2013 and 2015 during the morning (6-8 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times in minutes during peak periods including average and reliable[3] travel times for single occupant vehicle (SOV) trips.

Average SOV Reliable SOV

Kennewick to Pasco

Morning; 6-8 a.m.; Trip length 6.9 miles

SOV
2013 13 17
2015 13 16

Pasco to Kennewick

Evening; 3-6 p.m.; Trip length 7.0 miles

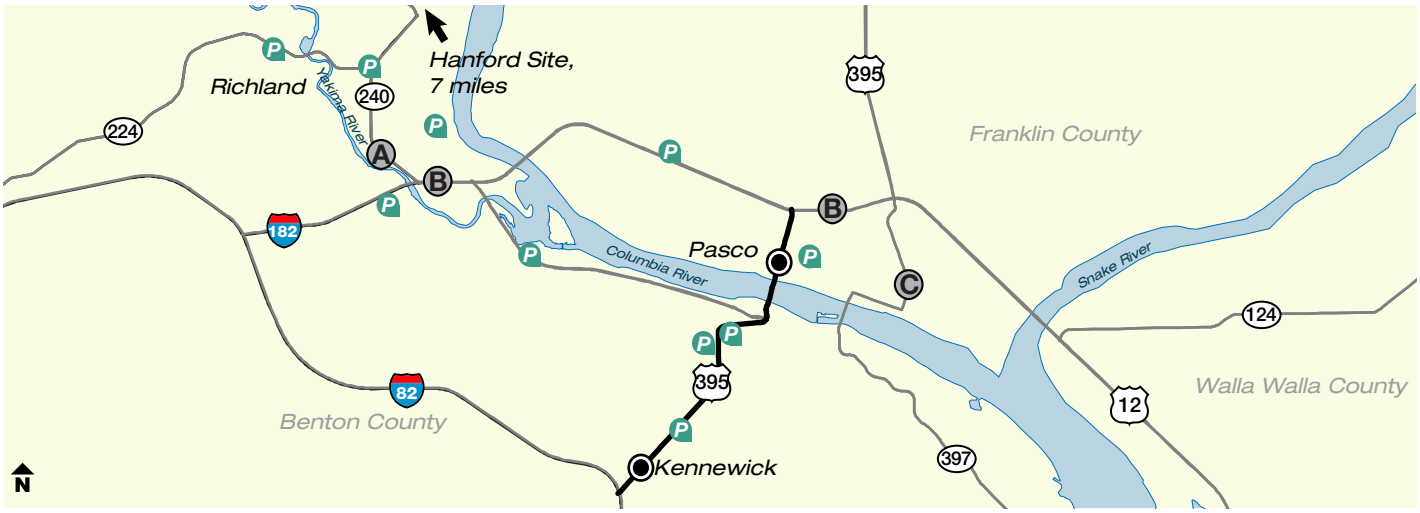
SOV
2013 15 20
2015 16 20

Park and ride capacity

2015; Average percent occupied for select park and rides (see map for locations)

Kennewick-Pasco commute

Park and ride (spaces)	2013 percent occupied	2015 percent occupied
Union Street & 27th Avenue (50)	79%	58%
Huntington Transit (96)	44%	58%
U.S. 395 & Yelm Street (39)	47%	39%
Pasco - North 22nd Avenue Transit (50)	41%	39%



Data sources and analysis: WSDOT South Central Region Planning Office, National Performance Management Research Data Set, WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

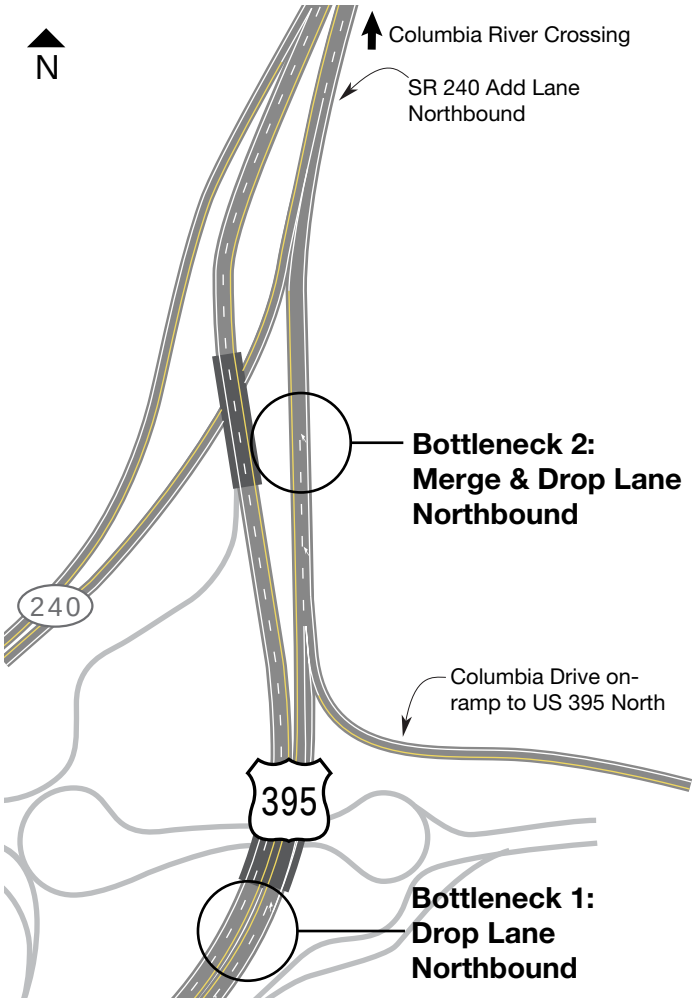
Notes: Measures at the top of the page are for the US 395 corridor in the Tri-Cities area for SOV trips only. 1 WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. 2 Annual vehicle delay for US 395 arterial corridor is calculated for peak periods only. 3 Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time).

US 395 is one of the key commute and economic corridors in the Tri-Cities region. Unlike other urban corridors discussed in the report, US 395 is partly an arterial; it has a five-mile signalized section in Kennewick with eight traffic signals, and a two-mile freeway segment mostly in Pasco. More than 72 million person miles were traveled between Kennewick and Pasco in 2015 on weekdays, a 6.2% increase over 2013.

Traffic at specific locations on the corridor worsened from 2013 to 2015, with morning and evening weekday commutes experiencing moderate congestion on a daily basis. Delay increased 7.6% on the corridor, with the signalized sections of the roadway contributing to the increase. In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington as trucks accounted for 11% of the total daily traffic volume on the corridor in 2015.

A focus on hot spots: The US 395/SR 240 interchange at the south end of the Columbia River Bridge is a key chokepoint where traffic volumes peak. There are two bottlenecks created by a series of merges, weaves and lane reductions (see graphic at top of p. 50). In the northbound direction, two lanes of traffic are restricted to one lane (bottleneck 1), followed by traffic merging from the Columbia Drive on-ramp into one lane (bottleneck 2). Shortly after, traffic merges from the SR 240 on-ramp. These capacity issues cause significant congestion as the corridor crosses the Columbia River.

Travel times fairly consistent in the Tri-Cities region



Routinely congested segments: Routinely congested intersections on the arterial in Kennewick include Yelm Street, Clearwater Avenue, Kennewick Avenue and 10th Avenue. In the freeway section of the corridor in Pasco, the Lewis Street interchange at the north end of the Columbia River Bridge and the I-182 interchange at the north end of the corridor experience regular congestion. Specific data for these routinely congested locations was not available. With the NPMRDS dataset provided by FHWA more detailed data might be available in the future.

What does congestion mean for travel times on the corridor?

The average travel times for the US 395 morning commute from Kennewick to Pasco remained at 13 minutes in 2015, while reliable travel time improved by dropping one minute compared to 2013. The peak direction evening commute from Pasco to Kennewick worsened by one minute in 2015 compared to 2013 while the reliable travel time remained the same between the years.

Park and ride: In 2015, park and ride (P&R) utilization rates ranged from 39% to 58% along the US 395 corridor depending on location. Three of the four P&R lots saw lower utilization rates than in 2013, but the largest P&R lot (at Huntington Transit Center) saw an increase. The total utilization for all lots combined remained unchanged. Any P&R lot that has 85% or more utilization is identified as operating at capacity. Depending on data availability, transit measures will be discussed in future Tri-Cities region analyses. The availability of P&R spaces within the transit service network provides essential access points to transit riders, vanpoolers, and carpoolers.

Future corridor analysis in the works for SR 240, I-182 and SR 397

In addition to US 395, other corridors such as SR 240, I-182 and SR 397 also experience congestion in the Tri-Cities area. During the publication of this report travel data was not readily available to analyze these additional routes.

SR 240 is an important commute and freight corridor in Richland connecting the Tri-Cities to the U.S. Department of Energy Hanford Site north of the Tri-Cities. The segment of SR 240 known as the Bypass Highway (see Point A on p. 49 map) extends from the I-182 interchange to Stevens Drive/Jadwin Avenue and has six traffic signals on it. The Bypass Highway experiences frequent and persistent delay during the commute peak periods. In 2015, there were 45.2 million weekday person miles traveled on the corridor. When detailed traffic data becomes available, WSDOT will conduct a more complete congestion analysis.

I-182 is an important freight and commute route with two known congested segments (see Points B on p. 49 map). One is near the SR 240 interchange in Richland from Queensgate Drive to George Washington Way. The other is in Pasco near the airport, from US 395/20th Avenue to SR 397. When data becomes available, the congestion level on I-182 will be analyzed.

SR 397 (see Point C on p. 49 map) provides access to the Port of Pasco and is an important freight route. It also serves as an alternate Columbia River crossing. WSDOT is interested in analyzing SR 397 as data becomes available to determine if there are any congestion concerns.

Washington's Ferry Corridor Capacity Analysis

Annual ridership[1]

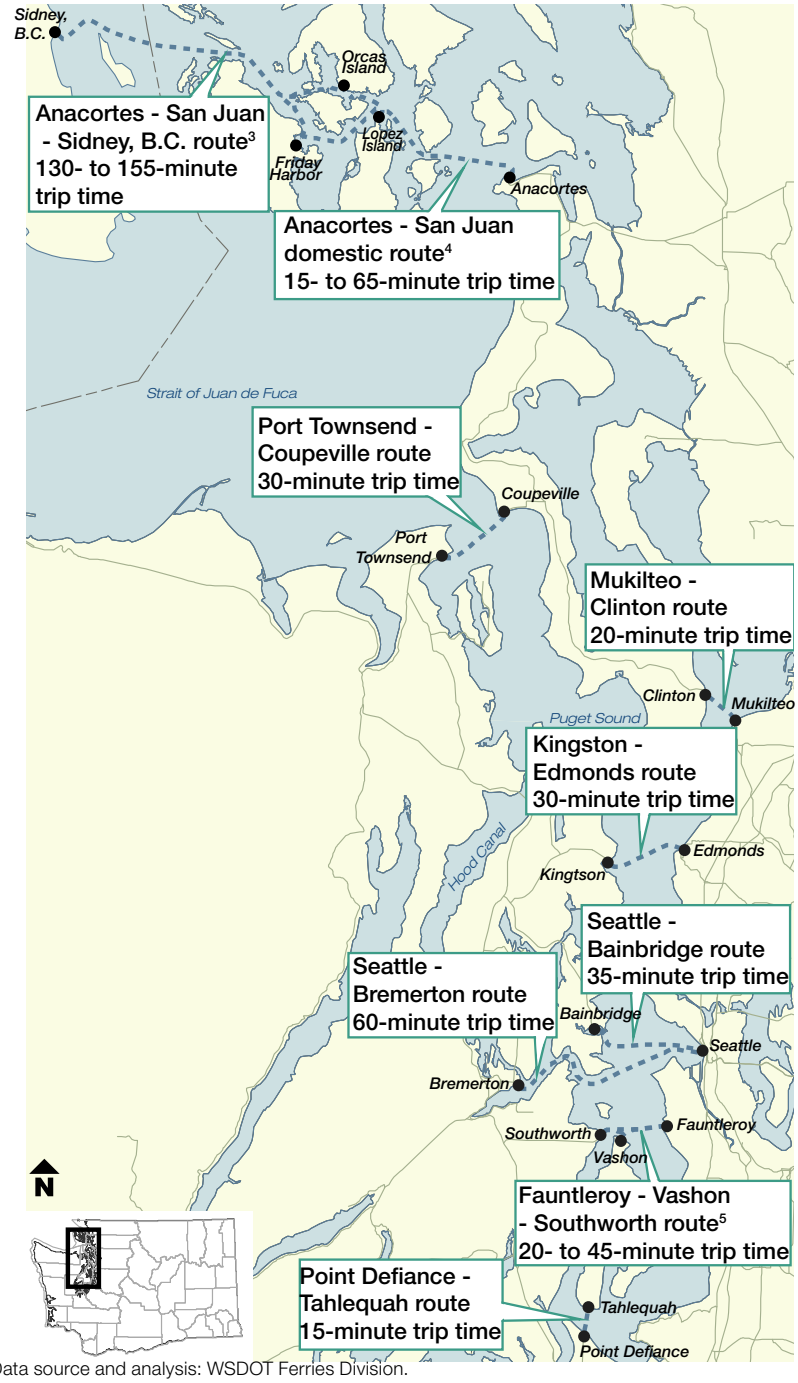
2013	vs.	2015	
22.54		23.88	6%
in millions of passengers			

Annual trip reliability[2]

2013	vs.	2015	
99.5%		99.5%	0%
of scheduled trips sailed			

Annual fuel usage & use per service mile

2013	vs.	2015		2013	vs.	2015
17.27		17.34	0.4%	19.03		19.09
in millions of gallons			0.3%	in gallons per mile		



Ferry capacity utilization

2013 and 2015; Vehicle utilization (driver + passenger utilization)

Ferry Route	2013	2015	Change (Δ)
Anacortes - San Juan domestic	54% (10%)	57% (11%)	3% (1%)
Anacortes - San Juan - Sidney, B.C.	57% (18%)	51% (17%)	-6% (-1%)
Edmonds - Kingston	65% (10%)	69% (12%)	4% (2%)
Fauntleroy - Vashon - Southworth	61% (9%)	57% (9%)	-4% (0%)
Mukilteo - Clinton	68% (12%)	67% (12%)	-1% (0%)
Point Defiance - Tahlequah	47% (7%)	54% (7%)	7% (0%)
Port Townsend - Coupeville	65% (11%)	70% (12%)	5% (1%)
Seattle - Bainbridge	61% (15%)	61% (16%)	0% (1%)
Seattle - Bremerton	43% (13%)	49% (15%)	6% (2%)
System-wide	**60% (12%)**	**62% (12%)**	**2% (0%)**

Notes: Utilization data is based on the cumulative capacity (in terms of the number of vehicle spaces and room for passengers) on all vessels serving that route, and is measured for all sailings in a calendar year. Utilization for the San Juan domestic route is measured at Anacortes, and for the Fauntleroy - Vashon - Southworth "triangle route" at Fauntleroy. 2013 utilization data for the triangle route has been updated to show a change in allotment assumptions. See Appendix p. 46 for number of trips data.

On-time performance by route

2013 and 2015; Annual percent of trips that departed on time

Ferry Route	2013	2015	Change (Δ)
Anacortes - San Juan domestic	91.4%	91.3%	-0.1%
Anacortes - San Juan - Sidney, B.C.	88.7%	93.3%	4.6%
Edmonds - Kingston	99.3%	98.3%	-1.0%
Fauntleroy - Vashon - Southworth	93.9%	92.0%	-1.9%
Mukilteo - Clinton	92.9%	94.6%	1.7%
Point Defiance - Tahlequah	99.1%	97.1%	-2.0%
Port Townsend - Coupeville	99.1%	99.3%	0.2%
Seattle - Bainbridge	95.3%	91.0%	-4.3%
Seattle - Bremerton	96.6%	97.6%	1.0%
System-wide	**95.6%**	**94.4%**	**-1.2%**

Notes: A vessel is considered on time if it departs within 10 minutes of its scheduled departure. WSDOT's annual goal is for 95% of trips to depart on time.

Ridership by route

2013 and 2015; Annual ridership in thousands

Ferry Route	2013	2015	%Change (Δ)
Anacortes - San Juan domestic	1,802	1,974	10%
Anacortes - San Juan - Sidney, B.C.	142	139	-2%
Edmonds - Kingston	3,855	4,103	6%
Fauntleroy - Vashon - Southworth	2,907	2,975	2%
Mukilteo - Clinton	3,907	4,113	5%
Point Defiance - Tahlequah	682	769	13%
Port Townsend - Coupeville	679	787	16%
Seattle - Bainbridge	6,270	6,362	1%
Seattle - Bremerton	2,293	2,660	16%
System-wide	**22,537**	**23,882**	**6%**

See Appendix p. 46 for more information

Data source and analysis: WSDOT Ferries Division.

Notes: 1 Passenger ridership includes vehicle drivers and passengers, as well as walk-on passengers and bicyclists. 2 Trip reliability is the ratio of actual sailings compared to the number of scheduled sailings. 3 The international route takes 130 minutes non-stop between Anacortes and Sidney, B.C., and 155 minutes if the trip stops at Friday Harbor. 4 Data for the San Juan inter-island route is combined with the San Juan domestic route. The 65-minute trip time is specifically for Anacortes to Friday Harbor with no stops, and the inter-island trips have shorter trip times. 5 Some trips are direct between two locations (with shorter trip times) and others serve all three locations.

On average, 62% of vehicle capacity on ferries is used

Annual ridership on WSDOT ferries increased 6%, with approximately 948,000 more passengers and 397,000 more vehicles in 2015 than in 2013. Annual trip reliability did not change in that time frame. Both years met the system-wide goal of completing at least 99% of scheduled sailings. Between 2013 and 2015, ferry vessel fuel use increased 0.4%. Fuel use is related to the number of sailings, the type and size of vessel, and route characteristics.

WSDOT's ferry service routes function as marine corridors in Washington state. They are integral links across the Puget Sound, connecting island and peninsula communities with the major employment centers, in addition to facilitating leisure trips.

Ferry route analysis:

Ridership by route: Ridership changes ranged between -2% and 16% from 2013 to 2015. The largest ridership increases (both 16%) were on the Port Townsend – Coupeville and Seattle – Bremerton routes. These increases are likely due to a regional economic upswing and lower gas prices, leading to an increase in discretionary trips measured by higher single ticket sales. The differential in housing prices across Puget Sound likely also plays a role by increasing passengers commuting to work.

Ferry route capacity: WSDOT owns and operates 23 ferry vessels—the newest in the fleet, Motor/Vessel *Samish*, was launched in June 2015. These vessels serve nine routes with stops at 19 ferry terminals in Washington and one in Sidney, British Columbia. Seven of the nine ferry routes are served by at least two vessels, operating simultaneously in order to keep terminal wait times low. The route capacity is defined as the cumulative passenger and vehicle capacities for all sailings of each vessel serving a particular route, and may fluctuate depending on vessel size or crew availability for each trip. Read more in the 2014 *Corridor Capacity Report* (p. 42).

Capacity utilization: In 2015, the utilization of vehicle spaces on all ferry trips averaged 62%, two percentage points higher than in 2013. Vehicle space utilization on individual ferry routes ranged between 49% (Seattle – Bremerton) and 70% (Port Townsend – Coupeville) in 2015. The Point Defiance – Tahlequah route saw the greatest increase in vehicle utilization, with a seven percentage point change to 54% in 2015. Ferry route utilization based on ridership and vessel capacity reflects utilization for all sailings over the entire day, not for peak periods as used to track capacity for most other transportation modes.

Because ferry vessels are capable of carrying many more passengers than vehicles, the passenger utilization rates are lower, ranging from 7% (Point Defiance – Tahlequah) to 17% (between Canada and the U.S.) of the available capacity in 2015.

Passenger capacity utilization on ferries, which includes drivers of the onboard vehicles, fluctuated for different routes between 2013 and 2015, but did not significantly increase system-wide. The highest route increases—two percentage points—were observed on the Edmonds – Kingston and Seattle – Bremerton routes. Simultaneously, vehicle capacity utilization and ridership increased on these routes. The only route with a slight decline in passenger capacity utilization, of less than 1%, was the Anacortes – San Juan – Sidney, B.C. route, likely because the route capacity itself expanded as more trips were added in 2015.

On-time performance: There were more than 162,000 sailings in 2015, an average of 444 sailings every day of the year (see Appendix p. 46). In 2015, 94.4% of sailings departed within 10 minutes of their scheduled departure, which is slightly below WSDOT's annual system wide goal of 95%. On four of nine routes, on-time performance held steady or improved from 2013 to 2015. The largest improvement, 4.6 percentage points, was on the Anacortes – San Juan – Sidney, B.C. route, with an on-time performance of 93.3% in 2015.

On-time performance declined on the Seattle – Bainbridge route by 4.3 percentage points to 91.0%, due in part to heavy traffic during the busy summer months and construction adjacent to the Seattle terminal, impacting vehicle loading and unloading. System-wide declines in on-time performance are mostly due to increased ridership which increases the time vessels need to be at the dock for loading and unloading. Additional impacts to on-time performance can be attributed to unplanned maintenance that required less than ideal vessel assignments in 2015.

Trip reliability: Eight of the nine routes met the annual system-wide goal of completing at least 99% of scheduled sailings in 2015. The Port Townsend – Coupeville route did not meet the annual goal as trip reliability dropped from 95.8% to 95.7% between 2013 and 2015, representing 14 more net missed trips on this route in 2015 than in 2013. Reliability changed less than one percentage point from 2013 on all routes.

Amtrak Cascades® Corridor Capacity Analysis

Passenger miles traveled

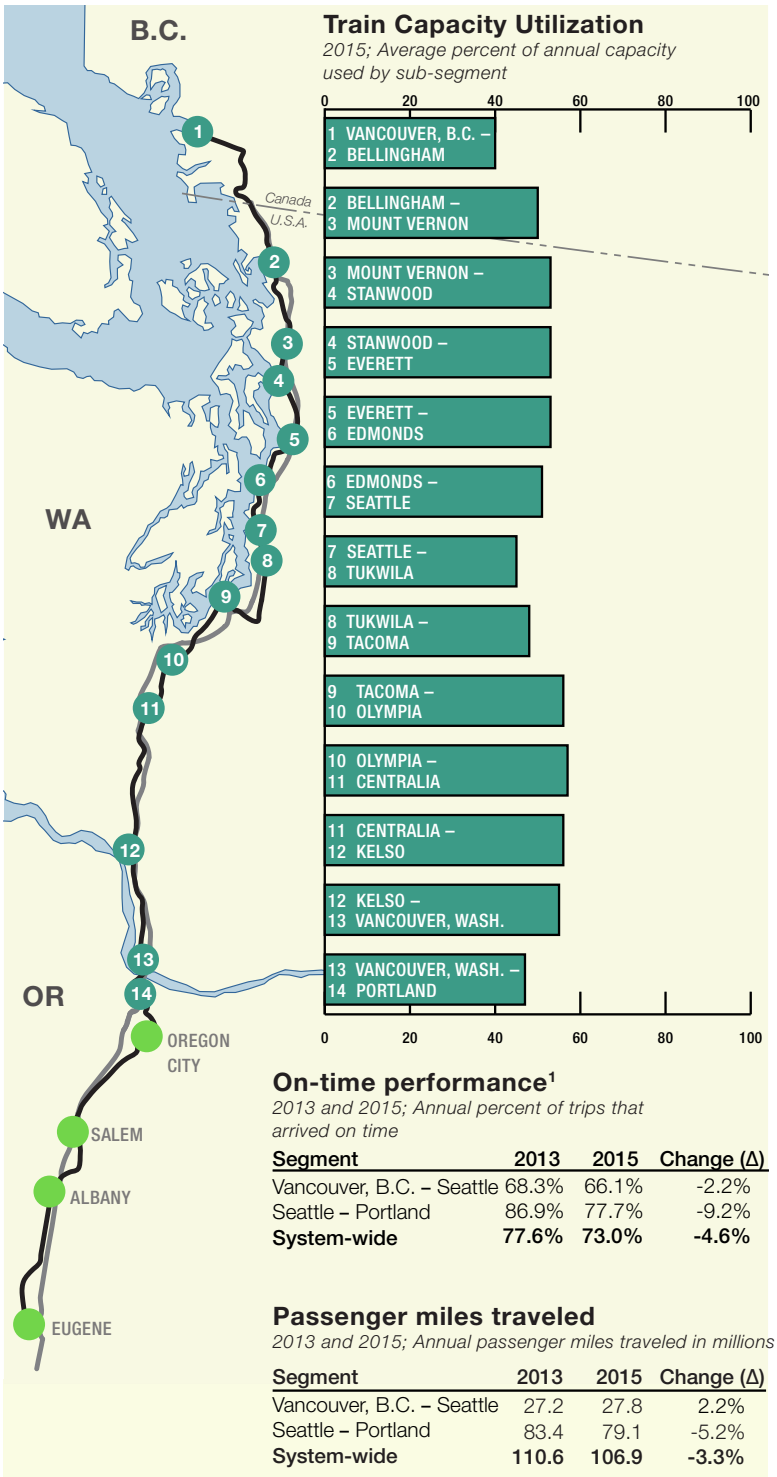
2013	vs.	2015	
110.6		106.9	3.3% ↓
in millions of miles			

Annual on-time performance[1]

2013	vs.	2015	
77.6%		73.0%	4.6% ↓
of scheduled trips			

Annual capacity utilization + annual ridership

2013	vs.	2015		2013	vs.	2015
59.8%		56.8%	3.0% ↓	694		672
for the peak sub-segment			3.2% ↓	in thousands of passengers		



Train Capacity Utilization

2015; Average percent of annual capacity used by sub-segment

On-time performance[1]

2013 and 2015; Annual percent of trips that arrived on time

Segment	2013	2015	Change (Δ)
Vancouver, B.C. – Seattle	68.3%	66.1%	-2.2%
Seattle – Portland	86.9%	77.7%	-9.2%
System-wide	**77.6%**	**73.0%**	**-4.6%**

Passenger miles traveled

2013 and 2015; Annual passenger miles traveled in millions

Segment	2013	2015	Change (Δ)
Vancouver, B.C. – Seattle	27.2	27.8	2.2%
Seattle – Portland	83.4	79.1	-5.2%
System-wide	**110.6**	**106.9**	**-3.3%**

As population and economic activity grow and congestion worsens along the I-5 corridor, the importance of providing travel options that reduce reliance on single-occupancy vehicles increases. Amtrak Cascades provides five daily intercity rail round trips for various segments of the Vancouver, British Columbia, to Eugene, Oregon, corridor, supporting the state's long-term strategy to provide a sustainable multimodal transportation system and increase person throughput.

Passenger miles traveled: In 2015, Amtrak Cascades passengers rode 106.9 million passenger miles in Washington, a decrease of 3.3% from 2013. Ridership simultaneously decreased by 3.2%, likely due to lower gas prices and more intense construction on the rail corridor leading to longer trip times and schedule changes. Washington trains carried each passenger for an average of 110 passenger miles per gallon of fuel in 2015, based on a locomotive fuel use estimate of 1.2 gallons per mile.

Capacity utilization: Riders utilized 56.8% of Amtrak Cascades train capacity in Washington on average in 2015 for the peak sub-segment (Olympia – Centralia), three percentage points lower than in 2013. Utilization rates for the peak sub-segment can limit available capacity for the entire corridor. For example, if the Olympia – Centralia sub-segment was sold out, someone in Seattle could not buy a ticket to Portland. Average train capacity fluctuates throughout the year, with trains selling out during weekends, holidays and the summer.

On-time performance: Trains in Washington achieved 73% on-time performance in 2015, down approximately 4.6 percentage points from 2013, due in part to ongoing construction projects that will reduce congestion and improve trip reliability with new bypass tracks for slower freight trains. The Seattle to Portland evening trip had the highest on-time performance, at 82.5%. The on-time performance goal is 80%, but inter-train congestion consistently causes corridor delays.

Data source and analysis: WSDOT Rail Division.

Notes: All "Washington" data is for trains between Portland, Oregon, and Vancouver, B.C. regardless of funding entity. See bit.ly/RailPerformance for more information. 1 A train is considered on time if it is within 10 minutes of scheduled arrival times for trains operating the Vancouver, B.C. – Seattle and Seattle – Portland segments; or 15 minutes of scheduled arrival times for trains operating the entire Vancouver, B.C. – Portland segment.

Incident Response Annual Report

WSDOT teams keep traffic moving at 50,092 incidents

Incident Response (IR), WSDOT's traffic incident management program, responded to 50,092 incidents in 2015, clearing scenes to keep traffic moving in an average of 12 minutes and 45 seconds from incident notification. WSDOT's assistance resulted in approximately $80.2 million in estimated economic benefit to travelers and businesses in Washington by reducing congestion caused by traffic incidents and helping prevent secondary incidents. WSDOT's annual IR budget was $4.5 million in 2015, meaning WSDOT provided an estimated $17.82 benefit for every dollar spent on traffic incident management.

Incident clearance times remain flat between 2013 and 2015

WSDOT's IR teams cleared incidents in an average of 12 minutes and 45 seconds in 2015, the same in 2013. The IR program's average incident clearance time has hovered between 12 and 13 minutes from 2011 through 2015 with the exception of 2014. In general, faster clearance times mean less incident-induced congestion and fewer secondary incidents.

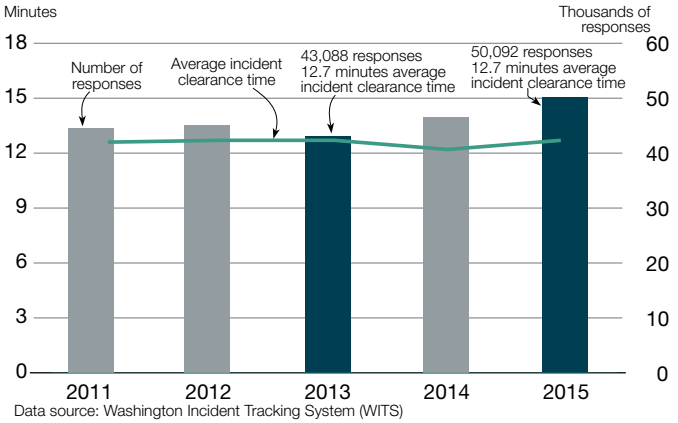
Traffic incident management is a key strategy for maximizing highway system performance

Traffic incidents such as collisions are responsible for nearly half of non-recurrent congestion (traffic congestion caused by one-time events). Non-recurrent congestion can also be caused by severe weather or large events. These events temporarily reduce the transportation system's ability to move people and goods. Traffic incident management is nationally recognized as a best practice for reducing or preventing non-recurrent congestion.

The WSDOT Incident Response program's mission is to clear traffic incidents safely and quickly, minimizing congestion and the risk of secondary collisions. The program is active in all six WSDOT regions with about 80 trained IR drivers and 62 dedicated vehicles. Teams patrol 493 centerline miles of state highway on major corridors during peak traffic hours and assist the Washington State Patrol in traffic emergencies at all hours.

Incident clearance times remain below 13 minutes, while responses increase by 16.3%

2011 through 2015; Clearance time in minutes; Number of incident responses in thousands



Data source: Washington Incident Tracking System (WITS)

Notes: Data is only for incidents to which a WSDOT Incident Response team responded

WSDOT prevents $80.2 million in delay and secondary collisions

WSDOT estimates that IR crews' proactive management of incident scenes provided an economic benefit of $80.2 million to travelers and businesses using Washington highways in 2015. These benefits are provided in two ways. First, by clearing incidents as quickly as possible, WSDOT crews reduce the time and fuel motorists wasted in incident-induced congestion. In 2015, WSDOT estimates that IR crews prevented about $45.4 million in incident-related congestion costs. Second, by proactively managing traffic at incident scenes, IR crews reduce the risk of secondary incidents caused by distracted driving or sudden changes in traffic conditions. WSDOT crews prevented an estimated 9,546 secondary incidents in 2015, resulting in $34.8 million

Incident Reponse teams work to clear incidents as quickly as possible.

WSDOT teams provide $80.2 million in benefit in 2015

WSDOT teams' performance at incidents in 2015 prevents $80.2 million in incident-related costs
2015; Incidents by duration; Time in minutes; Cost and economic benefit in dollars

		Blocking[1] incidents		All incidents		Economic impacts	
Incident duration	**Number of incidents[2]**	**Percent blocking**	**Average roadway clearance time**	**Average incident clearance time**	**Average roadway clearance time**	**Cost of incident-induced delay**	**Economic benefits[3] from IR program**
Less than 15 min.	36,819	17.5%	4.6	5.0	0.8	$48,718,154	$22,667,902
Between 15 and 90 min.	10,282	53.7%	25.6	30.4	13.9	$95,171,266	$41,683,947
Over 90 min.	628	87.3%	166.5	178.9	145.8	$37,656,864	$15,839,320
Total	**50,092**	**26.2%**	**21.5**	**12.7**	**5.5**	**$181,546,284**	**$80,191,169**
Percent change from 2013	**↑ 16.3%**	**↑ 1.7%**	**↑ 8.6%**	**↑ 0.6%**	**↑ 19.8%**	**↑ 19.2%**	**↑ 18.1%**

Data sources: Washington Incident Tracking System, Washington State Patrol, WSDOT Traffic Office, and Washington State Transportation Center.
Notes: 1 An incident is defined as blocking when it closes down at least one lane of travel on the road. 2 WSDOT teams were unable to locate (UTL) 2,361 of the 50,092 incidents. UTL incidents are included in the total number of incidents but not figured into other performance measures. 3 Economic benefits include the sum of benefits from saved time, gas and secondary incidents avoided due to IR teams' proactive work. Numbers may not add due to rounding.

of economic benefit. See WSDOT's *Handbook for Corridor Capacity Evaluation* pp. 45-47 for delay reduction benefit calculations as well as all other IR related metrics.

Incidents led to nearly $182 million in congestion-related costs

Traffic delay at the 50,092 incidents that WSDOT teams responded to in 2015 cost travelers on Washington highways an estimated $181.5 million. This is 19.2% more than the $152.4 million in costs that occurred in 2013. Without the work of WSDOT's IR crews, this cost would have been $261.7 million ($80.2 million in prevented delay and secondary collisions costs plus $181.5 million in actual delay costs).

Blocking incidents a quarter of all incidents, more than half of delay

About 26.2% of the incidents that WSDOT's IR teams responded to in 2015 blocked at least one lane of traffic (13,147 out of the 50,092 total incidents). These blocking incidents caused 62.2% of the incident-related congestion costs for the year.

Blocking incidents cause more congestion per minute than non-blocking incidents. Also, blocking incidents tend to last longer (compare the roadway clearance columns for blocking versus all incidents in the table above) as they are more complicated to clear.

Commercial vehicles involved in 6.5% of all incidents

Commercial vehicles, such as semitrucks, were involved in 3,269 incidents or about 6.5% of all incidents IR teams responded to in 2015 (not including unable to locate incidents, see notes in table above). On average these incidents took 18 minutes and 32 seconds to clear, about 5 minutes and 47 seconds longer than the overall average clearance time.

However, commercial vehicles were involved in a larger proportion of incidents lasting over 90 minutes, accounting for 24.8% of these incidents (156 out of 628). Furthermore, over-90-minute incidents involving a commercial vehicle took an average of 3 hours and 11 minutes to clear. This is roughly 12 minutes longer than all over-90-minute incidents including extraordinary incidents (those lasting longer than six hours).

Incidents involving commercial vehicles can be more complex to clear due to factors such as the size of the vehicle or any freight spilled due to the incident. These incidents can also require special towing equipment. Just like with other incidents, WSDOT's goal is quicker clearance times for less impact to the system.

Customer feedback: Incident Response program keeps traffic safe and moving

WSDOT drivers give comment cards to motorists who receive assistance. Below are comments the program received in 2015.

- *I was honestly surprised at how quickly [Incident Response] were at the scene and fixed the problem. Very nicely done.*
- *I had no idea that the DOT had this program. These guys really helped me out in a time of need and I appreciate this program.*
- *Heather did an outstanding job of helping me move to a safe location to replace a blown tire.*

Corridor Capacity Report Credits

The *Corridor Capacity Report* is developed and produced by a small team of data scientists at the WSDOT Office of Strategic Assessment and Performance Analysis each year, with the help of dozens of individuals both at WSDOT and across the state's transportation community. WSDOT gratefully acknowledges their contributions.

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Behind the scenes of the *Corridor Capacity Report*

Beginning with the 2014 *Corridor Capacity Report* WSDOT published detailed performance measure information as part of a data appendix along with a *Handbook for Corridor Capacity Evaluation*, which serves as a one-stop shop to help readers navigate the annual *Corridor Capacity Report*'s multimodal analysis of transportation system performance. The handbook is a tool for technical professionals working to implement system performance measurement and reporting as part of their agency's accountability initiatives and/or the federal Moving Ahead for Progress in the 21st Century (MAP-21) requirements.

WSDOT published a second edition of the document this year, which can be found at: www.wsdot.wa.gov/publications/fulltext/graynotebook/CCR_methodology_2nd_edition.pdf .

Americans with Disabilities Act information for the public

Accommodation requests for people with disabilities can be made by contacting the WSDOT Diversity/ADA Affairs team at wsdotada@wsdot.wa.gov or by calling toll-free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711.

Civil Rights Act of 1964, Title VI Statement to the Public

It is the Washington State Department of Transportation's policy to assure that no person shall, on the grounds of race, color, national origin, or sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any of its federally funded programs and activities. Any person who believes his/her Title VI protection has been violated may file a complaint with WSDOT's Office of Equal Opportunity. For additional information regarding Title VI complaint procedures and/or information regarding our non-discrimination obligations, contact OEO's Title VI Coordinator at (360) 705-7082.

WSDOT's 2016 *Corridor Capacity Report* is prepared by the
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