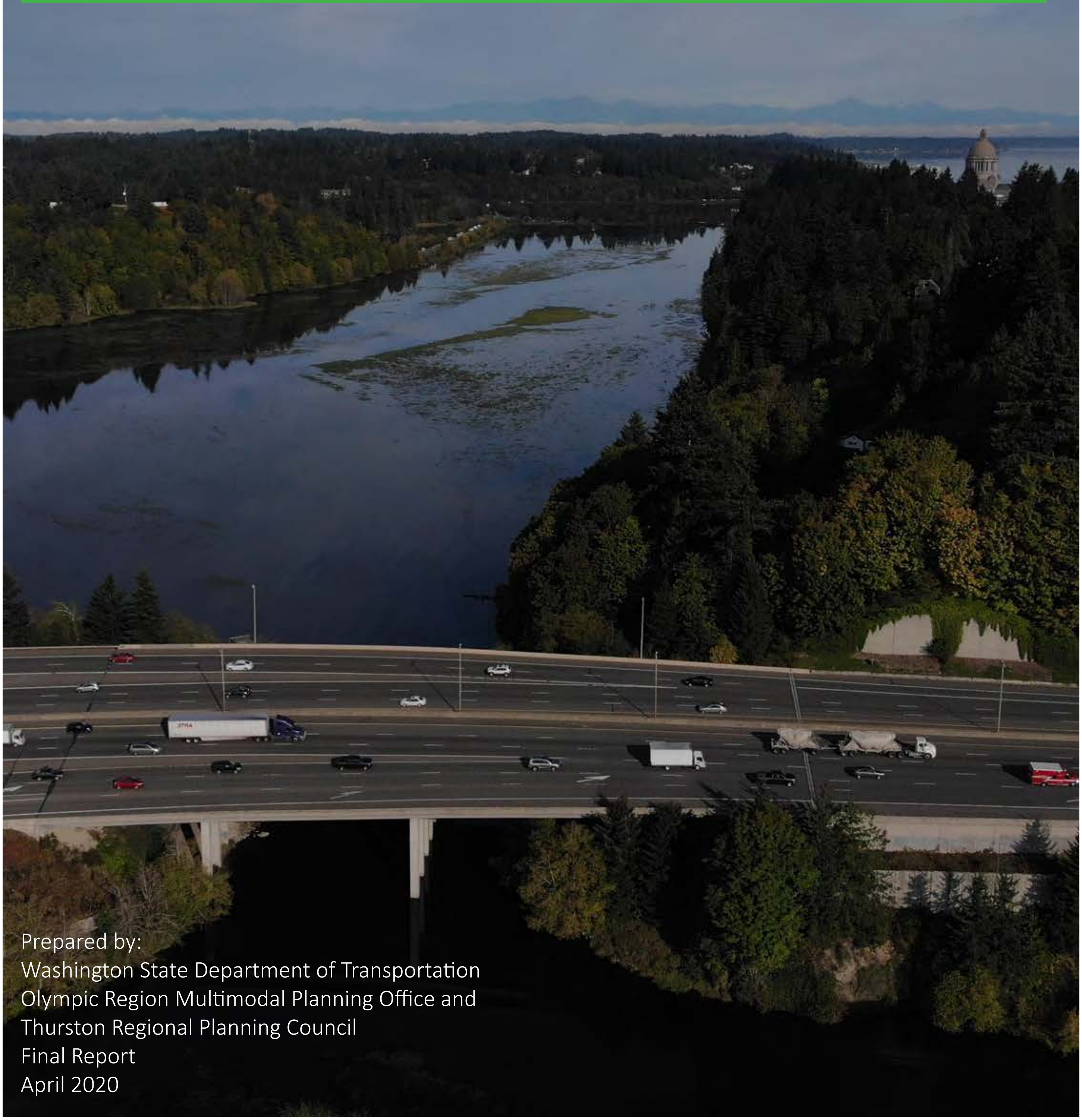
INTERSTATE 5: TUMWATER TO MOUNTS ROAD MID- AND LONG- RANGE STRATEGIES



Prepared by:
Washington State Department of Transportation
Olympic Region Multimodal Planning Office and
Thurston Regional Planning Council
Final Report
April 2020

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Interstate 5 Tumwater to Mounts Road
Mid- and Long-Range Strategies Planning Study

April 2020
Study limits milepost 99 to milepost 116

Approved by:

John Wynands | April 27, 2020

John Wynands | Date
WSDOT Olympic Region Administrator

Concurrence by:

Electronic Signature - Kerri Woehler | 04.27.20

Kerri Woelher | Date
Director, Multimodal Planning

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Executive Summary

In 2018, the Washington State Legislature funded a planning study of Interstate 5 between SR 121 in Tumwater (exit 99) and Mounts Road near DuPont (exit 116) to develop mid- and long-term strategies for improving the region's transportation system performance. Collaborating with local partners, WSDOT and Thurston Regional Planning Council (TRPC) developed strategies to meet study goals and support local agency plans while focusing on the legislative requirements[1]:

- *Identifying strategies for regional congestion management,*
- *Identifying potential improvements for the US 101/I-5 Interchange,*
- *Identifying a strategic plan for the Nisqually River bridges, considering ecosystem benefits.*

The study area includes the cities of Tumwater, Olympia, Lacey, parts of unincorporated Thurston and Pierce Counties, and the Billy Frank Jr. Nisqually National Wildlife Refuge. The study area is near the Nisqually Indian Tribe Reservation and Joint Base Lewis-McChord (JBLM). In addition to I-5, study partners considered facilities for all transportation modes present in these communities in their analysis including transit, vehicles on local roads, walking, and bicycling.

This segment of I-5 is important regionally and nationally for a number of reasons:

- It is the primary north-south route along the west coast, connecting regional and global economic centers.
- It serves as the primary commute route in the study area and the south Puget Sound region generally.
- It provides access to Joint Base Lewis-McChord and is important for base operations.
- It is one of three roads, and the only high-capacity and high-speed road, connecting Thurston and Pierce counties.

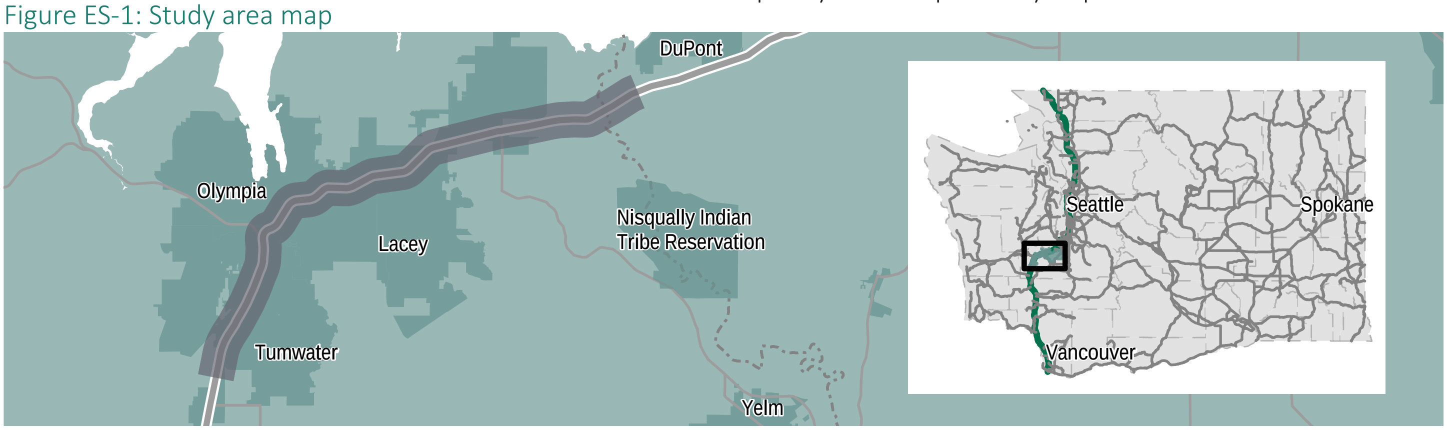
I-5 and US 101 meet just south of the Washington State Capitol. This is one of the places the legislature directed WSDOT to focus on.

- It passes directly through the Nisqually River valley near the river's estuary, an environmentally important place, the tradional home of the Niqually Indian Tribe, and habitat for threatened species of salmon and steelhead.

This segment of I-5 experiences recurring congestion due to high traffic volumes and weaving at interchanges. These issues occur mostly at three locations during peak commute periods: the US 101 interchange at Exit 104; between the state Capitol and Lacey at Exits 105 and 109; and near the Nisqually River bridges. I-5 also passes through the Nisqually River valley, an environmentally sensitive and important area for Endangered Species Act listed Chinook salmon and steelhead as well as the traditional home of the Nisqually Indian Tribe.

WSDOT's mission is to provide safe, reliable, and cost-effective transportation options to improve communities and economic vitality for people and businesses. WSDOT approach to achieving its mission is called Practical Solutions. This approach uses performance-based, data-driven decision making and early community involvement to guide the development and delivery of transportation investments. Our goal is to identify and solve problems as quickly and inexpensively as possible.

Figure ES-1: Study area map



1 Engrossed Substitute Senate Bill 6106, page 45 line 37 – page 46 line 6. http://lawfilesext.leg.wa.gov/biennium/2017-18/Pdf/Bills/Session%20Laws/Senate/6106-S.SL.pdf

I-5 passes through the Nisqually River Valley just upstream of where the river meets Puget Sound.

A strategic approach for I-5 through the Nisqually River valley

One of the outcomes the legislature required for this study was "...a strategic plan for the Nisqually River Bridges..." As it stands, the study team can only make recommendations based on the information available, which is largely focused on transportation. WSDOT is helping fund a study led by the Nisqually Indian Tribe and U.S. Geological Survey (USGS) of the Nisqually River and its delta near I-5. WSDOT expects results by summer 2020 which will provide data on potential for movement of the river channel and any effects I-5 has on salmon habitat and recovery particularly focusing on the estuary. This will inform evaluation of risks posed to I-5 and regional transportation by the river and potential impacts of I-5, and other factors like climate change, on fish and wildlife habitat. For the meantime, the study team developed a strategic approach for WSDOT and its partners regarding I-5 through the Nisqually Valley:

- Treat all strategy recommendations from this study provisional until the study being conducted by the Nisqually Indian Tribe and USGS is completed to provide a more complete picture of risks for I-5 and impacts on the river and delta.
- If any alteration to I-5 through the Nisqually River valley occurs, incorporate salmon productivity, flood control, and other environmental considerations into the design as contextual needs rather than as mitigation for impacts.
- If replacing I-5 through the Nisqually Valley is funded for environmental reasons, the design should 1) allow for future widening to alleviate the anticipated southbound chokepoint at Mounts Road and 2) address the active transportation gap between Thurston and Pierce counties.
- All partners should continue to develop interim solutions to help address habitat and flood protection concerns.

WSDOT used collaboration with partners and community engagement to steer the study process

WSDOT and TRPC developed a planning process, discussed in depth in Chapter 3, which included a broad range of perspectives, disciplines, and backgrounds in outreach and decision making. To achieve this, the study team surveyed local communities and collaborated with local government partners to develop goals and strategies. The study team also worked with two advisory groups, one of technical experts and one of executive staff and elected officials from local governments, tribal governments, and state and federal agencies. Both groups met regularly to review progress and advise the study team. Early on in the study WSDOT and TRPC developed overarching goals through community engagement and collaboration with partners that articulated desired outcomes for local partners and aligned with legislative intent for the study:

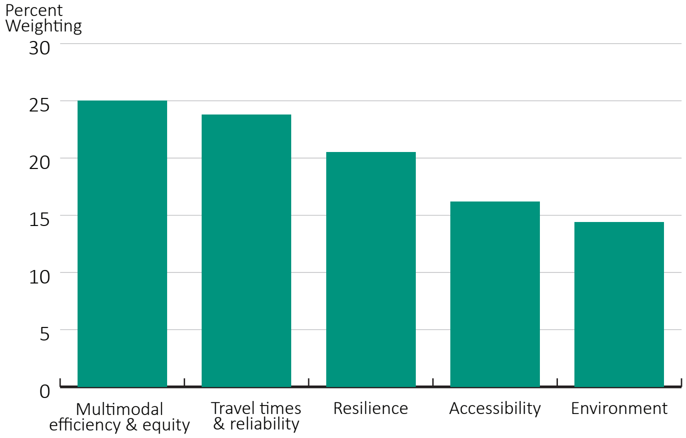
- **Travel times and reliability** – Improve travel times on I-5 and make them more predictable.
- **Efficiency and equity** – Increase the transportation system's ability to efficiently and equitably move all people and goods.
- **Accessibility** – Improve access to job sites, commercial services, and industrial areas.
- **Environmental** – Protect and enhance the environment including reducing the transportation-related impact on wildlife habitat in the Nisqually River delta.
- **Resilience** – Improve the transportation system's ability to operate during disruption and recover from it.

The study team used input from the technical advisory group and results from study surveys to prioritize the study goals. This step allowed the stakeholder advisory groups and public to determine how study goals were weighted in evaluating the overall effectiveness of model scenarios. Advisory group input and public input were given equal weight in calculating the final prioritization.

Exhibit ES-2: Study goal weigthing scores

Overall study advisory groups and public input ranked Efficiency & Equity highest among study goals, followed closely by travel times

Study goal area percent weighting calculated from advisory group input and public survey feedback



Notes: Goal area weightings were as follows: Efficiency & Equity 25.0%, Travel Times 23.8%, Resilience 20.5%, Accessibility 16.2%, Environment 14.4%

After developing these goals, WSDOT and TRPC developed strategies with the advisory groups that would support goal achievement, incorporating ideas from previous studies by WSDOT and local partners like Intercity Transit's Long-Range Plan, and public input. The study team conducted an initial screening of the strategies to ensure they aligned with study goals and applicable state and federal law. The strategies that made it through this initial screen were then grouped into "scenarios" to be modeled or categorized as unable to be modeled. In total, the study team and advisory groups developed ten scenarios that could be tested in models, and 45 strategies made it through the initial screen but were unable to be modeled and had to be evaluated through other means.

The study team then collaborated with study partners to evaluate the effectiveness of each for achieving study goals. Because there were strategies that could be modeled and those that could not, the study team developed two approaches for evaluating the different ideas investigated through the study.

The study team produced data from the modeled scenarios that could be translated into measures of system performance. The study team developed an initial set of performance measures for each study goal, discussed further in Chapter Six. Both study advisory groups helped develop these measures. For the strategies that could not be modeled, the study team collaborated with the advisory groups to evaluate each one.

Results from modeling suggest smaller improvements could yield big benefits

Exhibit ES-4 shows the overall effectiveness scores when comparing a scenario's performance to the prior scenario and compared to the 2040 baseline scenario, which included all projects currently funded for construction and population and employment growth projections based on observed regional trends, as well as cost estimates. The scenarios are shown in the order they were modeled, from left to right. Each scenario included all of the improvements from previous scenarios, building off of each other, so the order of modeling is important to keep in mind with two exceptions. In *Scenario Nine – Widen I-5: Add General Purpose Lanes, Retain HOV Lanes* and *Scenario Ten – Widen I-5: Add General Purpose Lanes, Convert HOV lanes to General Purpose*, shoulder use was converted to permanent auxiliary lanes and Scenario Ten the HOV lanes were switched to general use.

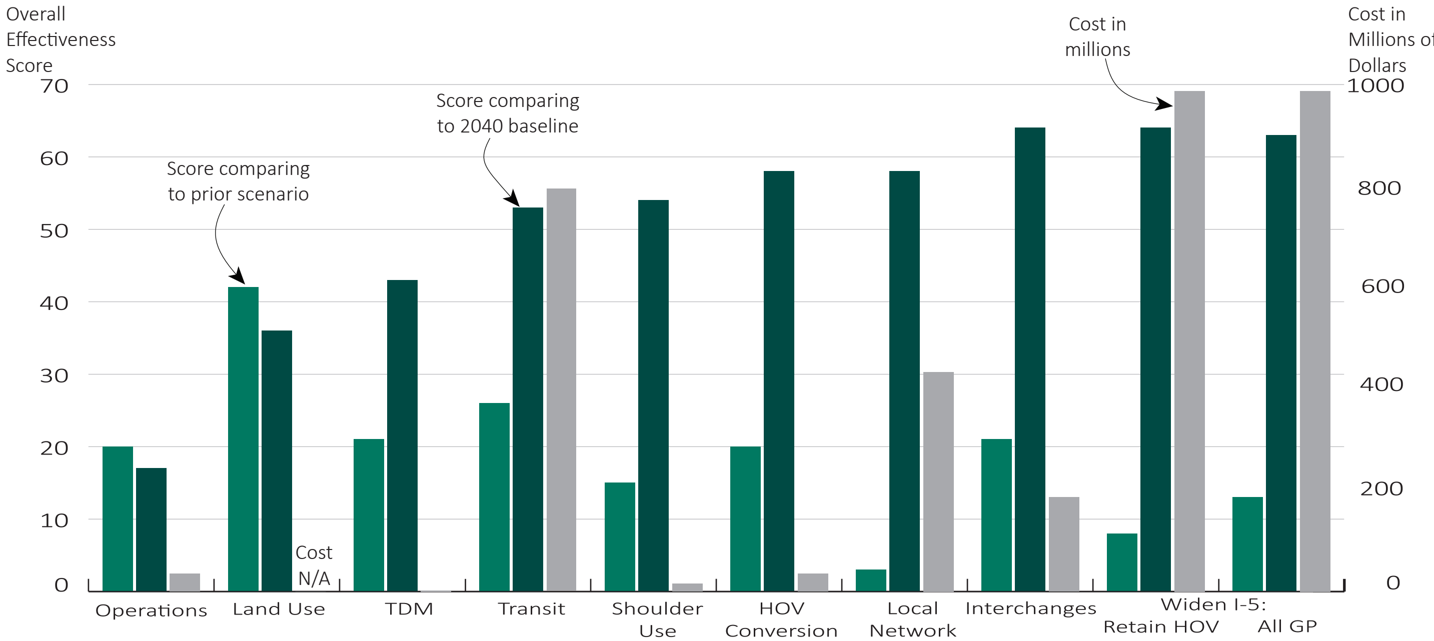
These were the primary figures that influenced discussions on study recommendations. Both sets of performance scores were important as they gave the study team and advisory groups an idea of the incremental benefit of each scenario (score compared to prior scenario) and the

Exhibit ES-3: Modeled strategy scenarios

Exhibit ES-4: Scenario effectiveness scores

Overall effectiveness scores compared to prior scenario and 2040 baseline show incremental and cumulative benefits of the modeled scenarios

Overall effectiveness scores from modeling results compared to prior modeled scenario and funded base; Planning-level cost estimates in millions of 2019 dollars



cumulative benefit of all the improvements together (score compared to 2040 baseline). Both sets of performance scores show that the scenarios modeled earlier on, which were also generally lower cost, provided the most incremental benefit with the exception of *Scenario Seven – Regional Transportation Plan Local Projects*.

The overall effectiveness scores comparing to 2040 baseline further show that the two widening scenarios, while showing some incremental benefit, do not improve the cumulative benefit after the other smaller improvements had been implemented in the model. Furthermore, the last two scenarios are by far the most expensive of the modeled scenarios costing $225 million more than all others that have an estimate combined. While planning-level cost estimates were not used to score scenarios, they were presented to advisory groups when discussing study recommendations. WSDOT uses the Practical Solutions approach to solving transportation issues. This means low-cost solutions to transportation performance issues are evaluated and exhausted prior to implementing higher-cost projects.

Recommendations for improving transportation system performance

The study team used performance data, and other information like planning-level cost estimates when available, as a tool to guide discussions of final recommendations with study advisory groups. Exhibit ES-5 shows the recommended timelines for further planning and implementation of the various modeled scenarios as well as their planning-level cost estimates if available.

The recommendations reflect the results of those final deliberations between the study team, study partners, and input from the public received through open house events. These are considered provisional recommendations until data from the study being conducted by the Nisqually Indian Tribe and USGS on the Nisqually River channel migration, risks to I-5, and sediment delivery to the estuary have been reviewed.

Most of the recommendations developed through this study will be investigated in further detail in the next phase of planning called a Planning and Environmental Linkages (PEL) study. Others, such as land use, are outside of WSDOT's authority to implement and will require active engagement with local partners who will be the lead

Strategies involving using existing infrastructure more efficiently such as improving transit service scored well according to study performance measures.

Exhibit ES-5: Recommended timelines for further planning and implementation of modeled scenarios

Recommendations require transportation system will be maintained in a state of good repair

As discussed in Chapter Four, WSDOT has maintained the majority of this section of I-5 in fair or better condition. Modeling conducted for this study assumed that WSDOT and its partners will continue to maintain and preserve the transportation system in a state of good repair so that roadway operations and capacity will be maintained. System-wide, Washington State is currently substantially under-investing in state of good repair. WSDOT has regularly communicated this Preservation gap to the Washington State Legislature – in early 2020, WSDOT estimated an annual gap of $690 million to preserve and maintain WSDOT's transportation assets. As this continues, there will be widespread failures in the state system, resulting in operational reductions such as speed reductions, weight limitations, etc.

Scenario	Planning-level cost estimates[1]	Recommended strategy timelines		
		Near term (0-5 years)	Mid term (5-10 years)	Long term (10-20 years)
#2 – Land Use	Currently N/A[2]			
#4 – Transit	$55 million			
#3 – Transportation Demand Management	$2 million			
#1 – Operations (state and local)	$35 million			
#5 – Part Time Shoulder Use	$15 million			
#8 – Interchange Improvements	$186 million			
#6 – HOV Conversions	$35 million			
#9 – Widen I-5: Add general purpose lanes, retain HOV lanes	$987 million[3]			
#7 – Local Network	$433 million	Does not appreciable contribute to study performance measures		
#10 – Widen I-5: Add general purpose lanes, convert HOV lanes to general use	$987 million[3]	Not recommended		

Notes: 1) While planning-level cost estimates were developed and presented for consideration to study advisory groups, it was not used as a factor for scoring the scenarios. Cost estimates are provided in 2019 dollars. 2) WSDOT was not able to calculate the cost of planning and implementing TRPC's Sustainable Thurston Land Use goals. Furthermore, any costs for implementing this strategy will likely be incurred by local agencies like city and county governments. 3) Cost estimate for Scenario Nine and Ten does not include an elevated causeway through the entire Nisqually River valley but does include replacing I-5 from the Nisqually River north/east to the BNSF train tracks with bridges. In general, there is a high level of uncertainty around costs for changes I-5 through the valley.

agencies. No one strategy is going to address all study goals alone, for example I-5 Travel Times and Reliability. These scenarios were modeled building off of each other and some may need to be implemented in conjunction to achieve the performance results discussed in this study.

COVID-19 implications for the results of this study currently unknown

WSDOT, TRPC, and their partners conducted this study between July 2018 and January 2020. Modeling used historic data on regional population, job growth and travel behavior to project future demand. This did not account for potential impacts of major disruptions such as COVID-19. While the near- and long-term effects of the pandemic are unknown, it will likely be different from the assumptions used in this study. *Scenario Three - TDM* is a good example of this, as expanded working from home has drastically reduced demand during the "Stay home, stay healthy" order.

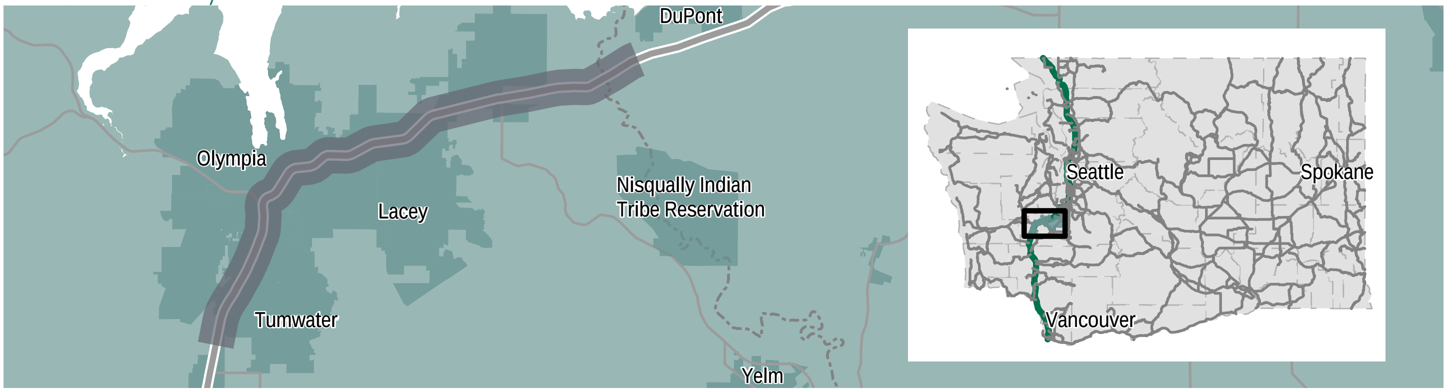
Next steps

There are several ways WSDOT and its partners can move the recommendations of this study forward. There is currently no funding identified to fund the implementation of the strategies identified in this study.

- Prepare for federal documentation requirements with "Planning & Environmental Linkages" study.
- Engage partners to help deliver strategies outside WSDOT's authority to implement.
- Work with the Nisqually Indian Tribe to analyze results of hydrologic study and develop recommendations.
- Communicate results of the study within the context of statewide priorities.

Chapter 1 - Introduction

Exhibtit 1-1: Study area



The Washington State Legislature allocated funds in the 2018 session for a planning study of I-5 between SR 121 in Tumwater and Mounts Road near DuPont to develop mid- and long-term strategies for improving the region's transportation system performance. This report documents the analyses and engagement process Washington State Department of Transportation (WSDOT) and the Thurston Regional Planning Council (TRPC) conducted to develop those strategies with local partners and the community at-large. In addition, the Legislature also directed WSDOT and partners to consider how the proposed transportation strategies can improve salmon habitat and benefit the overall ecosystem in the Nisqually River Delta. Collaborating with local partners, WSDOT and TRPC developed mid- and long-range strategies that meet the study goals as well as support local land use, transportation, and environmental goals focusing on the following items as required by funding legislation[1]:

"The study should further develop mid- and long-term strategies from the corridor sketch, and ***identify potential US 101/I-5 interchange improvements, a strategic plan for the Nisqually River bridges, regional congestion relief options,*** *and* ***ecosystem benefits to the Nisqually River estuary for salmon productivity and flood control."***

WSDOT approaches solving transportation issues using a process called *Practical Solutions.*[2] This approach to planning and designing focuses on achieving specific performance outcomes and working collaboratively with communities and partners in order to make the right investments in the transportation system at the right place and at the right time. For example, investing in incremental and multimodal improvements first, such as Transportation Systems Management and Operations or non-highway solutions, can avoid or delay costly expansion.

1 Engrossed Substitute Senate Bill 6106, page 45 line 37 – page 46 line 6. http://lawfilesext.leg.wa.gov/biennium/2017-18/Pdf/Bills/Session%20Laws/Senate/6106-S.SL.pdf

2 WSDOT Practical Solutions webpage https://www.wsdot.wa.gov/about/practical-solutions

The study area

This study focused on I-5 between the 93rd Avenue SW interchange in Tumwater (milepost 99) and Mounts Road east of the Nisqually River (milepost 116) and the nearby area. The study area includes the cities of Tumwater, Olympia, Lacey, unincorporated parts of Thurston and Pierce Counties, the Billy Frank Jr. Nisqually National Wildlife Refuge, and is near the Nisqually Indian Tribe Reservation. In addition to I-5, study partners considered communities' multimodal transportation facilities, such as local roads and transit, in their analysis. The study area's northern end is near Joint Base Lewis-McChord (JBLM) and the city of DuPont. Most of the surrounding area is suburban or urban with rolling terrain. There are also two large valleys along the Nisqually and Deschutes rivers.

This segment of I-5 experiences recurring delay or congestion due to high traffic volumes and weaving at interchanges, which reduces vehicle throughput. These issues occur mostly at three locations during peak commute periods: the US 101 interchange at Exit 104; within the Olympia and Lacey urban growth areas between Exits 105 and 109; and near the Nisqually River bridges.

I-5 and the Puget Sound regional context

I-5 is the primary north-south route along the United States' west coast, connecting most major cities between Canada and Mexico. This segment of I-5 in particular is an important freight corridor, providing the only high-speed, north-south interstate corridor on the west side of the Cascade Mountains for trucks serving major seaports in Seattle, Tacoma, and Vancouver B.C. and Seattle-Tacoma International Airport. Trucks on this section of I-5 make up 10.2% to 13.4% of all traffic. Between 11,000 and 14,000 trucks use this section of I-5 daily, the third-highest daily truck volume across the state[3].

3 WSDOT Freight and Goods data layer- https://wsdot.maps.arcgis.com/home/item.html?id=09185bbba7c94253a26961489bb8ad20

Commuters pull up to Joint Base Lewis-McChord's main gate. Photo courtesy of South Sound Military and Communities Partnership.

I-5 is important for operation of Joint-Base Lewis-McChord

In addition to its important role in commerce, this section of I-5 provides access to JBLM, the U.S. Department of Defense's premier west coast military installation and one of the largest military bases in the country. JBLM's location along I-5 and access to nearby seaports are essential to the base's function as a power projection platform. JBLM is the largest single-location employer in Washington State and the largest employer in Pierce County. Roughly 52,000 service members and civilians work at the base and 85% live off post[4] and many use I-5 to access the base.

I-5 is a major commuting corridor in south Puget Sound

I-5 is also important for local commuting and travel, connecting Olympia and Tacoma and providing local access to communities in between. Commuter destinations along the corridor include major employment centers like the state capitol, JBLM, downtown Tacoma, and other commercial and industrial centers. Multiple transit agencies provide bus and vanpool services, and there are multiple park-and-ride lots along the corridor. Sound Transit and Amtrak Cascades provide commuter and intercity/long-distance rail service, respectively. Bicycles are permitted on some of I-5 where alternate facilities are limited. A shared-use trail follows I-5 through Olympia and Lacey connecting with other regional trails. There is no trail connection between Thurston and Pierce counties so bicyclists must use highway or local roadway shoulders.

Alternate routes and capacity for I-5 are extremely limited

One of the reasons I-5 is so critical for regional and national travel is it is the only major highway connecting Thurston and Pierce counties. State Route 507 near Yelm and Nisqually Cutoff Road provide the only other connections. During major traffic disruptions, these two routes and a 75-mile detour around the west side of south Puget Sound through Tacoma, Purdy, and Shelton are the only alternates available to non-military vehicles. Other alternate routes such as Perimeter Road through JBLM and a gated maintenance path connecting to Mounts Road in DuPont just north of the Mounts Road interchange have only been made available during major disruptions such as the 2017 Amtrak derailment.

The Nisqually River and its delta

The Legislature directed WSDOT to consider "ecosystem benefits to the Nisqually River estuary for salmon productivity and flood control" in addition to considering transportation performance issues. The river and its delta – the traditional home of the Nisqually Indian Tribe – are designated critical habitat under the Endangered Species Act for listed Chinook salmon and steelhead and are critical to the exercise of the Nisqually Tribe's treaty rights. I-5 passes directly through this environmentally important and sensitive area and which has issues with adequate sediment delivery the delta, salmon habitat, and flooding.


Interstate 5 crosses the main stem of the Nisqually River just upstream of where it meets Puget Sound.

4 South Sound Military and Communities Partnership- https://cityoflakewood.us/south-sound-military-and-communities-partnership/

Chapter 2 - Related Studies and Planning Efforts

Prior to this study, WSDOT and local governments conducted several planning studies of issues along the corridor and completed plans outlining policy for land use and transportation within the study area. The study team reviewed the following related planning work:

- Local comprehensive plans and studies from cities, counties, and Thurston Regional Planning Council;
- WSDOT statewide plans;
- Relevant WSDOT planning studies, corridor sketches, or project development documents.

Where possible, WSDOT and study partners built on this previous work. The study team used that data and analysis as a base to help develop solutions and strategies.

Study team and partners considered local plans when developing strategies

WSDOT staff reviewed the relevant sections of transportation and comprehensive plans from the following local agencies:

- City of DuPont
- City of Olympia
- Pierce County
- City of Lacey
- City of Tumwater
- Thurston County
- City of Lakewood
- Nisqually Indian Tribe
- Thurston Regional Planning Council

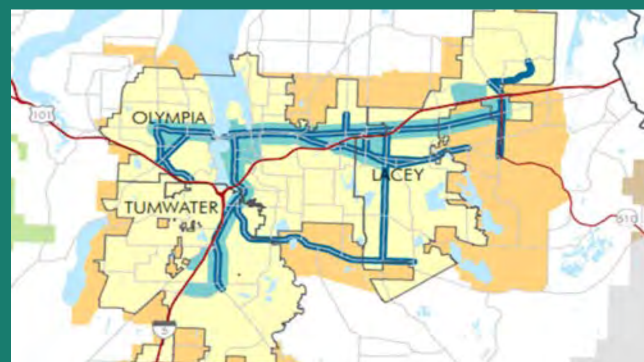
While all of these governments have differing projects and priorities, there were several common themes among their policy goals.[1] All held safety as a high priority, including for bicyclists, pedestrians, and transit users. Many also emphasized the importance of I-5 to the regional transportation system. In addition, they all shared in the following goals and values:

- Improving alternative travel modes (particularly transit, rail, and carpooling) and managing demand;
- Achieving land-use patterns that support an efficient transportation system;
- Maintaining the ability of freight traffic to travel within and through the region;
- Improving local network connectivity;
- Reducing barriers to accessing transportation services.

Within Thurston County, the local agencies shared transportation investment strategies and priorities as a result of TRPC's coordinating regional planning. For example, all the cities and the county adopted "Strategy Corridors" as discussed above.

The study team worked to incorporate local strategies and plans into the I-5 study

Municipalities along the study area in Thurston County have adopted "Strategy Corridors". These are roadways on the local network where local jurisdictions have committed to not widen the roadway beyond five lanes and pursue other strategies instead such as transit or improving network connectivity. WSDOT used policies like this as goalposts when developing strategies to ensure this study supports local plans.



Legislative policy goals & WSDOT statewide plans provide a policy framework for planning on I-5

The Washington State Legislature codified six transportation policy goals in RCW 47.04.280. The goals are not prioritized and include Economic Vitality, Preservation, Safety, Mobility, Environment, and Stewardship.[2] The law states, in part, that "public investments in transportation should support achievement of these policy goals." WSDOT has several statewide plans that layout how WSDOT will achieve

1 City of DuPont Comprehensive Plan: Chapter 9 – Transportation; https://www.dupontwa.gov/DocumentCenter/View/1455/Final_Full_09nov15?bidId=#page=120
City of Lacey Comprehensive Plan: Community Vision – Transportation & Land Use; https://www.ci.lacey.wa.us/Portals/0/docs/community_development/planning_documents/2016_iii_community_vision.pdf#page=32
City of Lakewood Comprehensive Plan: 6.0 – Transportation; https://cityoflakewood.us/wp-content/uploads/2019/11/1019-LAKEWOOD-COMPREHENSIVE-PLAN.pdf#page=151

2 Revised Code of Washington (RCW) Title 47, Chapter 47, Section 47.04.280 Transportation System Policy Goals; https://apps.leg.wa.gov/rcw/default.aspx-?cite=47.04.280

these goals, influencing how WSDOT approaches planning and the types of solutions considered. These plans fall into two main categories. First are the high-level policy plans, like the Washington Transportation Plan[3] completed by WSDOT and the Washington State Transportation Commission. Second are the “Modal” plans, which cover policy specific to individual modes of transportation like aviation or areas of transportation policy like freight mobility.

The Washington State Transportation Plan Phase Two document is WSDOT’s over-arching policy plan that sets a long-term vision for the state transportation system as well as strategies for achieving that vision. The most recent version of the Washington Transportation Plan established four focus areas[4] for WSDOT:

- Maintain and preserve assets
- Manage growth and traffic congestion
- Enhance multimodal connections and choices
- Align funding structure with multimodal vision

WSDOT staff used these focus areas where possible as a guide for the study. For example, WSDOT incorporated the estimated cost of maintenance over the life of new facilities into the overall comparison of benefit to cost to align with the “maintain and preserve assets” focus area. This cost information was used in discussing recommendations for the modeled scenarios, detailed in Chapter Eight of this report, with study stakeholders. Similar policy and strategy guidance came from other agency plans including the Highway System Plan, Freight System Plan, and other modal plans..

Previous corridor plans and studies provided strategies to build from

WSDOT has completed studies previously within the study area that provided data and ideas for strategies to improve system performance. WSDOT and its partners considered the strategies and data from these studies when developing solutions to test. For example, working with local partners WSDOT completed the I-5 Near-Term Solutions Study for this same stretch of I-5 a year before this study began. The Near-Term Solutions Study recommended part-time shoulder use and demand management as strategies for improving performance in the next five years. These strategies were incorporated into the study’s traffic modeling to determine their long-term system performance contribution. WSDOT reviewed the following studies relevant to the corridor:

- **I-5/US101 Interchange Study (2013)** – This study developed solutions to be modeled later for addressing operational issues at the US 101 interchange.
- **I-5 Near term Solutions Study[5] (2018)** – This study developed solutions to be modeled later for addressing operational issues at the US 101 interchange.
- **HOV Feasibility Study I-5: JBLM to 38th Street[6] (2017)** – This study investigated possible approaches to extending HOV lanes from 38th Street in Tacoma to/through the JBLM area.
- **Corridor Sketch Initiative[7] (2016-2017)** – WSDOT worked with local partners to develop high-level, baseline studies for highways around the state. A summary was developed for each corridor that documents strategies and solutions to address performance issues and manage system assets.
- **Martin Way & Marvin Road Interchange Justification Report (IJR)[8]** (2015) – The City of Lacey in association with WSDOT and FHWA prepared an IJR, looking into alternatives for improving operations at the I-5 interchanges with Martin Way (Exit 109) and Marvin Road (Exit 111).
- **West Olympia Access Study[9] (2016)** – The City of Olympia and WSDOT jointly evaluated transportation needs on Olympia’s west side. The City completed an IJR to investigate alternative solutions for US 101 near I-5.

3 Washington State Transportation Plan; https://washtransplan.com/
4 Washington State Transportation Plan Goal Areas; https://washtransplan.com/wp-content/uploads/2018/05/WTPPhase2-2017-web-PlanAndAppendicies-1.pdf#page=13

5 I-5 Near-Term Action Agenda Folio; https://www.trpc.org/DocumentCenter/View/5867/WSDOT_NearTermImprovements_030118
6 HOV Feasibility Study I-5: JBLM to S 38th Street Summary Report; https://www.wsdot.wa.gov/publications/fulltext/LegReports/15-17/I5_JBLM_HOV_LaneFeasibilityStudy_SummaryReport.pdf
7 Corridor Sketch Initiative website; https://www.wsdot.wa.gov/planning/corridor-sketch-initiative
8 IJR for I-5/Martin Way Interchange and I-5/Marvin Road Interchange; https://www.ci.lacey.wa.us/Portals/0/docs/Public_Works/signed-ijr-martin-way-and-marvin-rd.pdf
9 West Olympia Access Study website; http://olympiawa.gov/city-services/transportation-services/plans-studies-and-data/west-olympia-access-study.aspx

Chapter 3 - Study process

WSDOT and the Thurston Regional Planning Council collaborated in creating a planning process that included a broad range of perspectives, disciplines, and backgrounds in outreach and decision making. To achieve this, the study team surveyed local communities and collaborated with local government partners to develop goals and strategies for this segment of I-5. The study team worked with two advisory groups, one of technical experts and one of executive staff or elected decision-makers from local governments, tribal governments, and state and federal agencies that met regularly to review progress and advise the study team. The table below lists the agencies and governments invited to participate in advisory groups. Not all organizations invited chose to participate.

The study team used the standard planning process of: 1) developing the purpose and goals, 2) analyzing existing and historical conditions, 3) developing performance measures, 4) developing strategies and solutions to achieve those goals, 5) evaluating potential solutions, and 6) developing recommendations based on evaluations. The study team conducted public engagement at various points in the process tailored to fit the needs of the study.

The study team met with the advisory groups thirteen times between June 2018 and January 2020 to gather input and discuss key policy considerations (see Exhibit 3-1). In addition to advisory group meetings, the study team conducted one-on-one interviews with potentially affected or interested organizations and agencies. The study team also consulted with relevant subject matter experts from the jurisdictions and within WSDOT such as WSDOT's Bridges & Structures office.

WSDOT and its partners developed strategies and solutions to a conceptual level to model and test. These were not detailed enough for construction which will require more detailed design and modeling. WSDOT's *Practical Solutions* framework calls for a focus on identifying needs and assessing alternative strategies at this step of the overall process. Further refinements to solutions will happen in subsequent planning efforts as shown in Exhibit 3-2.

The study team invited the following organizations to participate

- Confederated Tribes & Bands of the Yakama Nation
- Confederated Tribes of the Chehalis Reservation
- Cowlitz Indian Tribe
- City of DuPont
- Federal Highways Administration
- Intercity Transit
- Joint Base Lewis-McChord
- City of Lacey
- City of Lakewood
- Nisqually Indian Tribe
- City of Olympia
- Pierce County
- Pierce Transit
- Port of Olympia
- Puyallup Tribe of Indians
- City of Rainier
- Sound Transit
- Squaxin Island Tribe
- Town of Steilacoom
- City of Tenino
- Thurston County
- Thurston Economic Development Council
- Thurston Regional Planning Council
- City of Tumwater
- South Sound Military and Communities Partnership
- City of Yelm

Staff from WSDOT and TRPC meet with a study advisory group to discuss study progress and develop recommendations.

Exhibit 3-1: Study schedule

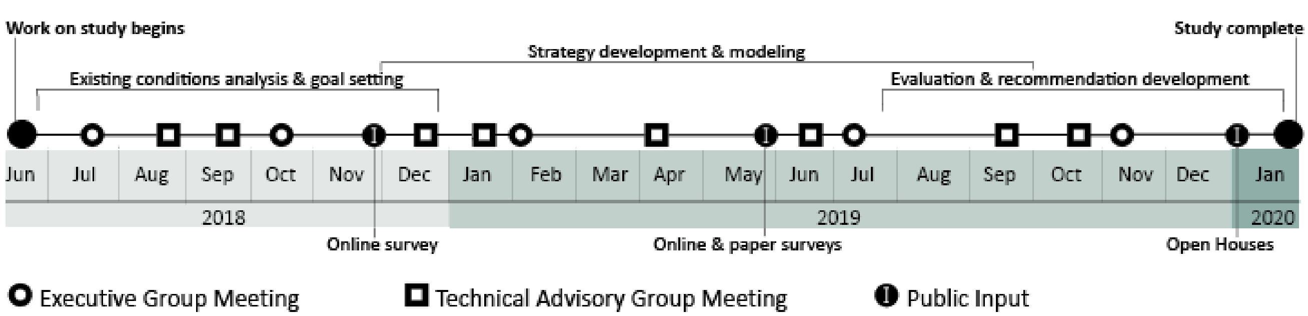


Exhibit 3-2: WSDOT's Practical Solutions framework

Study goals and performance measures

The study team collaborated with stakeholders and engaged the public in developing study and community goals for the corridor. The study goals include (not listed in order of priority):

- Improve travel times on I-5 and make them more predictable.
- Increase the transportation system's ability to efficiently and equitably move all people and goods.
- Improve access to job sites, commercial services, and industrial areas.
- Protect and enhance the environment including reducing the transportation-related impact on fish and wildlife habitat in the Nisqually River delta.
- Improve the transportation system's ability to operate during disruption and recover from it.

The study looked at performance of the transportation system as a whole, acknowledging the differing community and environmental needs throughout the corridor. The team recognized that different portions of the corridor call for different solutions, including strategies off the state highway system.

Community engagement

WSDOT and TRPC proactively reached out to communities that may be affected by future projects to obtain their feedback on the strategies and priorities developed by the study team and stakeholders. WSDOT's goal in community engagement is to include as many perspectives, disciplines, and backgrounds as practicable to guide decision making. WSDOT and TRPC sought to achieve the following through this study's community engagement effort:

- Increase awareness around WSDOT's planning efforts for this stretch of I-5
- Collect and document community members' preferred performance outcomes, priorities, and concerns
- Ensure WSDOT is aware of potential effects of different strategies on communities
- Inform and obtain feedback from the affected communities on the recommended strategies

To that end, WSDOT and TRPC carried out a paper survey, two online surveys, two in-person open house events, and an online open house using an online interactive story map. The study team gave particular focus to seeking input reflecting community demographics as much as practicable[1]. Paper surveys were made available at accessible, commonly-used public spaces like at transit centers and libraries. The study teams also partnered with willing stakeholder agencies to directly distribute paper surveys such as the Nisqually Indian Tribe. Information was included offering translated copies of the survey in other languages as requested. See Appendix A for the study's communications and community engagement plan.

WSDOT study surveys received more than 4,600 responses

WSDOT sought feedback on community members' preferred outcomes and priorities mainly through the surveys. The study team collected 4,600 responses total, resulting in more than 6,500 open-ended responses to questions about study goals and strategies. WSDOT made both surveys available online and advertised them via email, social media, and local news. TRPC also made a paper version of the second survey which they distributed at publicly accessible locations such as libraries, food banks, and transit routes. The Nisqually Indian Tribe also helped distribute paper surveys.

In addition to online surveys, WSDOT and TRPC worked with local partners to distribute paper surveys at commonly used public spaces like transit centers.

1 WSDOT is required to protect the civil rights of all people affected by the agency's projects by making a concerted effort to engage minority, low-income and Limited English Proficient (LEP) populations. See WSDOT's Community Engagement Plan for the agency's guiding principles on this topic. https://www.wsdot.wa.gov/sites/default/files/2019/05/22/Planning-CommunityEngagementPlan-2016Update.pdf

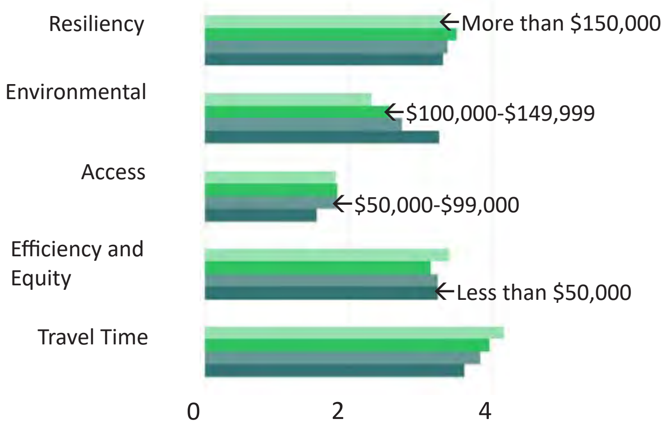
The study team used public input to set study priorities, develop strategies, and account for user group needs

The study team used survey responses in three primary ways. First, they incorporated respondents answers on study goal priorities with input from the advisory groups (weighted 50/50) to develop the final scoring schemes for modeling results. Second, the study team used responses to refine the actual goals. An entire new goal of system resilience was added based on public input. Third, the study team and the advisory groups reviewed all comments regarding improving system performance that came from the surveys. Finally, the study team used comments from the open-houses and surveys for further refinement of the strategies.

Exhibit 3-3: Survey support of study goals differ

Support of study goals differed by respondent characteristics, travel time main goal overall

Average goal ranked by household income, five is most important



Overall respondents most valued improving travel times, while some placed a higher value on environment and equity

WSDOT asked survey respondents to rank five study goals developed collaboratively with local, tribal, state and federal partners (see Exhibit 3-3). In the first survey, respondents overall ranked "moving people and cars efficiently" as the highest priority. Most respondents in the second survey ranked "improving travel times on I-5 and making them more predictable" as their highest priority.

The study team found that respondent support among the study goals was different based on certain characteristics. For example, in the first survey, respondents with a household income of less than $25,000 valued the goal of ensuring equitable access to transportation services 35 percent higher than the overall average. Those with household incomes of $150,000 or more valued the same goal about 9 percent less than average.

Another notable trend was respondents who used commute modes other than driving alone valued improving travel times up to 16 percent less and equity and environmental goals up to 51 percent and 23 percent more, respectively. The study team added a new resiliency goal and reworded other goals adapting the content to reflect responses. The second survey yielded similar results.

Respondents' transportation needs correlated to primary commute mode, income, and age

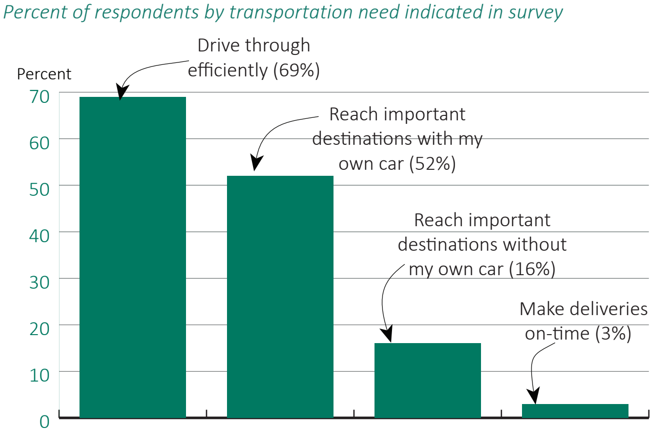
The study team asked respondents what they need most from the transportation system (in addition to safety). The most common answer was to be able to drive through the corridor efficiently and reliably (see Exhibit 3-4). Similar to respondents' weighting of study goals, there were notable differences in transportation needs based on characteristics such as commuting mode, income, and age.

Respondents who used any commute mode besides driving alone valued reaching destinations without a private vehicle more than average, ranging from 19 percent higher for those who carpool to 287 percent higher for those who only bike, walk, or use transit. Similarly, these groups tended to value driving through the corridor less than the overall survey sample on average.

Exhibit 3-4: Survey respondent transportation needs

Overall, most respondents say they need to drive through the corridor efficiently

Percent of respondents by transportation need indicated in survey



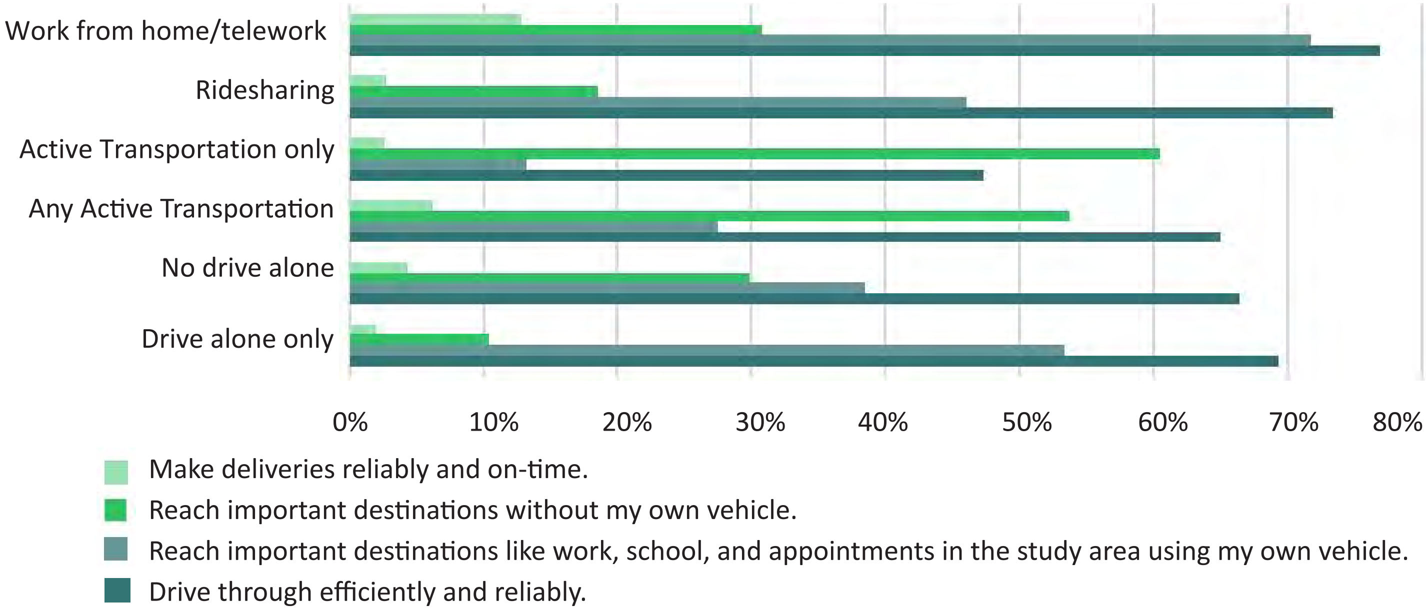
Respondents with household incomes of $75,000 or less also valued reaching important destinations without their own vehicle 21 to 60 percent higher than the overall average. Respondents with household incomes above $100,000 valued the same goal 17 percent less than average.

Finally, older respondents tended to value reaching important destinations with their own car less than the overall survey sample on average. Respondents over 45 valued this goal 10 to 21 percent lower than average, while respondents 44 and younger valued it 19 to 27 percent higher than average.

Exhibit 3-5: Survey transportation needs differ

Respondents transportation needs differed by their main commute mode

Percent of respondents indicating transportation needs by primary commute mode

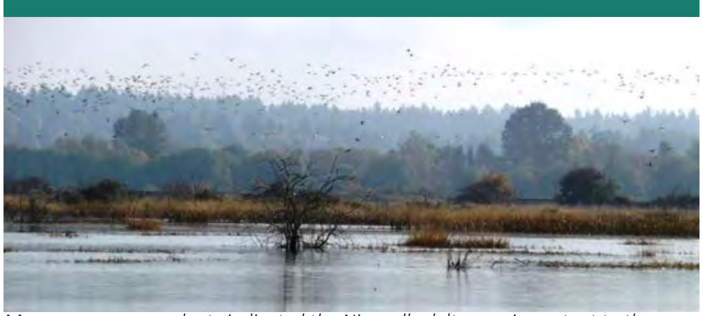


Respondent comments lean toward resiliency, transit, environment

WSDOT staff reviewed roughly 6,500 open-ended responses related to study goals and outcomes in the first survey. Among responses related to study goals, 25 percent suggested adding resilience to disruptions like the Amtrak derailment that occurred in 2017 as a goal and many more expressed concern about it.

Another, more common, comment was to have reduced reliance on driving alone by expanding transit and other options as a study goal. 43 percent of responses about study goals mentioned this outcome. WSDOT and its study partners incorporated this intent into existing goals and measures.

"...I think there needs to be more push on reducing the number of cars on the road through better, more varied, swift, reliable, and financially accessible to all public transportation..."



Many survey respondents indicated the Nisqually delta was important to them. One comment read "Protect the integrity of the Nisqually River delta." Photo courtesy of the Nisqually River Council.

Improvements to alternate routes and interchanges had most support overall; Support for HOV and transit correlated to income, commute mode, living in study area

WSDOT asked respondents what types of improvements they would support among options ranging from highway expansion to demand management and improvements to local roads in the second survey. "Adding capacity to, or developing, an alternate to I-5" was the most common response, with roughly 75 percent of respondents indicating support. "Improving traffic flow at interchanges like US 101/Olympia City Center" was a close second with 70 percent indicating support.

Respondents with lower household incomes and those who do not commute by driving alone were more supportive of transit, walking, and biking improvements. Support for improving conditions for walking or biking was 50 to 199 percent more than average for respondents who do not drive alone. Among respondents who drive alone, 60 percent supported adding new lanes to I-5, compared to 31 percent of active transportation users.

Respondents who live in zip codes touching the study area were more likely to support HOV, interchange, and bicycle/ pedestrian improvements by 6, 7, and 15 percent more than average, respectively.

Most respondents indicated they are frequent commuters in study area

Most respondents indicated they travel within the study area at least a few times a week, generally during peak commute hours (4 p.m. to 7 p.m. and 7 a.m. to 9 a.m.) to commute to and from work. Common uses also included visiting family and friends, recreational activities, and medical services. Roughly half of all respondents work in the Downtown Olympia/Tumwater area and about 61 percent live in the study area. A large majority of respondents (88 percent) indicated they drive alone to work. About 62 percent marked drive alone as the only commute mode they use.

Survey sample over-represented certain groups compared to study area

Respondent demographics differed from the study area, in some cases by a wide margin. For example, 15 percent of respondents had a yearly household income of at least $150,000, double the proportion in the study area. The same applied to respondents with household incomes of $100,000 to $150,000. On the other hand, 13 percent of respondents had a yearly household income of less than $50,000. This is roughly two thirds less than the study area population where households with incomes less than $50,000 make up 41 percent of the population.

Respondents between 35 and 64 years old were also over-represented compared to the study area, while ages 25 and younger or 65 and older were under-represented. For example, about a quarter of respondents were between 45 and 54 years old, twice the rate of the study area population. Results were similar for ages 35-44 and 55-64.

Results for respondents' race/ethnicity were close to the study area in some cases and not in others. For example, 82 percent identified only as "white", while 79 percent of the study area population identified as such in census data. Others over-represented in the survey sample included Native American and Native Hawaiian/Pacific Islander at three and one percent of the survey sample compared to 1.4 and 0.9 percent of the study area population. The next largest groups of respondents identified as two or more races/ethnicities, Asian/Asian American, and Hispanic or Latinx, four, three, and two percent. Within the study area, the largest racial/ethnic groups after white are Hispanic or Latinx, two or more races, and black/African American with 9, 6, and 3 percent.

Chapter 4 - Existing conditions

WSDOT analyzed existing conditions along I-5 in the study area to help guide the study's focus and to help develop strategies. WSDOT collected data on the current conditions for the following topics:

- Facility conditions including maintenance and preservation needs
- Geometric elements
- Environmental assets and factors
- Land use, demographics, and employment in and around the study area
- Observed crash history along I-5 in the study area[1]
- Regional roadway, bicycle and pedestrian, and networks
- System operational performance

Facility conditions

WSDOT tracks conditions for two major facility categories for highways; pavement[2] and bridges/structures.[3] Within the I-5 Tumwater to Mounts Road study area, there are roughly 108 lane miles of pavement and 64 bridges (18 roadway bridges and 2 rail bridges pass over I-5, and I-5 has 34 bridges over a roadway or waterway), including ramps and crossroads. According to agency data, these assets along the corridor are generally in good shape.

WSDOT evaluates the condition of asphalt and concrete pavement on state-managed roadways annually looking at various criteria such as surface cracking, rutting, and smoothness. The agency uses these criteria to classify pavement into five condition categories: very good, good, fair, poor, and very poor. About 99.6 percent of surveyed pavement within the study area is in fair or better condition, with 85 percent rated as good to very good. Data was not available for 19 percent of study area pavement.

In addition to pavement conditions, WSDOT tracks the time until sections of pavement are due for preservation. WSDOT considers about 11 percent of the corridor past due or very past due for preservation. The vast majority of the study corridor – about 89 percent of centerline miles – has not reached its due date for rehabilitation. However, within that figure about a fifth of the corridor will be due for preservation work by the end of Fiscal Year 2020 (June 30th, 2020).

WSDOT considers both I-5 bridges over the Nisqually River bridges to be in fair condition with more than 30 years of remaining service life.

Exhibit 4-1: Pavement condition

Almost all surveyed[1] pavements on study corridor are in fair or better condition

Corridor directional[2] miles and percent by pavement condition

CONDITION RATING	MILES[2]	PERCENT
Very Good	11.62	40.8%
Good	12.7	44.6%
Fair	4.04	14.2%
Poor	0.12	0.4%
Very Poor	0.00	0.0%

Notes: 1 No data was available for 6.8 miles, or about 19%, of the corridor. 2 Directional miles is the number of miles in each direction of travel (e.g. north and south for this section of I-5). None of the pavement surveyed on the corridor was in "very poor" condition.
Data source: Washington State Pavement Management System 2016 version (for the 2017-2019 biennium).

Exhibit 4-2: Pavement due year

Almost all surveyed pavements on study corridor are in fair or better condition

Corridor centerline miles and percent by due for preservation category; Average years till due

Due year category	Total	Percent	Average years till due
Future Due	21.8	58%	18.1
Near Due	4.6	12%	3.8
Due	7.3	19%	1.2
Past Due	3.0	8%	-1.7
Far Past Due	1.0	3%	-5.9

Notes: 1 Directional miles is the number of miles in each direction of travel (e.g. north and south for this section of I-5). Data source: Washington State Pavement Management System 2016 version (for the 2017-2019 biennium)

1 Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.
2 Pavement Annual Report – WSDOT Gray Notebook 72, p. 9 https://wsdot.wa.gov/publications/fulltext/graynotebook/gray-notebook-Dec18.pdf#page=9
3 Bridges Annual Report – WSDOT Gray Notebook 74, p. 7 https://wsdot.wa.gov/publications/fulltext/graynotebook/gray-notebook-Jun19.pdf#page=7

Maintenance needs on the study corridor are only a part of statewide needs

WSDOT facilities within the study area are part of a larger statewide system that the agency is responsible for maintaining. The agency uses multiple performance measures and statewide goals to monitor facility conditions such as to maintaining 90% of pavement lane miles in fair of better condition. According to the most recent available data, there was a preservation backlog of $346 million for pavement statewide in 2017 and a highway maintenance backlog of $98 million per biennium. Similarly there are multiple needs for bridges statewide. For example, there were 459 state-owned bridges that needed seismic retrofitting at an estimated cost of $614 million in Fiscal Year 2019. See WSDOT's Gray Notebook for more (links on previous page).

WSDOT regularly inspects bridges and categorizes their condition. Bridges classified in "Poor" condition are monitored, repaired, or replaced. Of the 64 bridges on the study corridor, there is only one listed as in poor condition; the Plum St SE northbound Ramp over Eastside St SE due to concrete deck deterioration . WSDOT has prioritized this for rehabilitation. A "Poor" condition rating does not mean a bridge is unsafe or in danger of collapse. Bridge inspectors have authority to close or restrict any bridge deemed unsafe at any point.

Geometric elements

WSDOT reviewed how the corridor was designed and laid out, called the geometric elements, to see if it affects system performance and meets current requirements. Some geometric elements on this section of I-5 use old design standards. For example, several off-ramp tapers, where ramps split from mainline I-5, diverge at a steeper rate than currently used for facility design speeds. Several on-ramp designs do not use acceleration lengths or taper rates currently used for a 60 mph mainline design speed. While geometric elements on most of the corridor meet current performance needs, changes could improve how facilities operate at several intersections of ramps and crossroads. WSDOT's Practical Solutions approach uses a performance data rather than standards. Proposed improvements will be evaluated on overall system performance.

WSDOT also reviewed all bridges on and over I-5 in the study area. Some of them would require widening or replacement to implement some of the improvements described in Chapter Seven of this study.

According to the WSDOT Bridge Engineering Information System, some of the bridges are considered functionally obsolete . For more information see the detailed geometric element summary included in Appendix B.

Environmental assets and factors

WSDOT conducted a preliminary environmental review of the study area focused on select environmental assets that either can affect the scope of future investments or are existing assets that need to be protected. This review is only a snapshot of the information available and did not examine the full range of environmental issues that will be addressed during site specific project development. WSDOT reviewed the following environmental assets for the study area:

- Climate vulnerability impacts
- Chronic environmental deficiencies
- Noise Walls
- Stormwater management
- Fish passage barriers
- Wetland mitigation sites
- Habitat connectivity priorities
- Historic preservation

WSDOT will analyze environmental data further as project locations become clearer, to determine what the environmental constraints and needs may be and how significant they are. WSDOT will use this information to also refine project purpose and goals if needed. WSDOT found several factors and assets that could constrain improvements.

First, there are five segments WSDOT has identified along the corridor as a high-priority for stormwater retrofits and two segments as medium-priority. These segments occur in the Nisqually River valley, near Carpenter Road, and near the Pacific Avenue Interchange. The corridor crosses multiple watersheds with Total Maximum Daily Load (TMDL) requirements for pollutants including the Upper Chehalis, Deschutes, Henderson Inlet, and Nisqually TMDL zones. Furthermore, there are several water bodies along the corridor on the state's 303(d) list, meaning their "beneficial uses are impaired by pollutants".[4]

Second, WSDOT has ranked three one-mile corridor segments as high-priority for investing in improvements to reduce collisions with wildlife[5]. There are also three segments with medium priority for ecological stewardship, one near the Deschutes River in Olympia and two near the Nisqually River delta. The segment adjacent to the Billy Frank Jr. Nisqually National Wildlife Refuge has a high ecological stewardship priority rank.

4 Washington State Department of Ecology – "Water quality assessment & 303(d) list" https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d

5 Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

Additionally, there are six documented fish passage barriers on the corridor which are in the federal injunction area.[6] There's also one wetland mitigation site along the corridor and as well as several noise walls which would need to be considered in project development.

For details on environmental assets along the study corridor not discussed here, see Appendix C – Environmental Assessment.

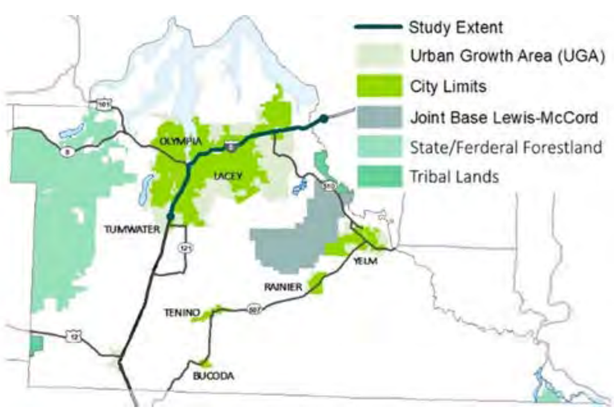
Land use

The study area is located primarily in Thurston County at the southern end of the Puget Sound with a small portion in southern Pierce County near DuPont and part of JBLM. At 736 square miles, Thurston County is the eighth smallest county in Washington. Thurston County is a mostly rural county but has several urban and suburban areas. About 13 percent of the land area is incorporated or unincorporated urban area, 70 percent is rural, one percent is tribal reservation and 16 percent is state or federal forest land. Lacey, Olympia, and Tumwater are the largest cities in Thurston County and together form the north urban area. In southern Thurston County are the cities of Rainier, Tenino, and Yelm, the Town of Bucoda, and unincorporated Grand Mound. There are two tribal reservations: the Confederated Tribes of the Chehalis Reservation and the Nisqually Indian Tribe Reservation.

Population and demographics

According to TRPC's report, *The Profile*,[7] Thurston County's population was approximately 252,000 as of the 2010 census, with most people living in unincorporated areas.

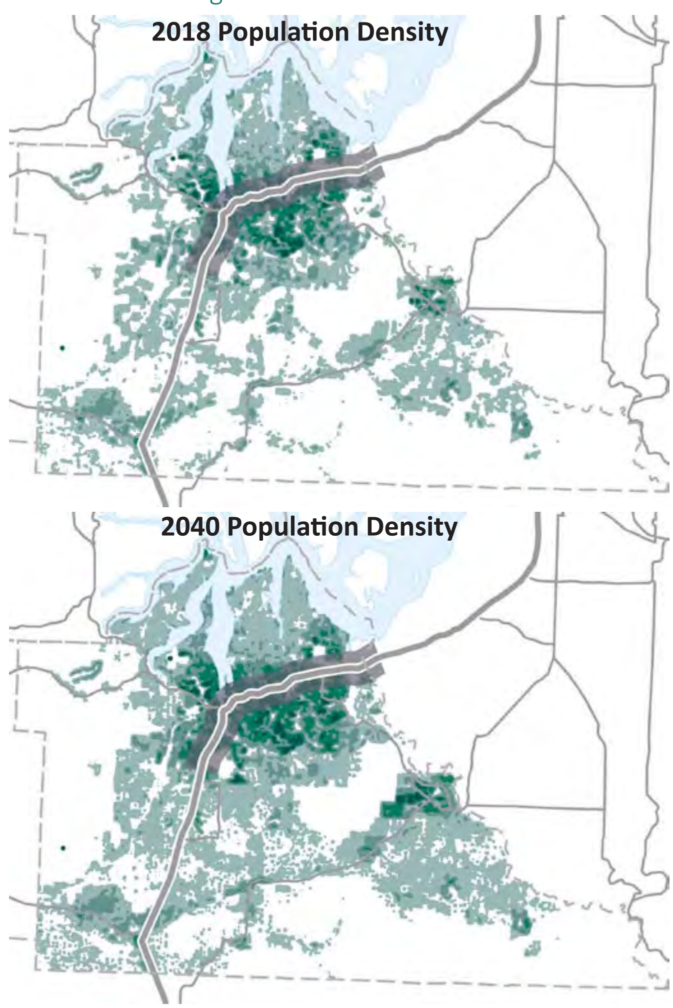
Exhibit 4-3: Major administrative areas Thurston County



Since then, the county's population has grown and the balance has shifted towards urban areas. Thurston County's population was 281,700 in 2018. It is one of the fastest growing counties in Washington State. 63 percent of Thurston County's population lives in the Lacey–Olympia–Tumwater urban area, 6 percent in the south county communities of Bucoda, Rainier, Tenino, Yelm, and Grand Mound, 0.3 percent in a tribal reservation, and the remaining 31 percent in rural unincorporated areas.

TRPC forecasts the population will continue to grow to roughly 371,000 by 2040, an increase of 119,000 or 47 percent. Furthermore, TRPC forecasts the balance of population will continue to concentrate in incorporated cities and urban growth areas between 2018 and 2040 (70,000 people). Other urban areas are also expected to absorb a significant amount of growth. Yelm's population is projected to add 20,000 residents, an increase of 4.1 percent per year.

Exhibit 4-4: TRPC forecasts greater population densities in and around existing urban areas in 2040



6 The Ecological Stewardship rank reflects a highway segment's overlap with the ranges of select Endangered or Threatened wildlife and its proximity to connected networks of habitat identified by the Washington Habitat Connectivity Working Group. The listed species selected for inclusion in the ranking process were those species known to be most affected by highways, either due to road mortality or behavioral avoidance or both. WSDOT – "Federal court injunction for fish passage" https://www.wsdot.wa.gov/Projects/FishPassage/CourtInjunction.htm

7 Thurston Regional Planning Council; The Profile webpage; https://www.trpc.org/391/The-Profile-Thurston-County-Statistics-D

Exhibit 4-5: Map of demographic analysis area

Population dynamics in Thurston County are also changing. The area is becoming more diverse. As of 2017, the American Community Survey[8] estimated people identifying as non-Hispanic white accounted for about 76 percent of the population compared to about 80 percent in 2010. Currently the largest minority groups in the county are Hispanic/Latinx, Asian, and two or more races which all grew between 2010 and 2017. TRPC also forecasts the population will gradually be older overall. The median age of Thurston County increased from 38.3 years in 2010 to 38.9 years in 2017. This trend is expected to continue.

Demographics within the study analysis area generally include a slightly higher proportion of population in minority groups, with limited English proficiency, and with a disability than the county as a whole. Exhibit 4-6 gives a demographic profile for the study area based on analyses conducted for Title VI[9] and the National Environmental Policy Act (NEPA).[10] The table also gives two measures of transit-dependency in the study area. In addition to the summary data in the table, there are three block groups that meet guidelines for limited English proficiency outlined in WSDOT's Environmental Manual – Social and Community Effects chapter[11]; two for Spanish speakers and one for Asian and Pacific Island Language speakers with five percent or more of people indicating limited English proficiency.

Exhibit 4-6: Study Analysis Area Demographics

Study Analysis Area Demographics

2012-2016 average, 2016 American Community Survey

	TOTAL	PERCENT
Population	107,861	-
Households	42,984	-
Minority Populations		
Black/African American	4,281	4.0%
Native American	1,518	1.4%
Asian	7,700	7.1%
Hawaiian/Pacific Islander	959	0.9%
Some other race	988	0.9%
Two or more races	6,800	6.3%
Hispanic/Latinx Origin (Any Race)	8,988	8.3%
Total Minority Population	28,848	
Senior Population		
65 or Older	16,538	15.3%
Poverty Status		
Income below poverty in last 12 months	11,862	11.0%
Limited English Proficiency		
Spanish	717	0.7%
Other Indo-European Language LEP	94	0.1%
Asian and Pacific Island Languages LEP	1,239	1.1%
Other Languages	132	0.1%
Total	2,182	2.0%

Data from the Office of the Superintendent of Public Instruction[12] for the 36 schools in the study analysis area shows comparable proportions of minority students, with the exceptions of Hispanic/Latinx and two or more races which were both higher than American Community Survey data showed (7.6 and 5.0 percentage points higher, respectively). The number of individuals with limited English proficiency is also growing. Roughly 4.3 percent of students were "transitional bilingual", more than twice the limited English proficiency population in the study area. The number of children on free and reduced lunches was 34.3 percent, significantly higher than the proportion of people with incomes below the federal poverty level.

8 American Community Survey; Census Data webpage; https://data.census.gov/cedsci/

9 Title VI refers to Title VI of the Civil Rights Act of 1964 which prohibits discrimination based on race, color, or national origin in programs or activities which receive federal financial assistance. There are certain analyses agencies must conduct to ensure projects are not likely have a disparate impact or disproportionate impacts on populations protected under Title VI, and the Environmental Justice and Limited English Proficiency Executive Orders; WSDOT Environmental Justice webpage; https://www.wsdot.wa.gov/environment/technical/disciplines/social-and-land-use-effects/environmental-justice

10 WSDOT NEPA & SEPA guidance webpage; https://www.wsdot.wa.gov/environment/technical/nepa-sepa

11 WSDOT Environmental Manual Chapter 458; Page 458-8; https://wsdot.wa.gov/publications/manuals/fulltext/M31-11/458.pdf

12 Washington Office of Superintendent of Public Instruction State Report Card website; https://washingtonstatereportcard.ospi.k12.wa.us/

Employment

Roughly 145,600 people work in Thurston County. State government is the largest employment sector with over 24,000 employees. Education, health, and social services, professional and business services, and retail trade are the next largest sectors. Over 37,000 new jobs have been added since 2000, an increase of 1.7 percent per year.

Like population, employment is expected to increase about 50 percent from 129,000 to 194,000. As employment grows, the balance of job types are expected to change. The education, health, and social services sector is projected to overtake state government within the next 25 years. Additionally, Joint Base Lewis McChord is located on the eastern end of the study corridor in Pierce County and is the largest single employment site in Washington state with roughly 52,000 military personell and civilian worker jobs on site.

Commuting increase between counties

I-5 connects the study area to Tacoma and Seattle to the north and Centralia to the south. Over 121,000 trips cross the Thurston-Pierce border on I-5 each day. US-101 and US-12 also serve as important connections to Aberdeen, Hoquiam, and the Olympic Peninsula. Most Thurston County residents (72 percent) work in the county. However, a significant number commute out of county, primarily to Pierce and King Counties. TRPC estimates that by 2045 these outbound commuters will increase to 54,100, up from 35,300 in 2015.

Commute modes and timing, like population, are also changing albeit more slowly. People are leaving earlier and experiencing longer commutes. At the same time, more people are working from home. Other travel modes including biking, walking, transit, and carpooling have remained relatively stable in terms of the proportion of commuters but are all growing in terms of total number.

Exhibit 4-7: Commuting flows between Thurston and neighboring counties

Regional roadway network

While I-5 is the primary highway through the study area, a network of other state highways and local roads serve residents, travelers, and businesses from in and outside the region. According to TRPC's 2040 Regional Transportation Plan, there are approximately 2,400 centerline miles of roads in Thurston County (including I-5).[13] In addition, there are a few hundred more centerline miles of roadway in areas near the northern end of the study corridor in Pierce County. While the network of local roads and state highways is extensive, there are some notable things about how it is laid out and its effect on travel patterns in the region.

First, very few local roads provide alternate paths to I-5. Martin Way and Pacific Ave/Steilacoom Rd, the 4th Ave/State Ave couplet, and Harrison Ave provide east-west alternate routes through Olympia and Lacey. Capitol Blvd provides a north-south alternate route through Tumwater. These local arterial roads also tend to be heavily used due to how smaller local roads often have a circuitous, disconnected layout. In some cases this is due to topography and other physical features. For example, Budd Inlet and Capitol Lake bisect Olympia and only two roads besides I-5 cross it. In other cases, local roads were built with few outlets ending in a cul-de-sac or dead end. This funnels travelers onto the arterial roads and highways.

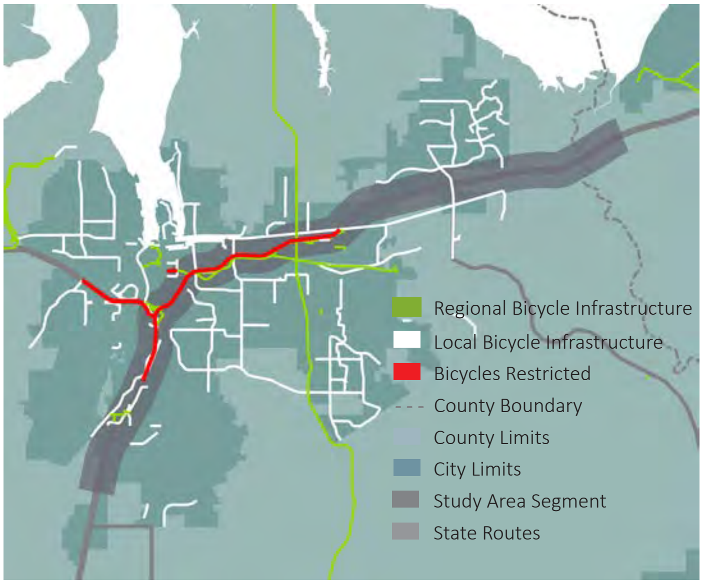
Second, there are relatively few places to cross I-5. Over the 17 miles of the study corridor there are 21 places where vehicle traffic can cross the highway of which 10 are interchanges and 11 are local road crossings. There are also three bicycle/pedestrian only crossings. Looking at seventeen mile stretches of I-5 through Tacoma and Seattle, we see 29 and 47 highway crossings, respectively. In the Tacoma area, 10 are interchanges and 19 are local crossings with one additional bike/pedestrian only crossing. In Seattle, there were 12 interchanges and 35 local crossings with an additional four bike/pedestrian only crossings. The sparse number of places to cross I-5 through the study area further concentrates traffic on certain local roads and encourages the use of I-5. It also has implications for active transportation users as it lengthens trips that need to cross the highway, reducing the likelihood of people using active modes.

Regional bicycle and pedestrian

In addition to the interconnected network of roads and highways throughout the study area, there is also infrastructure specifically built to support walking, biking, and transit including rail. Thurston Regional Planning Council and other local agencies have a strong commitment to developing transportation facilities that

13 TRPC Regional Transportation Plan – What Moves You, Appendix D, P.5; https://www.trpc.org/DocumentCenter/View/2787/Appendix-D--Inventory-of-Facilities

Exhibit 4-8: Bicycle facilities network in the region



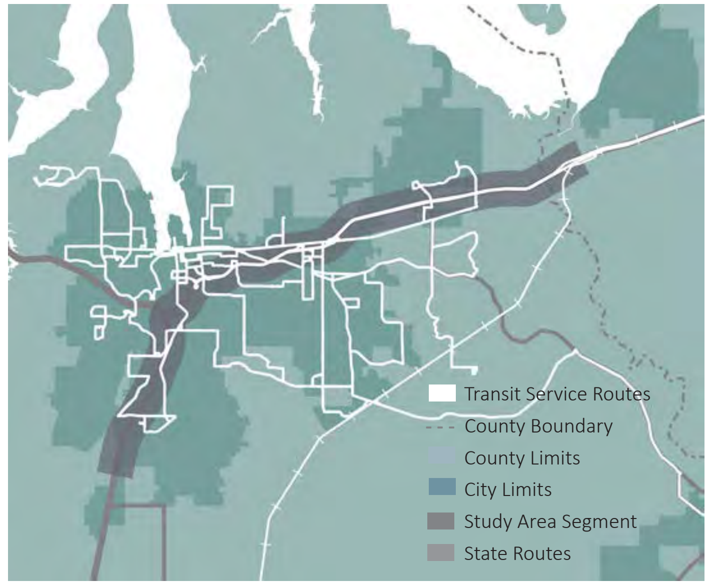
"encourage walking, bicycling, transit use, and other alternatives to driving alone." There are approximately 105 miles of bicycle infrastructure supporting local trips such as marked bike lanes and bike boulevards in addition to a large interconnected system of sidewalks. Communities along the study area also have 59 miles of shared-use trails that provide regional connections for biking and walking. While these trails connect communities within Thurston County or within Pierce County, there are currently no dedicated bicycle or pedestrian facilities between the two counties. Bicyclists in the "highly confident" category may use roadway shoulders on one of the three roadway connections (including I-5) but these are likely considered too dangerous by most users.[14]

Construction of some new facilities will be completed within the span of time this study considered. For example, WSDOT is constructing a connection between Gravelly Lake Drive SW and Thorne Lane SW that will facilitate walking and biking in the Lakewood/Tillicum area. Local partners are also working on a shared-use path between Yelm in Thurston County and Roy in Pierce County but this project is currently in the planning stages and construction is not funded. As of now there are no active transportation connections between the two counties funded for construction.

Regional transit network

Transit connections between Thurston and Pierce counties are similarly limited. Currently InterCity Transit, which serves the north Thurston County urban areas and Yelm, has one bus route between Olympia and Tacoma with frequent service (15-30 minutes between trips) at peak commute times, up to 90 minutes between trips during off peak times, and no late night service. Additionally, bus service between Thurston and Pierce counties do not provide a travel time benefit compared to taking a private car as there are no High Occupancy Vehicle (HOV) lanes on I-5 until the Tacoma area.

Exhibit 4-9: Transit service in the study area mainly serves local travel



Transfers from InterCity Transit bus service to Sound Transit bus routes and Sounder Commuter Rail in Lakewood and Tacoma also provide transit connections to the Seattle area. Pierce Transit does not currently provide service between Thurston and Pierce counties.

Current plans for future service expansion in the study area is mainly oriented toward local service.[15] The lack of HOV lanes to incentivize transit ridership and reduce the cost of running commuter trips for service providers hinders further expansion of regional commuter bus service.

Expansion of Sounder Commuter Rail service is planned within the study area. According to current plans, Sound Transit will complete extension of commuter rail service to DuPont, at the study area's northeastern edge, in 2036.[16] While this would not create a commuter rail connection into Thurston County it would bring an additional option within closer reach for Thurston residents.

Amtrak provides passenger rail service from Centennial Station, located in unincorporated Thurston County on the edge of Lacey. The station is served by two bus routes and is not connected to the urban area with pedestrian or bicycle routes. Four daily round trips are provided on the Amtrak Cascades[17] inter-city service and one daily round trip is provided on the Amtrak Coast Starlight[18] long-distance service. The departure and arrival schedules do

14 Federal Highway Administration; Bikeway Selection Guide; P. 13 https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf#page=15

15 Thurston Regional Planning Council, 2040 Regional Transportation Plan – Public Transportation Projects and Studies; p. 457; https://www.trpc.org/DocumentCenter/View/2940/Appendix-P--Regional-Project-List-Detail#page=61

16 Sound Transit – DuPont Sounder Extension website; https://www.soundtransit.org/system-expansion/dupont-sounder-extension

17 https://www.amtrakcascades.com/

18 https://www.amtrak.com/routes/coast-starlight-train.html

Exhibit 4-10: Number of crashes in the study corridor

Crashes on the study corridor increased between 2013 and 2017
2013-2017; Number of crashes by year and state route, percent change year over year

Year	2013	2014	2015	2016	2017
Total Incidents	715	755	867	1,010	1,044
I-5	601	643	737	873	912
US 101	114	112	130	137	132
Percent Change	-	6%	15%	16%	3%

not align with peak commuting times in the study area. Amtrak trains can provide a travel time benefit compared to automobile travel between Olympia, Tacoma, and Seattle but only if there is considerable congestion on the highway.

Safety analysis[19]

WSDOT provides and supports safe, reliable, and cost-effective transportation options to improve livability and economic vitality for people and businesses. WSDOT conducts a standard analysis of recent safety performance for all corridor planning studies . This analysis summarizes the total number and contributing factors of all crashes on the corridor, as well as US 101 between I-5 and Black Lake Boulevard, over a five-year period with a focus on those resulting in serious injuries or fatalities.

Between January 1, 2013 and December 31, 2017 a total of 4,391 crashes occurred within the study area including both the mainline highway and ramps. Of that total, about 85.8 percent occurred on the I-5. The remaining 14.2 percent occurred on US 101. The number of crashes rose each year with the largest increase of 16 percent happening between 2015 and 2016.

There were 37 types of primary contributing factors attributed to incidents that occurred in the study area. The most common primary contributing factor cited was driver inattention, which accounted for 1,066 crashes or just under one quarter of all incidents. Exceeding reasonable safe speeds was a close second at 1,034 crashes or 23.5 percent. Combined with the third most common contributing factor, following too closely, the top three contributing factors accounted for nearly two thirds of all crashes. Exhibit 4-12 provides the top ten primary contributing factors. The remaining 27 other primary contributing factors accounted for 1 percent to 0.02 percent of all crashes.

WSDOT also tracks other factors present at crashes such as lighting, pavement, and weather conditions. The majority of crashes (70.2 percent) occurred under daylight. Roughly 56.2 percent of crashes occurred with dry pavement conditions, while 42.1 percent occurred with wet pavement. Slightly more than half of crashes occurred in clear to partly cloudy conditions. The next highest category was fog, smog, or smoke, accounting for 26.3 percent of crash conditions. About 6.2 percent of crashes occurred during inclement weather such as rain or snow, but these accounted for 29.3 percent of crashes resulting in injury.

There were 26 crashes resulting in serious injuries and eight resulting in fatalities between 2013 and 2017. Combined, these account for less than one percent of all crashes in the study area. All of the crashes resulting in fatalities and 24 of those resulting in serious injuries occurred on I-5. Furthermore, all but one of the fatal crashes occurred on the mainline highway as did roughly 80% of serious injury crashes. The one fatal crash not on the mainline involved a bicyclist. Primary contributing factors were split between exceeding reasonable safe speeds, driver impairment, inattention, and "other." Overall, most crashes resulted in property damage only.

Exhibit 4-11: Incident contributing factors

Most common contributing factors for incidents was driver inattention, speeding, and following too close
2013-2017; Incidents by primary contributing factor

Primary Contributing factor	Count	Percent
Inattention	1,066	24.3%
Exceeding Reas. Safe Speed	1,034	23.5%
Follow Too Closely	739	16.8%
Other	344	7.8%
Did Not Grant RW to Vehicle	325	7.4%
None	183	4.2%
Under Influence of Alcohol	134	3.1%
Operating Defective Equipment	118	2.7%
Apparently Asleep	77	1.8%
Unknown Driver Distraction	58	1.3%

19 Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

Exhibit 4-12: Number of incidents by serverity

More than three quarters of incidents resulted in property damage only between 2013 and 2017, fatal and serious incidents accounted for less than one percent of total

2013-2017; Number and percent of incidents by severity of injury for I-5, US101 and study corridor total

	Grand Total	Fatal		Suspected Serious Injury		Suspected Minor Injury		Possible Injury		Property Damage Only	
Total	4391	8	0.2%	26	0.6%	233	5.3%	770	17.5%	3,353	76.4%
I-5	3766	8	0.2%	24	0.6%	199	5.3%	673	17.9%	2,862	76.0%
US 101	625	0	0.0%	2	0.3%	34	5.4%	97	15.5%	491	78.6%

Notes: Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

System performance

One of the main purposes of this study is to identify and recommend strategies for addressing transportation performance issues along I-5 between Tumwater and DuPont. As stated in the introduction of the report, WSDOT has documented several performance issues within the study area. These issues can be understood in two basic categories: 1) recurring performance issues; and 2) non-recurring performance issues. Recurring performance issues happen on a regular and predictable basis such as congestion during the weekday morning or evening rush hours. Non-recurring performance issues do not occur regularly or predictably, such as congestion due to inclement weather or special events.

Recurring congestion

WSDOT has previously documented recurring performance issues on the study corridor in agency publications like the Corridor Capacity Report. Data on these performance gaps from previous WSDOT publications include:

- Results from WSDOT's Corridor Sketch Initiative[20] indicate I-5 in the study area experienced recurring congestion (average speeds under 40 mph) over 3.4 miles in the southbound direction and 7.5 miles in the northbound direction in 2015.
- According to WSDOT's 2017 Corridor Capacity Report,[21] in 2016 this segment of I-5 experienced:
  - Southbound delay (average speeds under 51 mph) between mileposts 104-109,
  - Twenty minutes of routine congestion (average speeds under 45 mph, 40 percent or more of all weekdays) during the evening commute on south-bound I-5 approaching Olympia, and
  - Reduced vehicle throughput (vehicles per hour) on southbound I-5 near Olympia city center during midday and the evening commute peak down to roughly 73 percent of maximum throughput.

20 WSDOT Corridor Sketch Initiative webpage; https://www.wsdot.wa.gov/planning/corridor-sketch-initiative

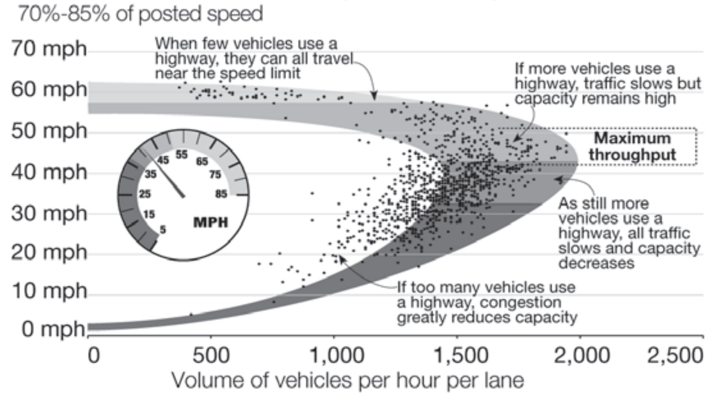
21 WSDOT 2018 Corridor Capacity Report, P. 34; https://www.wsdot.wa.gov/publications/fulltext/graynotebook/corridor-capacity-report-18.pdf#page=34

Maximum throughput speed is the highway's most efficient state

Maximum throughput is the speed at which the most vehicles can move through a highway segment. WSDOT considers this more meaningful than posted speed or free-flow speed as the basis of performance measurement. WSDOT aims to provide a transportation system that is the most productive and efficient, rather than free-flowing but where fewer vehicles pass through a segment during peak travel periods. Maximum throughput is achieved when vehicles travel at speeds between 70 percent and 85 percent of the posted speed limit (for a 60 mph speed limit, between 42 and 51 mph). For more information, see *WSDOT's Handbook for Corridor Capacity Evaluation.*

Understanding maximum throughput: An adaptation of the speed/volume curve

Represents I-405 northbound at 24th NE, 6-10 a.m. weekdays volume; Speed limit 60 mph; Maximum throughput speed ranges between: 70%-85% of posted speed

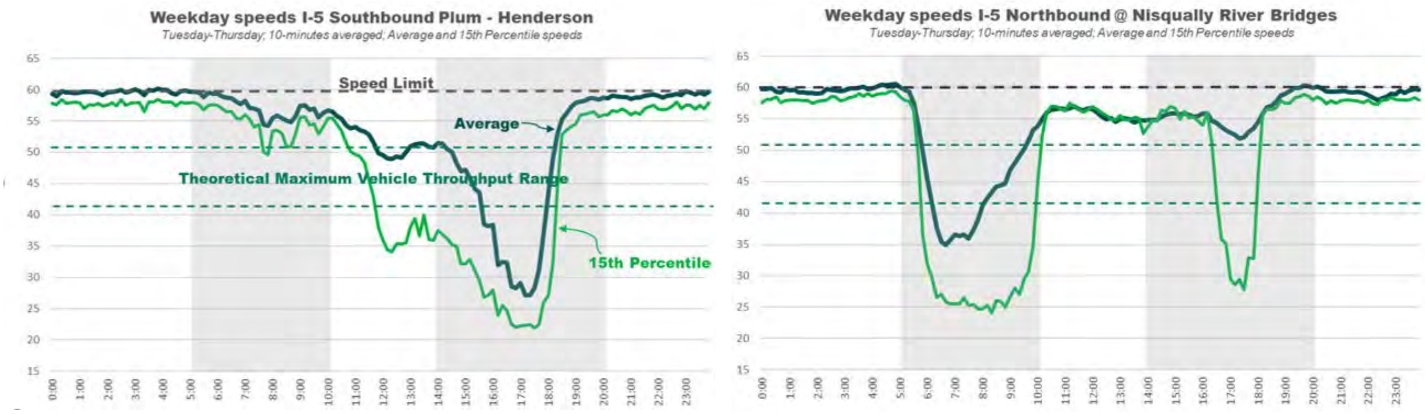


Data source: WSDOT Northwest Region Traffic Office.

Exhibit 4-13: Weekday speeds on southbound I-5 at Exit 105 and norhtbound I-5 at Nisqually River bridges

I-5 southbound approaching US 101 and northbound approaching through the Nisqually Valley showed average speeds below WSDOT's maximum throughput range on a typical weekday

2017; Average and 15th percentile speeds on typical weekdays (Tuesday – Thursday) by 10-minute increments



- WSDOT's 2013 I-5/US 101 Interchange Study found Level of Service below adopted thresholds at several locations including ramps at the US 101 interchange, Olympia City Center, and Pacific Avenue in Lacey.

WSDOT also analyzed data available through the National Performance Measurement Research Dataset[24] which supplies information on traffic speed for the entire National Highway System. The agency looked at annualized average and 15th percentile travel speeds for 2017 in five minute increments throughout a typical weekday (Tuesday through Thursday). Essentially these represent speeds during typical and "bad" days, respectively. Two locations on the corridor showed average speeds below maximum throughput ranges:

- I-5 southbound between Pacific Avenue and Henderson Avenue near the Capitol Boulevard arch bridge in the afternoon and evening, and
- I-5 northbound near the Nisqually River bridges between Exit 114 and the Mounts Road intersection in the morning.

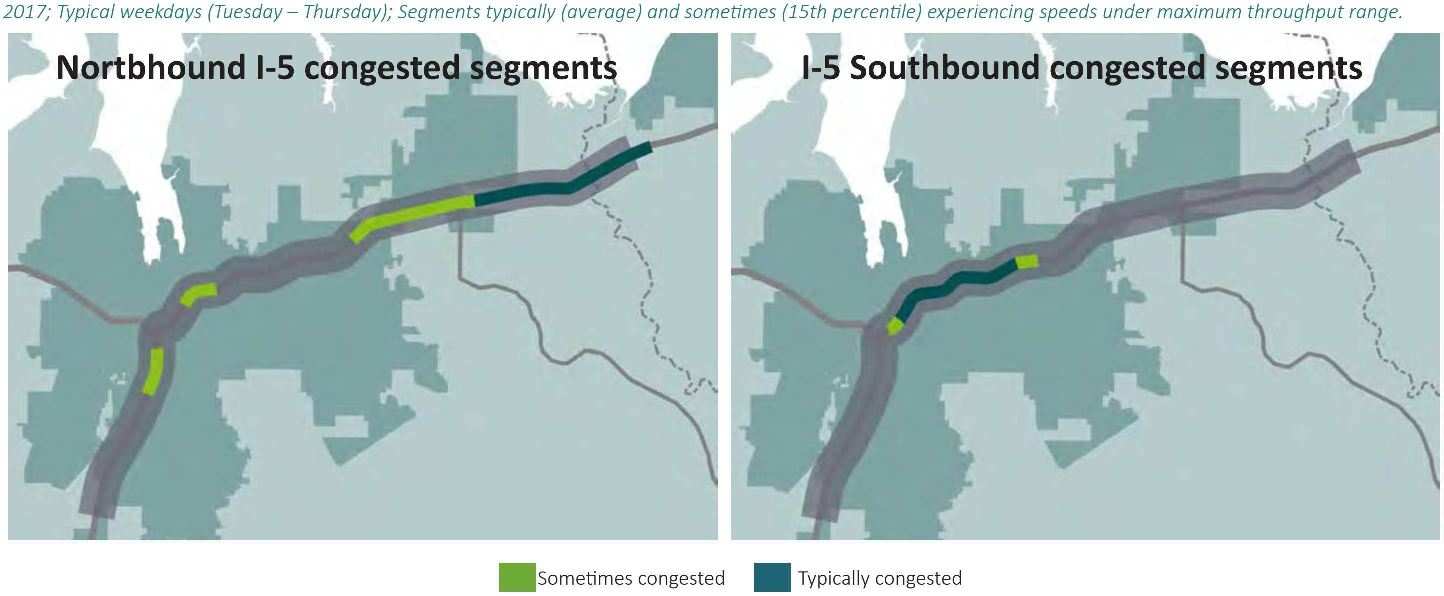
These are locations where drivers encounter congested conditions on a typical weekday commute. Another thing to note about the graphs below is the difference between the average speeds (the dark green line) and the 15th percentile speeds (the light green line). The wider the gap, the greater the difference between typical conditions and a "bad day". A good example is I-5 northbound at the Nisqually River bridges in the evening. Average speeds do not fall below maximum throughput but the 15th percentile falls well below, indicating that while the segment generally operates well in the evening throughout

24 Federal Highway Administration Operations Performance Measurement webpage; https://ops.fhwa.dot.gov/perf_measurement/index.htm

Exhibit 4-15a: Recurring congestion on I-5 through study area

I-5 experiences recurring congestion mainly through the Nisqually River Valley and approaching US 101

2017; Typical weekdays (Tuesday – Thursday); Segments typically (average) and sometimes (15th percentile) experiencing speeds under maximum throughput range.



Seasonal changes in traffic: I-5 at the Nisqually River Bridges

Northbound I-5 at the Nisqually River bridges, like many parts of the transportation system, experiences seasonal changes in traffic performance. As shown in the graph at right, average speeds in August at the height of the summer travel season dip well below those from other times of year, particularly in the afternoon. WSDOT analyzed variation in potential contributing factors including traffic volume and incidents. The agency found that seasonal changes in traffic volumes mirrored changes in traffic speeds. August in addition to experiencing the slowest speeds had the highest average daily traffic volume of roughly 59,900. This is 18% more than the lowest volume month, January, which had an ADT of about 50,600.

Transportation models like the one built by the Thurston Regional Planning Council for this study are usually calibrated to "typical" or "average" traffic conditions. So seasonal changes like this may not be captured within the model.

For more details see the Modeling Validation and Calibration Report in Appendix D.

Exhibit 4-16: northbound I-5 average speeds in January and August

Northbound I-5 speeds near Nisqually River Bridges in summer well below winter speeds

2017; August and January, Tuesday-Thursday, 10-minute averaged speeds

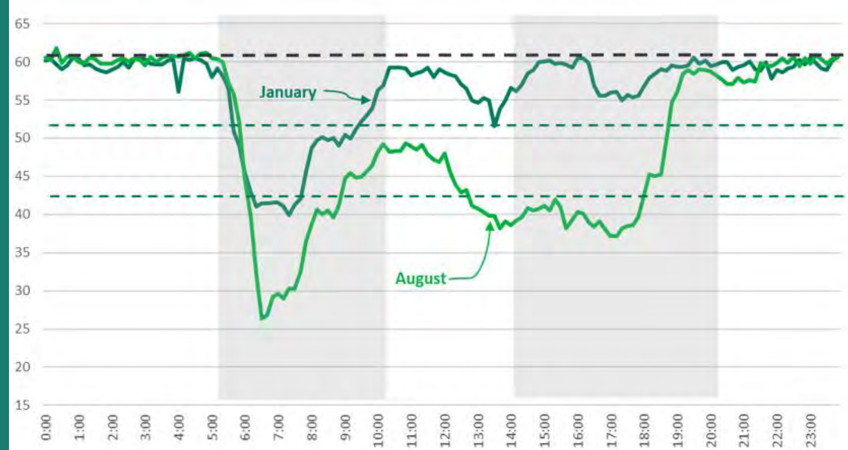
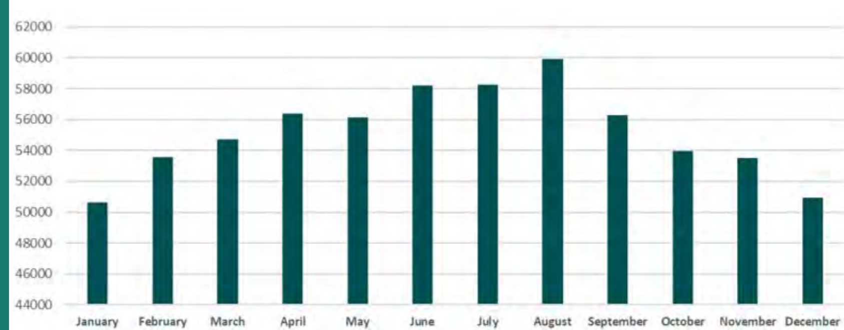


Exhibit 4-17: Average daily traffic peaked on northbound I-5 in August

Traffic volumes on I-5 through the Nisqually River Valley peaked during the summer travel season

2017; Tuesday-Thursday, Monthly average daily traffic



the year it can experience significant slowdowns. There were also five locations that had 15th percentile speeds below maximum throughput including:

- US 101 eastbound at the I-5 interchange (AM),
- I-5 northbound at Exit 104 to US 101 (PM),
- I-5 southbound at US 101 (PM),
- I-5 northbound between Martin Way and Marvin Road/SR 510 (AM), and
- I-5 northbound at the Nisqually River (PM).

At these locations and times, typical conditions were not very congested but on "bad days" they could experience slowdowns. The scale of these slowdowns varied from location to location. For example, as shown in Exhibit 4-14 for northbound I-5 at the Nisqually River, the 15th percentile speeds dropped below maximum throughput speeds for around two and a half hours in the evening commute period, reaching speeds under 30 mph. On the other hand, on US 101 eastbound approaching I-5, 15th percentile speeds dropped below maximum throughput speeds for roughly 15 minutes in the morning around the commute peak (not shown).

Non-recurring congestion

Using the same dataset as the safety analysis, WSDOT looked into trends for all crashes over the five year period between 2013 and 2017 along the study corridor to see how they might relate to congestion.[25] According to the Federal Highway Administration, non-recurring congestion accounts for roughly half of all congestion[26] with the top three causes being 1) incidents ranging from a disabled vehicle with a flat tire to an overturned semi-truck (25 percent), 2) inclement weather conditions (15 percent), and 3) work zones (10 percent). Events like these can reduce how many vehicles the roadway can move at a given time, called the effective capacity.

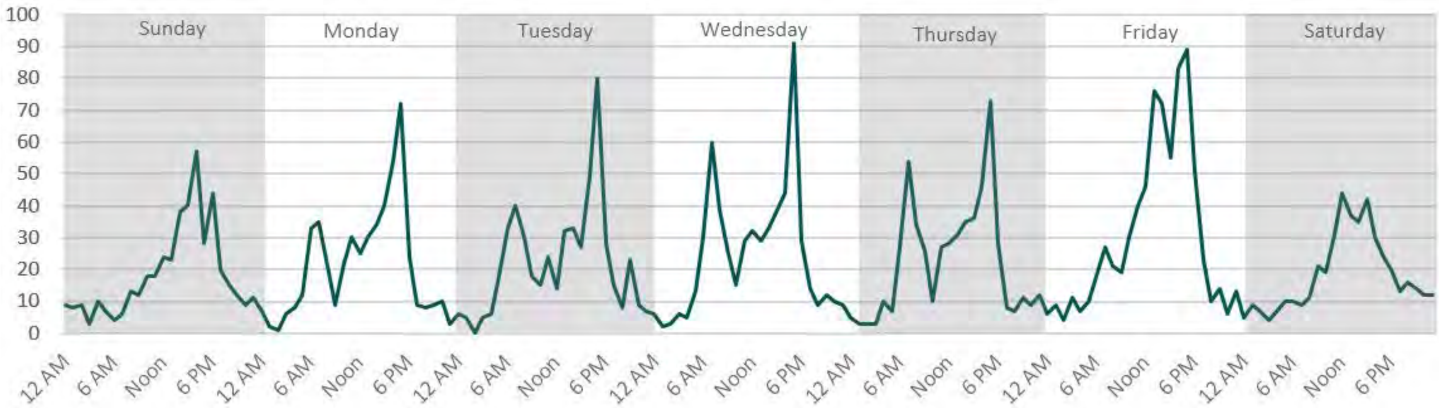
The occurrence of crashes on the study corridor roughly correlated with the most active times of day for driving such as the peak commute periods during the week and mid-day and evenings on weekends. The evening peak commute period (3-6 p.m.) within the study area accounted for 30 percent of crashes on I-5 and 25 percent on US 101 both during weekdays. As for individual days,

26 "Reducing Non-Recurring Congestion", https://ops.fhwa.dot.gov/program_areas/reduce-non-cong.htm

Exhibit 4-18: Number of crashes on I-5 by hour of the week

Number of crashes correlate to times with high traffic volumes, highest was Friday afternoons

2013-2017, All crashes on I-5 between mileposts 99 and 11



Notes: Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

Fridays experienced the most crashes on I-5, accounting for roughly 20 percent of crashes.

For US 101, Wednesdays experienced the highest number, accounting for 18 percent of crashes. Weekends accounted for roughly a quarter of crashes for both routes.

The location of incidents also correlate to segments of the corridor that experience congestion. For example, on I-5 in the southbound direction, 191 incidents occurred between milepost 105 and 106, roughly at the Olympia City Center exits where WSDOT has documented mobility performance issues. For comparison, thirty three incidents occurred over the same period in the southbound direction between mileposts 113 and 114 just west of the Nisqually River bridges.

Chapter 5 - Developing a strategic plan for Interstate 5 through the Nisqually River valley

The Nisqually River delta and Interstate 5 with Puget Sound in the background. I-5 traverses through the Nisqually River valley adjacent to the delta, important habitat for Endangered Species Act-listed Chinook salmon and steelhead.

In addition to transportation issues, the Legislature directed WSDOT to consider "ecosystem benefits to the Nisqually River estuary for salmon productivity and flood control" and develop "a strategic plan for the Nisqually River Bridges."[1] The traditional home of the Nisqually Indian Tribe, the river and its delta provide critical habitat for Endangered Species Act-listed of Chinook salmon and steelhead. The river flows approximately 78 miles from its source at the Nisqually Glacier on Mount Rainier to its delta at the Billy Frank Jr. Nisqually National Wildlife Refuge, draining a 720 square mile watershed. This is the nation's only river to begin in a National Park and end in a National Wildlife Refuge and the largest river flowing into Puget Sound south of the Tacoma Narrows Bridges. The Washington State Department of Fish and Wildlife (WDFW) ranked it as a high priority watershed[2] for production of Chinook salmon, an important food for the endangered southern resident Orcas[3] and the Nisqually Indian Tribe's treaty-secured rights to harvestable levels of salmon.

Significant funds have been invested to improve salmon habitat in the Nisqually River and its delta. The US Fish and Wildlife Service and the Nisqually Indian Tribe restored roughly 900 acres of the delta to tidal flooding from Puget Sound with the removal of the Brown Farm Dike. This was the largest tidal marsh restoration project in the Pacific Northwest and, with other projects, restored more than 21 miles of historic tidal slough systems and re-connected historic flood plains. The project increased potential salt marsh habitat in Puget Sound by 50 percent.[4] Despite these investments, hurdles remain for restoring salmon habitat in the Nisqually River and its estuary.

I-5 experiences some traffic congestion through the Nisqually River valley

As discussed in Chapter Four of this report, the portion of I-5 going through the Nisqually Valley experiences congestion. Typical weekdays see slowdowns in the northbound direction during the morning peak. There is also recurring southbound congestion just north of the valley along I-5 starting at the Mounts Road interchange (exit 116 in the evenings. These slowdowns worsen at the height of travel season in the summer and expand, lasting for most of the day and into the evening peak commute period. While not considered in the study performance measures, extensive weekend congestion also occurs on this segment of northbound I-5 during the summer travel season.

WSDOT maintains I-5 pavement and bridges through the Nisqually Valley in fair or better condition

WSDOT has maintained the majority of this segment of I-5 in fair or better condition to serve the needs of

1 Engrossed Substitute Senate Bill 6106; 2018 Regular Session Law; p. 46, lines 3-6; http://lawfilesext.leg.wa.gov/biennium/2017-18/Pdf/Bills/Session%20Laws/Senate/6106-S.SL.pdf#page=47

2 WDFW – "Washington's Orcas Are Hungry: Increasing the food supply for Southern Resident Killer Whales" https://www.arcgis.com/apps/Cascade/index.html?appid=b7f52cd0c3cb44ecadb1e16d49fd04c3

3 Office of the Governor – Orca Recovery Taskforce webpage https://www.governor.wa.gov/issues/issues/energy-environment/southern-resident-orca-recovery

4 United States Fish and Wildlife Service – Nisqually Delta Restoration http://www.nisquallydeltarestoration.org/

the traveling public. As of the 2017-2019 biennium, roughly 96 percent of I-5 pavement is in fair or better condition according to the agency's statewide pavement management system dataset[5] with 75 percent in good or better condition. There are eight bridges on the main line of I-5 through the Nisqually River valley. WSDOT inspects bridges every two years and all these bridges are in fair or better condition.

The northbound bridge over the Nisqually River was originally constructed in 1937 and refurbished with a new deck in 1982. WSDOT projects a remaining service life of 30-35 years for the bridge. However, the northbound bridge has a weight restriction for large freight loads due to the age and design of the structure.

The southbound bridge over the river was constructed in 1967 when I-5 was expanded through the region. To reduce costs, I-5 was put on fill through most of the Nisqually Valley, rather than on piers as originally constructed. The southbound bridge has an estimated 45-50 years of remaining service life. Both bridges have received preservation work over the years such as concrete deck overlays and repainting of steel structures to extend their service life.

Reduced sediment delivery to the Nisqually delta affects salmon recovery

One of the barriers to salmon recovery is reduced sediment delivery to the delta which occurs mainly due to the large impoundment behind Alder and La Grande dams. According to a study by USGS, roughly 90 percent of sediment is trapped in Alder Reservoir behind these dams.[6] However, another study by USGS and the Nisqually Indian Tribe reports that of the sediment that is making it to I-5, only 10-15 percent is making it to the delta with most of the rest going out into Puget Sound. The same study estimates that due to this reduced sediment delivery and parts of the estuary having subsided while they were cut off from Puget Sound, recovery of a significant portion of the delta restoration could take up to 250 years.[7] In a presentation made in February 2019, the Nisqually Indian Tribe's Natural Resources department outlined a belief that this is potentially due to the design of I-5 constraining where water can flow into the estuary.[8]

5 WSDOT – Pavement Condition online map https://wsdot.maps.arcgis.com/home/item.html?id=f49a4724610548c693680fa745b0a44e

6 USGS and Nisqually Indian Tribe Report "Suspended Sediment Delivery to Puget Sound from the Lower Nisqually River, Western Washington, July 2010-November 2011", page 1; https://pubs.usgs.gov/sir/2016/5062/sir20165062.pdf#page=9

7 USGS ESRP Learning Project Annual Progress Report: Restoring Sediment Supply to Sustain Delta Marsh, Nisqually Delta, Washington: Annual Report Year 1; Grossman E., Stevens A., & Curran C.; Not yet Published

8 Nisqually Indian Tribe Natural Resources Department presentation to Thurston League of Women Voters; February 17, 2019; https://www.youtube.com/watch?v=-FLfl_x5nF8

WSDOT helping to fund study of Nisqually River near I-5 Bridges

WSDOT provided $150,000 to help the Nisqually Indian Tribe and USGS complete a study of the Nisqually River's hydrology near I-5. The study will provide information on risks to I-5 from changes in the river channel, productivity of habitat in the delta, the effect of sea-level rise and I-5's location on transitional habitat from fresh water to saltwater, and potential for major flooding with changing climate factors. Results from this study will help inform WSDOT's long-term strategies for I-5 through the Nisqually delta. WSDOT is expecting results in summer 2020.

The Nisqually River delta at I-5 when the river was flowing at about 20,000 cubic feet per second and roughly 12 feet gauge height during a flood event in February 2020. This was just below a moderate-level flood event. The record flood from 1996 hit 17.13 feet of gauge height. Photo courtesy of the Nisqually Indian Tribe.

The ability of water to flow into the estuary during flooding also has potential implications for sediment delivery to the estuary. According to the USGS and Nisqually Indian Tribe study of sediment delivery, 36 percent of sediment that was delivered to Puget Sound by the Nisqually River was transported during two days of peak high-water events.

There are four main locations where water can flow past I-5 into the Nisqually River delta

Water can flow past I-5 through the Nisqually River Valley at four locations: the bridges over the main stem of the Nisqually River; over the wetlands east of the river; over an overflow channel at the interchange with Martin Way and Nisqually Cutoff Road (Exit 114); and the bridges over McAllister Creek. Before I-5 was built on fill, water and sediment could move more freely past the highway and into the delta. Other development and roads upstream of I-5 in the valley also affect where water can flow.

Major to moderate flooding has occurred on the Nisqually River in six of the last 30 years.[9] While major flood stage is 14 feet, in 1996 the river hit a record flood of 17.13 feet flooding roughly 12,000 acres of private land upstream of I-5. These properties remained flooded even after the Nisqually River and McAllister Creek had receded under "bankfull" volumes. In their February 2019 presentation, the Nisqually Indian Tribe's Natural Resources department stated a belief that this is evidence that floodwaters were not being effectively moved past I-5. According to TRPC's Hazard Mitigation Plan, the February 1996 flood cost uninsured private property owners in Thurston County losses of more than $22 million. The plan further states that "floods in Thurston County are common, and on an annual average basis, are the costliest natural hazard." The most recent flood, pictured above crested at about 12 feet, only reaching minor flood stage.

An adult Pink salmon migrating up the Nisqually River to spawn. Salmon are anadromous, meaning they are born in fresh water and migrate to sea. Out-migrating juveniles use habitat where fresh and saltwater meet while their kidneys reverse function, which is essential for their ability to survive at sea. Photo courtesy of the Nisqually River Council.

As sea levels rise, salmon habitat transition between fresh water and salt water may be reduced

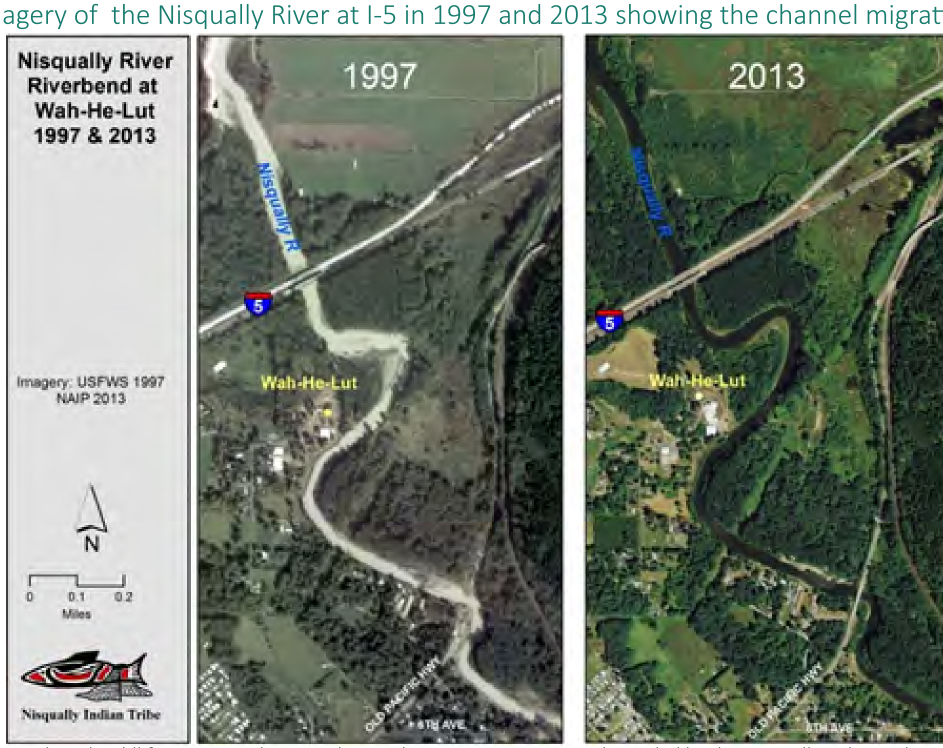
Another potential issue for salmon recovery in the Nisqually River is loss of habitat for young salmonids to transition between fresh and salt water due to rising sea levels. As sea levels continue to rise, the wedge of saltwater that intrudes into the delta twice a day will reach farther up the delta. In their February 2019 presentation, the Nisqually Indian Tribe's Natural Resources department outlined a belief that the location of I-5 in through the river valley may restrict where fresh water and salt water mix, making the gradient from fresh water to salt water more extreme which could impact survival of young salmon migrating out to sea.

The Nisqually River's channel just upstream I-5 has been slowly migrating

Over time, rivers running through low-lying areas meander, changing their course year to year by varying degrees. This is especially common in high-gradient rivers in wet places such as western Washington. Exhibit 5-1 shows that the Nisqually River channel has been changing its course just

9 Thurston Regional Planning Council Hazard Mitigation Plan, Chapter 4.3 Flood Hazard Profile; https://www.trpc.org/DocumentCenter/View/4173/HazMit_Ch4-3_Flood?bidId=

Exhibit 5-1: Aerial imagery of the Nisqually River at I-5 in 1997 and 2013 showing the channel migration



The photos above from the US Fish and Wildlife Service and National Agriculture Imagery Program (provided by the Nisqually Indian Tribe Department of Natural Resources) show the developing bend in the river just upstream (south) of the I-5 bridges in 1997 and 2013. As can be seen, the bend extended further northeast toward I-5 and a wetland complex.

upstream of the I-5 bridges crossing the main stem of the river, slowly forming a long bend. The Nisqually Indian Tribe in partnership with USGS is assessing how the channel will continue to migrate, what level of peak flows are likely to cause the channel to move, and potential risks to I-5.

In their February 2019 presentation, the Nisqually Indian Tribe's Department of Natural Resources stated a concern that a single major flood event like the one in 1996 could remove enough trees and vegetation in the riparian forest between the river and the highway to undermine the section of I-5 on fill between the Nisqually River Bridges and the bridges over the wetland complex. Such an event would cause significant disruptions in the supply chain because trucks would be re-routed on less direct routes. It could also affect access and operations for JBLM. The channel migration study, when completed, should provide more information regarding the potential for flooding to move the river bend.

Addressing the Nisqually River Bridges strategic plan requirement

The legislature articulated that the study include "…a strategic plan for the Nisqually River Bridges..." However, as of the date of this report, the study team can only make recommendations based on the information available, which is largely focused on transportation. As discussed on page 5-2, WSDOT is helping fund a study, led by the Nisqually Indian Tribe and USGS, of the current and expected future states of the Nisqually River and its delta near I-5 and any risks posed to I-5 from the river. WSDOT expects results by summer 2020, which will provide this critical environmental data.

From a transportation perspective, modeling for this study projects a significant bottleneck occurring by 2040 just north of the bridges on I-5 at Mounts Road. Otherwise, WSDOT considers the bridges to have significant service life left and are in fair or better condition, notwithstanding the load restriction on the northbound bridge over the river. However, these bridges are part of a larger picture of the configuration of I-5 across the Nisqually delta. The biggest potential factor is the unknown risk to I-5 from the migration of the Nisqually River's channel just upstream of the bridges. Given the current lack of environmental data, the study team developed the following recommendations for a strategic approach:

- All recommendations from this study regarding transportation system needs and improvement strategies should be considered provisional until the Nisqually Indian Tribe/USGS study is completed to provide a more complete picture of risks posed to I-5 and the environmental impacts of the facility on the river and delta.
- If any alteration to I-5 through the Nisqually River valley occurs, it is recommended that salmon productivity, flood control, and other environmental considerations be incorporated into the design as contextual needs rather than as mitigation for construction impacts.
- If replacing I-5 through the Nisqually Valley is funded for environmental reasons, it is recommended that the design 1) allow for future widening, called forward compatibility, to alleviate the anticipated southbound chokepoint at Mounts Road and 2) address the active transportation gap between Thurston and Pierce counties.
- Regardless, it is recommended that all partners continue to develop interim solutions to help address salmon productivity and flood protection concerns.

The Nisqually River and I-5 Bridges looking south. The bend in the river just upstream of the bridges is partly visible in the background.

Chapter 6 - Modeling and strategy development

For this study, WSDOT and TRPC partnered to develop a transportation modeling framework for the Thurston Region and adjacent areas, with emphasis on I-5 between 93rd Avenue in Tumwater to Mounts Road and US 101 from I-5 to Black Lake Boulevard. The modeling framework includes an integrated Travel Demand Model and a Dynamic Traffic Assignment model platform. The demand model estimates how many people will be traveling between different locations in the model area, by what mode of transportation, and when during the day they will travel. The traffic assignment model uses results from the demand model and predicts what routes people will take and how the system will operate under the forecasted traffic demand. The study team used these models to compare performance of the various scenarios identified in the study.

All model scenarios were built for a future year of 2040. TRPC developed the population and land use forecasts used in the modeling framework as part of their regional work program. See Appendix E for a description of assumptions and data used to produce TRPC's 2040 Land Use Forecast.

A forecast is only as accurate as the assumptions that underlie it. They give us important information about our general direction, given what is known today. There are many other factors, unable to be considered in the forecast, which may impact future travel patterns. Decision-makers, planners, and the general public looking at results from this study should keep these limitations in mind.

Models are useful but results must be considered with caution

Transportation models statistically estimate regional travel behavior. They rely on observed historical data such as population growth and household transportation survey results about travel behavior to forecast future conditions and behavior. They cannot predict some kinds of disruptive changes such as natural disasters or changes in travel behavior due to new technologies like autonomous vehicles. They should only be used for generalized planning purposes. For specific investment decisions more detailed modeling, such as operational modeling, is generally used.

WSDOT was unable to account for the following potential future conditions with modeling:

- Changes in travel behavior
- Future disruptions like natural disasters
- The effect of new technologies
- The effect of construction on travel behavior
- Induced travel demand from new capacity

Developing strategies

WSDOT and TRPC collaborated with study advisory groups to develop strategies to achieve study goals, incorporating ideas from previous studies and public input as discussed in chapters two and three. The study team used the following process to develop and refine strategies with local partners:

1. Present strategies from previous plans and public input to the advisory groups and brainstorm additional ideas.
2. Screen ideas to ensure they meet the study purpose.
3. Sort strategies into those that could be modeled and those that could not.
4. Engage relevant agencies and partners to determine any critical issues with individual ideas.
5. Work with advisory groups to refine ideas that could be modeled into strategy scenarios.
6. Work with advisory groups to refine and evaluate ideas that could not be modeled.
7. Work with advisory groups to analyze effectiveness of modeled scenarios and develop recommendations.

Exhibit 6-1: Examples of improvement ideas by source

I-5/US 101 Interchange Study	Reconfigure 4th Ave roundabout to allow direct access to Deschutes Parkway
Corridor Sketch	Update signal timing and channelization on local arterial streets
2040 Regional Transportation Plan	Add a fourth lane to I-5
I-5/Martin Way and Marvin Road Interchange Justification Report	Install loop ramps on Martin Way interchange (Exit 109) with transit-only access to park & ride
WSDOT Highway System Plan	Install ramp metering
I-5 Near-term Solutions Study	Install part-time shoulder use on Southbound I-5
Public input surveys	Establish some sort of commuter or light rail service between Olympia and Tacoma

Exhibit 6-2: Modeled strategy scenarios

Reviewing previously completed studies and brainstorming new strategies with the study advisory groups and produced 81 ideas to consider for modeling. Public input provided an additional 66 ideas for consideration. See Exhibit 6-1 for examples of ideas gathered from previous studies and public input. A full list of ideas considered is provided in Appendix F.

The study team and technical advisory group reviewed all ideas. Many of the ideas from public input were similar to each other or those produced by the advisory groups. Similar ideas were combined and all were screened to ensure alignment with the study purpose and goals and that they did not go against any WSDOT policy or state, local, or federal rules. Only three ideas were initially removed from consideration for these reasons. An example of one of these was "halting development in the study area" as neither WSDOT nor its partners have the authority to implement this idea and it does not support study goals.

The study team also considered if an improvement idea would be able to be modeled. There were several reasons an idea may not have been able to be put into the model.

- The idea was larger than the scope of the model used
- The idea involved an undeveloped or developing technology
- The software used could not model the idea
- The idea was too vague as proposed

A good example that encompassed several of these issues was the suggestion for a statewide rapid transit system. This study used a model of the transportation system within the south Puget Sound region, mainly Thurston and Pierce counties. Implementation of rapid transit systems within this region is only just being piloted and is outside the scope of this study. The additional planning and modeling for that type and size of network needed to achieve large scale regional performance impacts is too complex and outside the fiscal resource for alternative development as well. Finally, big questions like where a statewide rapid transit system would be located and how it would be operated would need to be answered and refined.

The study team further grouped ideas that could be modeled by the strategy they would fall under. For example, expanding telework options was grouped in transportation demand management and adding a lane to I-5 was grouped in capacity expansion/widening. These groups of solutions ultimately formed the strategy scenarios that the study team would later test in the model to evaluate their effect on the transportation system.

The study team and advisory groups also worked together to determine the order in which scenarios would be modeled. The final order used was selected to implement one aspect of Practical Solutions; which is to use lower cost solutions to achieve performance outcomes before considering more expensive fixes. Lower cost solutions were modeled first with each subsequent scenario including improvements from previous scenarios except where strategies were mutually exclusive. The table below shows the strategy scenarios that were modeled along with the order of modeling.

The baseline scenario: It's the year 2040

The baseline scenario includes all projects currently funded for completion in the study area before 2040 and a "business as usual" population and land use forecast developed by TRPC in 2012 that was based on observed trends in population and job growth as well as development patterns. The scenario includes the following elements:

- TRPC 2040 Land Use forecast. This is the 'business as usual' land use forecast developed in 2012.[1]
- Traffic signal timing updates to facilitate optimized traffic flow through the study area within the model.

1 TRPC 2040 Land Use Forecast Documentation website- https://www.trpc.org/236/Population-Employment-Forecasting

- Funded operations, travel demand, transit and capacity projects.

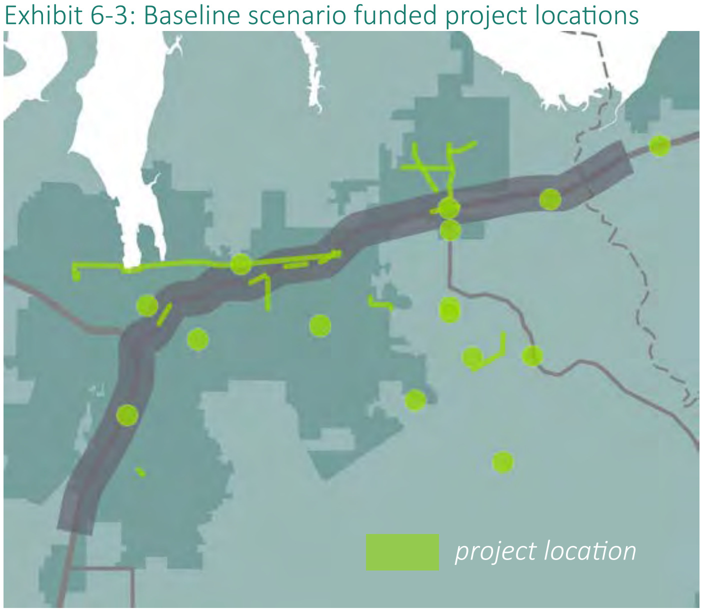
Exhibit 6-3 shows the location of projects included in the baseline scenario. See Appendix G for a list of all projects included in this scenario.

The study team used the performance measure results from this scenario to see how the transportation system would perform in the future given current trends in development and travel patterns and to compare against for the subsequent modeling scenarios.

In general, many of the performance issues seen today remained but are forecasted to be more severe such as the regularly occurring backups on southbound and northbound I-5 approaching the US 101 interchange. There were also new performance issues that arose due to added demand and changes in the roadway network. The main example of this is on southbound I-5 at the Mounts Road interchange (exit 116).

Currently, the roadway drops from four lanes to three at this location with the right lane being an exit only lane for the interchange. After improvements are completed through the JBLM area[2] which will widen the highway, add some new frontage road connections, and improve interchange operations, the highway will neck down from five lanes to three lanes, with one lane dropping as an exit only lane and another merging right before the Mounts Road bridge. The model predicts this location will become a new bottleneck with traffic backing up as far as Thorne Lane SW in Tillicum on southbound I-5 given the assumptions of the model and demand forecast.

Exhibit 6-3: Baseline scenario funded project locations




Operational improvements are small changes that help improve traffic flow at key locations. For example, WSDOT is planning to add ramp metering to southbound I-5 through Olympia to help smooth traffic flow at merge points.

The scenarios developed for this study do not consider all possible strategies

The study team was not able to model all potential solutions or strategies that could be used to improve transportation system performance in the study area. There are several reasons for this. First and foremost was the study had a finite amount of time and financial resources to spend on modeling solutions.

Another reason was if an idea conflicted with local or state development policies or plans. Finally there were also technical limitations to the modeling software used that precluded modeling some strategies. There were a few key strategies the study team, advisory groups, and/or the public were interested in that were not modeled:

- Any rail transportation solutions including light rail like the Link system or commuter rail like the Sounder.
- Changes to the local transportation system beyond those identified in current local plans.
- New state highways to serve as an alternate to I-5.
- Tolling facilities to manage demand.

Further study would be needed to investigate the viability of these options.

Scenario One – Operations

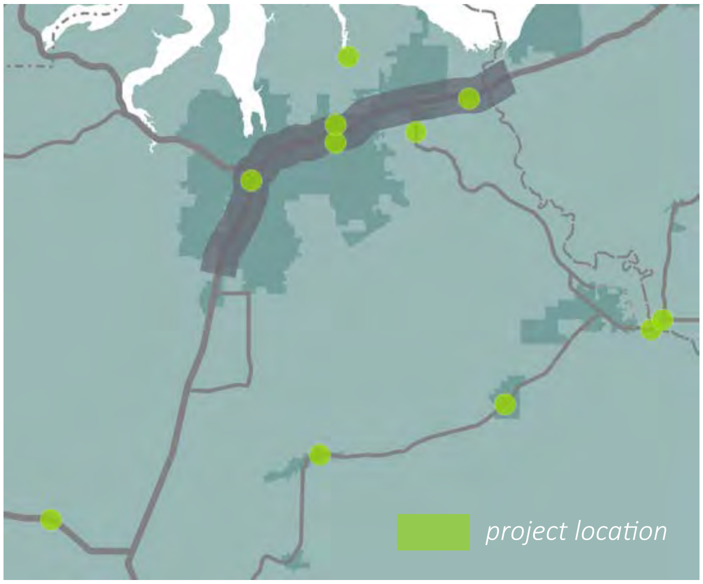
Scenario One - Operations contains a varienty of intersection improvements identified by project partners to address congestion issues in the 2040 baseline scenario. Operations refers to features and enhancements made to roads and transportation facilities that support movement of people and goods across the transportation network.[3]

There are 11 of these improvements, which are all off of I-5 with the exception of a small revision to the merging taper on the ramp between northbound I-5 and westbound US 101 at Exit 104 (shown on page 6-4, Exhibit 6-4). Some of the improvements are on WSDOT facilities like SR 507 near

2 WSDOT JBLM Area Improvements website- https://www.wsdot.wa.gov/Projects/I5/JBLMImprovements/default.htm

3 WSDOT Transportation Systems Management and Operations: Operations webpage- https://tsmowa.org/category/Operations%20%26%20Supporting%20Infrastructure

Exhibit 6-4: Scenario 1 Operational improvements



Yelm while others are on the local roadway network. The general intent of this strategy was to improve performance through small projects at key locations on the network. See Appendix G for a full list of projects included in this scenario.

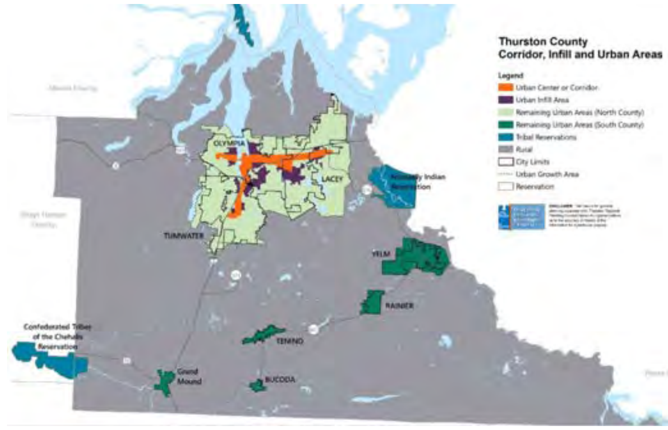
Scenario Two – Sustainable Thurston Land Use[4]

Scenario Two – Sustainable Thurston Land Use assumes the region will achieve goals in TRPC's Sustainable Thurston vision rather than the "business as usual" 2040 Land Use Forecast.[5] Similar to the adopted forecast used in the previous scenario, the visionary 2040 forecast was last updated in 2013. Sustainable Thurston has two primary goals for land use:

- By 2035, 72 percent of all households in Thurston County's cities, towns, and unincorporated growth areas will be within a half mile (comparable to a 20-minute walk) of an urban center, corridor, or neighborhood center with access to goods and services to meet their daily needs.
- Between 2010 and 2035, 5 percent of new housing will locate in the rural areas. Rural areas are defined as outside of the cities, towns, unincorporated urban growth areas and tribal reservations.

The intent of modeling this scenario was to test how transitioning auto-oriented corridors into an urban form more conducive to alternate modes of travel like walking and mixing housing, services, and amenities might affect travel behavior and system performance. You can see what strategies TRPC plans to use to achieve these goals in Appendix G.

Exhibit 6-5: Sustainable Thurston Land Use designations



Scenario Three – Transportation Demand Management[6]

For *Scenario Three - Transportation Demand Management*, the study team built assumptions into the model that the region would achieve a higher level of participation in programs like teleworking and that more places in the region would have metered parking. Transportation demand management as a strategy focuses on reducing the amount people need to travel, particularly by driving alone during peak commute times. This is achieved by helping people use the infrastructure in place for transit, ridesharing, walking, biking and telework. *Scenario Three* consists of three elements

- Expanded participation in telework/compressed work week and other commute trip reduction techniques. The study uses the assumption that this would result in 25 percent of employees in the government non-education and professional service sectors reducing travel by one day a week.
- Managed parking at key employment sites, including raising the parking rate where parking is currently managed.
- New shared use trails.

The areas where expanded managed parking was built into the model is shown in the map below. A list of all projects from this scenario can be found in Appendix G.

Scenario Four - Intercity Transit Long-Range Plan[7]

For *Scenario Four – Intercity Transit Long-Range Plan*, the study team added new local bus service that is part of InterCity Transit's long-range plan. This included the new bus rapid transit demonstration route "The One" as well as the new Zero-Fare system that was implemented

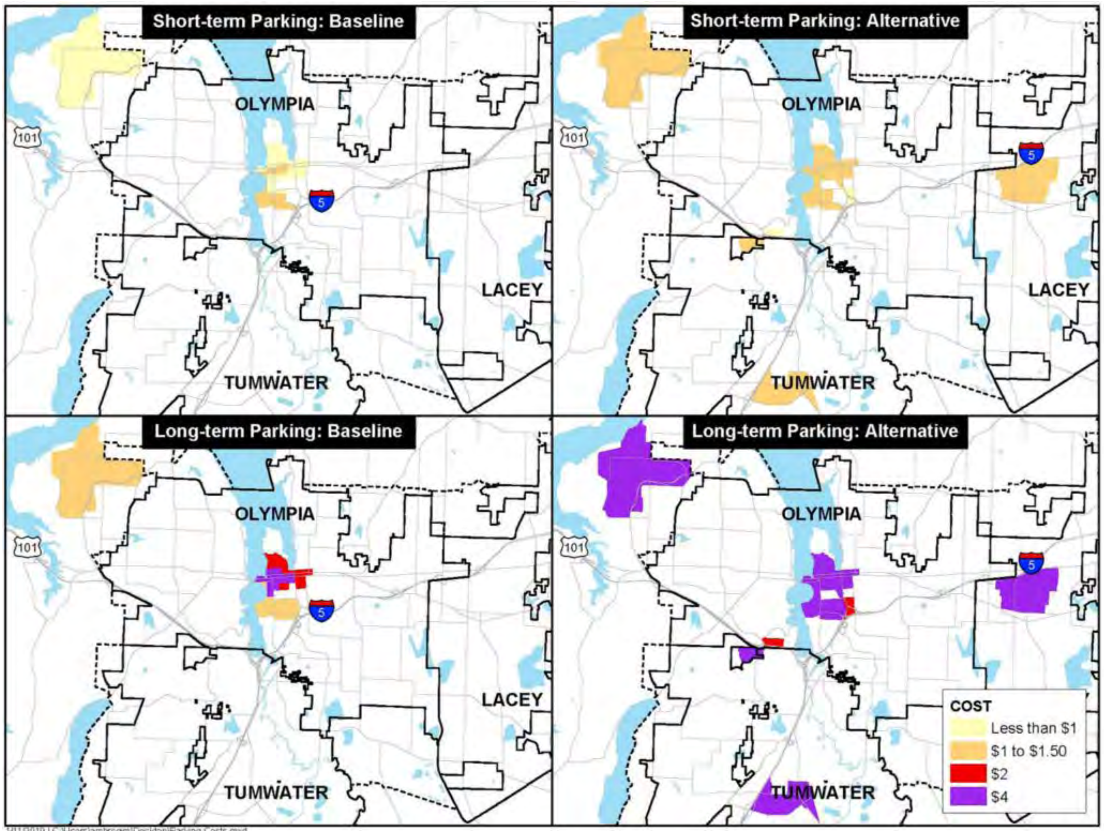
4 Scenario two – Land Use also includes improvements from all previous scenarios

5 TRPC About Sustainable Thurston webpage- https://www.trpc.org/262/About-Sustainable-Thurston

6 Scenario three – Transportation Demand Management includes improvements from all previous scenarios

7 Scenario four –Transit includes improvements from all previous scenarios

Exhibit 6-6: Map of changes to parking pricing used in *Scenario Three — Transportation Demand Management*



January 1, 2020. The study team used an assumption that these changes, along with population growth and more transportation-efficient land use from *Scenario Two*, would result in a substantial increase in ridership. *Scenario Four* consists of the following elements:

- Increased transit services per Intercity Transit's Long Range Plan[8]
- New transit routes (See Exhibit 6-7).
- A transit queue jump in downtown Olympia near the Olympia Transit Center.
- An assumed 30 percent increase in transit ridership based on implementation of a variety of measures to increase transit ridership, including a Zero-fare transit system.

8 InterCity Transits Plans, Publications, and Fact Sheets website- https://www.intercitytransit.com/agency/plans-publications-fact-sheets

Figure 6-7: Map of additions to transit service used for *Scenario Four — Intercity Transit Long-Range Plan*

The areas where expanded transit service was built into the model is shown in the map below. A list of all improvements from this scenario can be found in Appendix G.

Scenario Five – Part-Time Shoulder Use[9]

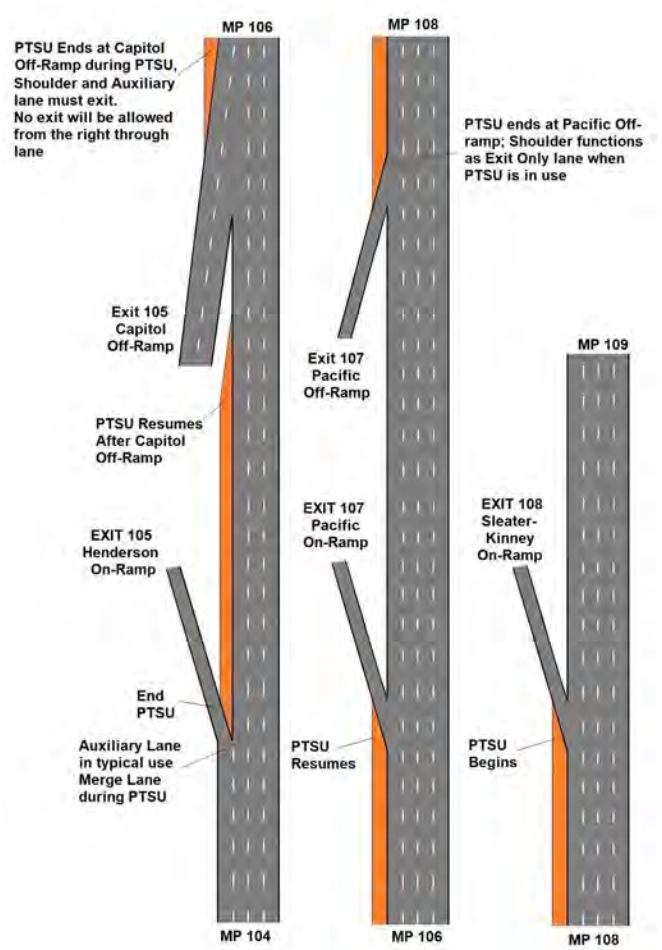
For *Scenario Five – Part Time Shoulder Use*, the study team added part time shoulder use as identified in the I-5 Near-Term Solutions Study. Part time shoulder use involves repurposing road shoulders during high demand conditions in order to improve efficiency and reduce congestion-related crashes on the transportation system.[10] Part time shoulder use fits well within the Practical Solutions framework as it uses the existing highway footprint to add a lane for storage and congestion relief at peak periods, reducing costs for acquiring new right of way and construction especially if the shoulders are already thick enough to support regular use.

9 Scenario Five – Part-Time Shoulder Use includes improvements from all previous scenarios.

10 WSDOT Transportation Systems Management & Operations website- https://tsmowa.org/category/operations-supporting-infrastructure/dynamic-lane-assignment

For Scenario Five, the study team modeled allowing travel on the existing shoulder in the south-bound direction of I-5, between the Sleater-Kinney on-ramp and the Henderson on-ramp (see Exhibit 6-8).

Exhibit 6-8: Diagram of Part-Time Shoulder Use sections



Scenario Six – High Occupancy Vehicle Lane Conversion[11]

Scenario Six – High Occupancy Vehicle (HOV) Lane Conversion investigates what the effect of converting the left lane in both directions of I-5 between US 101 and Mounts Road HOV Lanes would be on study goals. HOV lanes are reserved for vehicles with either two or more or three or more occupants. These facilities move more people in fewer vehicles, as is the case on I-5 near Northgate in Seattle where the HOV lanes move close to three times as many people per lane than general purpose lanes.[12] HOV lanes also benefit transit users by providing faster more reliable travel times for transit.

The study team modeled HOV lanes with a two plus occupancy requirement. In addition to the HOV lane conversion itself, Scenario Six included additional improvements that would help HOV and transit travel. Finally, the study team assumed WSDOT would complete HOV lanes between Mounts Road and 38th Street in Tacoma,[13] creating a continuous HOV lane from Olympia to Everett. Specific improvements are outlined in Appendix G. The scenario includes four elements:

- Converting an existing general capacity lane to HOV.
- Adding HOV bypass at on-ramps with ramp meters.
- Increasing express transit service frequency.
- Adding new park-and-ride lots or expanding capacity in existing park and ride lots.

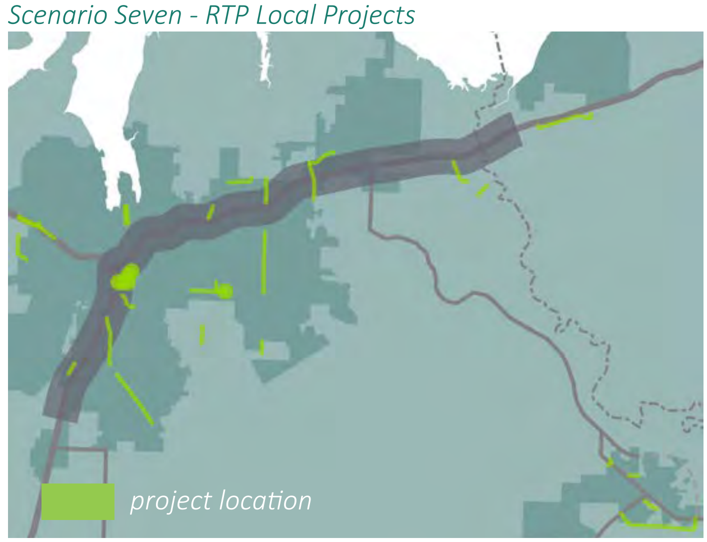
Scenario Seven – Regional Transportation Plan Local Projects[14]

Scenario Seven – Regional Transportation Plan (RTP) Local Projects consists of 31 unfunded local roadway and state highway projects not on I-5 that are included in TRPC's 2040 RTP and anticipated to be included in the 2045 RTP. There were also two projects on the local network identified by the technical advisory group members that the study team included in the model. *Scenario Seven* generally includes projects consisting of:

- Street and road capacity projects (new lanes, center turn lanes, medians and roundabouts).
- Street and road extensions.
- Additional operational improvements.

Specific improvements are outlined in Appendix G. Further details on most of the projects can be found in the RTP, available on TRPC's website.[15]

Exhibit 6-9: Map of unfunded local projects included in *Scenario Seven - RTP Local Projects*



11 Scenario Six – High-Occupancy Vehicle Lane Conversion includes improvements from all previous scenarios.

12 WSDOT 2018 Corridor Capacity Report- https://www.wsdot.wa.gov/publications/fulltext/graynotebook/corridor-capacity-report-18.pdf#page=11

13 WSDOT HOV Feasibility Study: I-5 JBLM to 38th Street- https://dot.wa.gov/publications/fulltext/LegReports/15-17/I5_JBLM_HOV_LaneFeasibilityStudy_SummaryReport.pdf

14 Scenario Seven – Local Network Improvements includes improvements from all previous scenarios.

15 TRPC Regional Transportation Plan – What Moves You: Appendix P Regional

Scenario Eight – Interchange Improvements[16]

Scenario Eight – Interchange Improvements includes improvements to interchanges along I-5 beyond projects already included in previous scenarios (particularly the 2040 baseline scenario). These improvements come from various sources including TRPC's 2040 RTP, previous WSDOT planning efforts, and ideas developed with study advisory groups. Interchanges are common places for highway operations problems due to vehicles merging, diverging, or weaving. Issues can also be caused by other aspects such as old designs or when interchanges are spaced too close. *Scenario Eight* includes the following major improvements:

- A braided ramp on southbound I-5 approaching US 101 (Exits 105 and 104) to separate traffic destined for US 101 westbound before the Henderson Ave on-ramp, reducing the weave there.
- Revisions to the Martin Way interchange (Exit 109) that reduce the need for left turns on Martin Way and provides direct access for transit to the Martin Way Park and Ride from the northbound on-ramp.
- Roundabouts to improve traffic flow at the Tumwater Blvd SW (Exit 101), Trosper Rd SW (Exit 102), and Mounts Road (Exit 116).
- Part-time shoulder use on northbound I-5 between Exits 103 and 104 (US 101).

All improvements included in this scenario are listed and described in Appendix G.

Scenario Nine – Widen I-5: Add General Purpose Lanes, Retain HOV Lanes[17]

Scenario Nine consists of making I-5 eight lanes wide (four in each direction) between the US 101 interchange and Mounts Road while retaining the HOV lanes established in *Scenario Six – HOV Lane Conversion*. In addition, this scenario includes some other capacity expansion type projects such as new ramps and auxiliary lanes designed to improve traffic flow issues observed in previous scenarios. *Scenario Nine* includes these major elements:

- Widen I-5 to four lanes in each direction between Mounts Road and US 101. This scenario retains the I-5/US 101 Braided Ramp interchange option in lieu of a fourth lane on the southbound I-5 mainline at the Plum St/Henderson Blvd interchange (Exit 105).
- Add auxiliary lanes at key locations such as southbound I-5 through Lacey and Olympia and northbound I-5 between US 101 and Pacific Ave. This replaces part-time shoulder use for southbound I-5 from Scenario Five – Part-Time Shoulder Use.
- Add a flyover exit ramp from I-5 northbound to US 101.

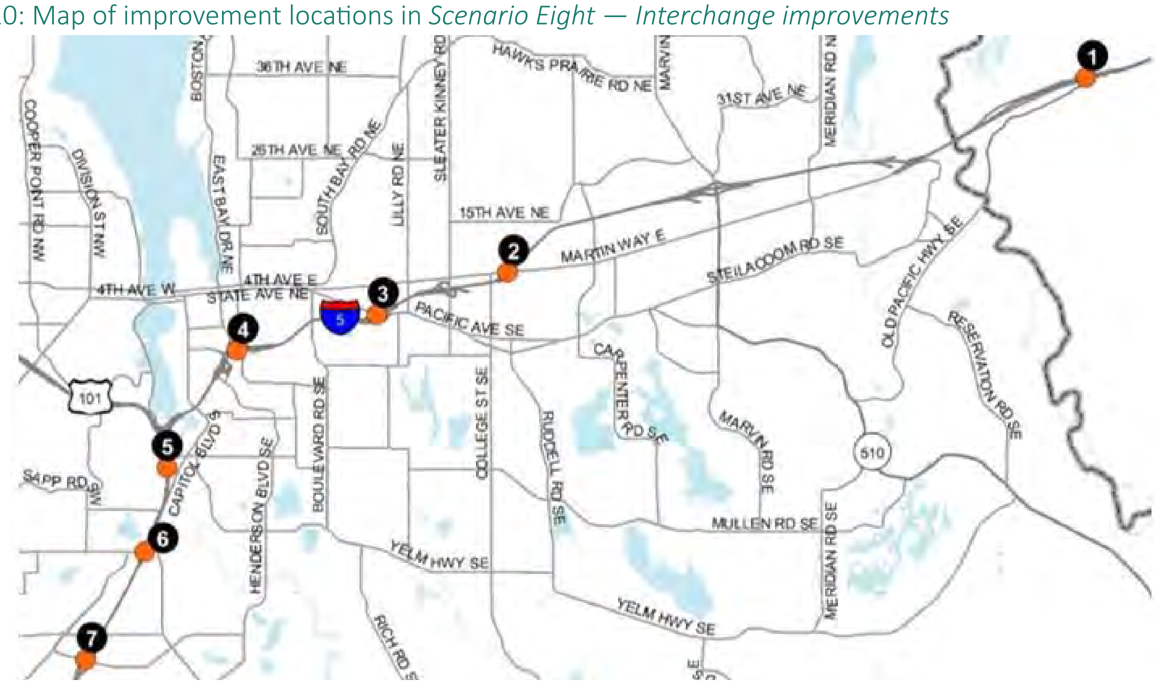
See Appendix G for a list of improvements included in this scenario as well as graphics and maps showing the rough

Project List Detail-https://www.trpc.org/DocumentCenter/View/2940/Appendix-P--Regional-Project-List-Detail

16 Scenario Eight – Interchange Improvements includes improvements from all previous scenarios.

17 Scenario Nine – I-5 Capacity Expansion: Add a General Purpose Lane, Retain the HOV Lanes includes all improvements from previous scenarios except Scenario Six – Part-Time Shoulder Use. Scenario Nine expands the highway in these locations to include a full auxiliary lane and shoulder.

Exhibit 6-10: Map of improvement locations in *Scenario Eight — Interchange improvements*



design of new facilities used in the model.

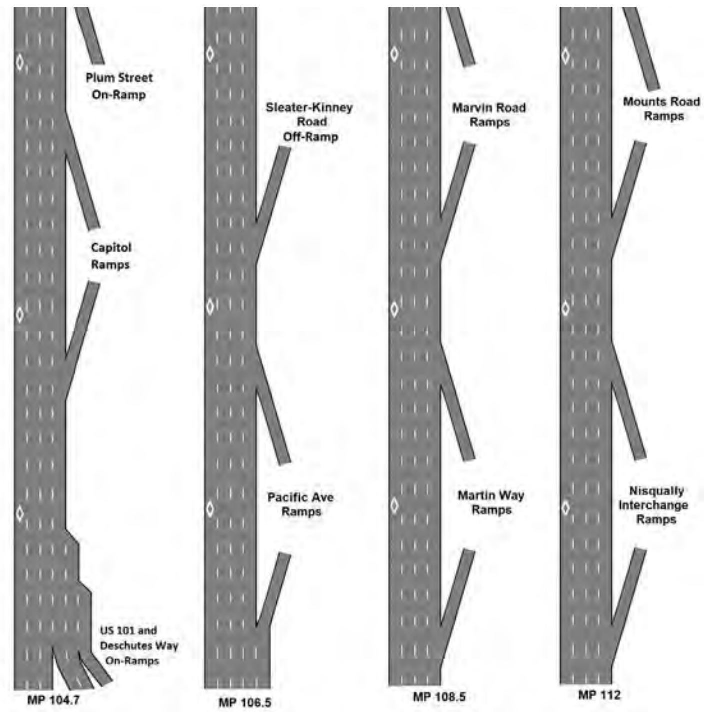
Scenario Ten – I-5 Capacity Expansion: Add General Purpose Lanes, Convert HOV Lanes to General Purpose[18]

Scenario Ten consists of the same elements as *Scenario Nine*, except the HOV lanes on I-5 in each direction are converted to general purpose use. The study team included this scenario to see if there was substantive performance differences between this scenario and Scenario Nine and based on public input received during

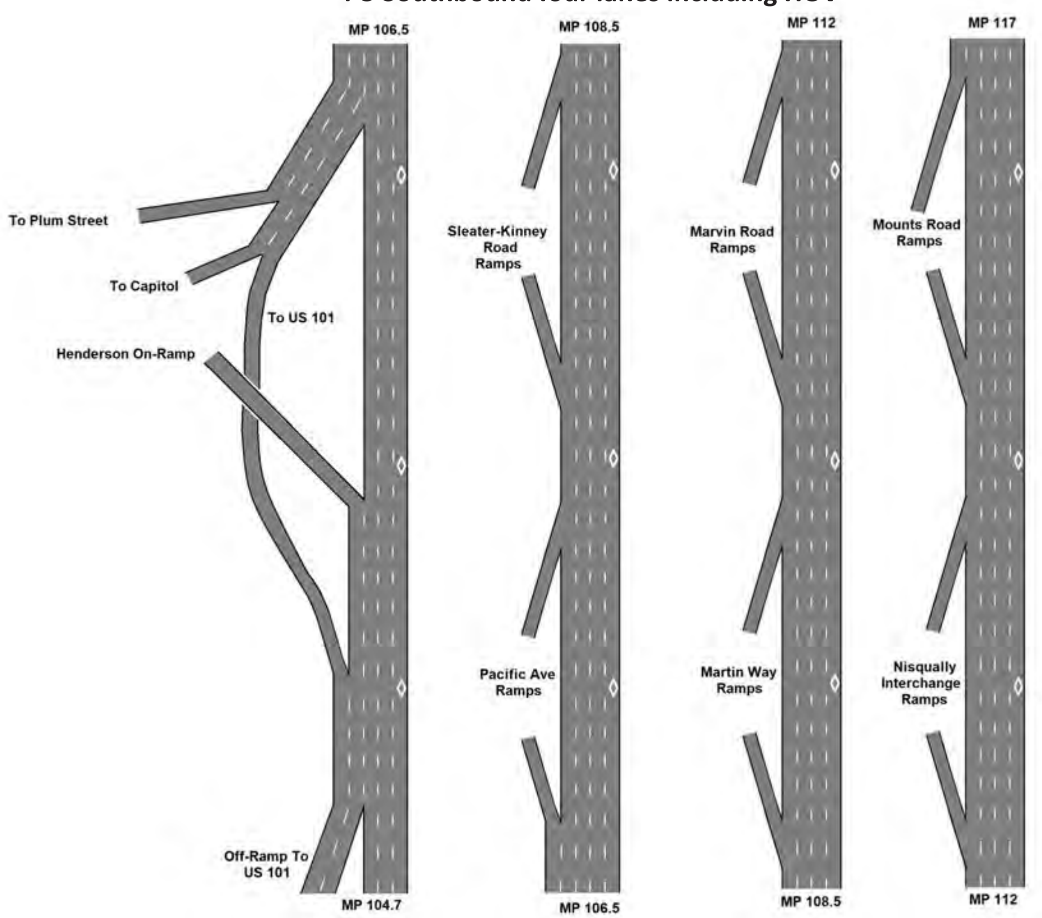
18 Scenario Ten – I-5 Capacity Expansion: I-5 Capacity Expansion: Add General Purpose Lanes, Convert HOV Lanes to General Purpose includes all improvements from previous scenarios except Scenario Six – Part-Time Shoulder Use, and Scenario Nine – I-5 Capacity Expansion: Add a General Purpose Lane, Retain the HOV Lanes. Scenario Ten expands includes a full auxiliary lanes and shoulders where scenario six had part-time shoulder use. The HOV lanes from scenario six are converted to general purpose use,

Exhibit 6-11: Diagram of improvements included in Scenario Nine- Widen I-5: Add General Purpose Lanes, Retain HOV

I-5 Northbound four lanes including HOV



I-5 Southbound four lanes including HOV



Chapter 7 - Strategy evaluation and modeling results

After developing the various strategies, the study team collaborated with partners to evaluate the effectiveness of each for achieving study goals defined in Chapter 1. Because some strategies could be modeled and others could not, the study team developed two approaches for evaluating the strategies. The study team produced data from the modeled strategies that were used to measure system performance. For the strategies that could not be modeled, the study team worked with the advisory groups to develop a process that would reflect the groups' collective evaluation of each idea.

Evaluating strategies that were unable to be modeled

The study team, in collaboration with advisory groups, determined that modeling was not possible for 45 strategies. Chapter 3 covers the multiple reasons why modeling was not appropriate for these strategies. However, the team did not want to eliminate viable strategies because of modeling limitations, so they developed an alternate group scoring and review process to evaluate their potential, which included the following steps:

Step one – Screen strategies for feasibility

Some strategies were not feasible to construct or implement for various reasons, including conflicts with WSDOT policy or needing changes in state or federal rules or law. Very few strategies were screened out using this step, but examples include "charging JBLM mitigation fees for impacts to surrounding communities" and "installing emergency call boxes along I-5."

Step two – Consult relevant agencies and subject matter experts

The study team met with experts from partners and within the WSDOT to ensure that proposed strategies do not go against their plans, policies, or law. Relevant agencies generally included local or regional governments or state agencies that own facilities or land that would be directly affected by the strategy. Some strategies were screened out through this process such as "Close the truck weigh station north of Mounts Road during peak periods" and "Adding capacity to Steilacoom Rd SE between Pacific Ave and Nisqually Cutoff Rd SE."

Step three – Score strategies

The study team and advisory groups then evaluated strategies that were given the green light by relevant agencies and subject matter experts for their effectiveness by study goal area. The study team gave a high-level rating for each idea using the categories: very positive; somewhat positive; neutral; somewhat negative; and very negative. The technical advisory group then reviewed and revised the scores.

Step four – Review results with advisory group and develop recommendations.

Given the high-level nature of the evaluation for the strategies that could not be modeled, the study team and advisory groups used this process more to guide discussion than as a definitive analysis. In the same vein, recommendations around these strategies generally involved recommending or not recommending further study. Details of the results of this evaluation for all strategies that could not be modeled can be found in Appendix H.

Evaluating strategies that were modeled

The study team collaborated with advisory groups to develop a methodology for evaluating the effectiveness of the strategy scenarios described in Chapter 5. This involved several key steps.

Step one – Prioritize the study goals relative to each other

The study team used input from the technical advisory group and results from study surveys to prioritize the study goals listed in Chapter 3. The purpose of this step was to allow the stakeholder advisory groups and public to determine which study goals were most important in evaluating the effectiveness of modeled scenarios.

The study team used an exercise with the technical advisory group called "forced-choice pair comparison" (example table in Exhibit 7-1) a common tool for developing group priorities. Participating members of the technical advisory group considered each study goal against the others individually in terms of which were most important to the legislative purpose, their organization's priorities, and performance of the transportation system (as well as any other considerations they thought were important). The study team took the resulting scores from each participant and averaged them by goal area to create a group weighting. The advisory group members then reviewed the averaged results and determined that the results did a good job of capturing the groups' values. No changes were made to the result from the exercise based on the discussion.

Respondents to the public surveys also provided input on their priorities for the study goals. Both surveys asked respondents to rank study goals from most to least

Exhibit 7-1: Advisory Group members filled out a "forced-choice pair comparison" exercise to develop study goal priorities

Study Goals	Travel times & reliability	Efficiently, equitable move people & goods	Improve accessibility	Nisqually habitat	Network redundancy/ resiliency	Score
Travel times & reliability	A	B	C	A/D	E	1.5
Efficiently, equitably move people and goods		B	C	B/D	E	2.5
Improve accessibility			C	C	C/E	4.5
Nisqually habitat				D	E	2
Network redundancy/ resiliency					E	4.5

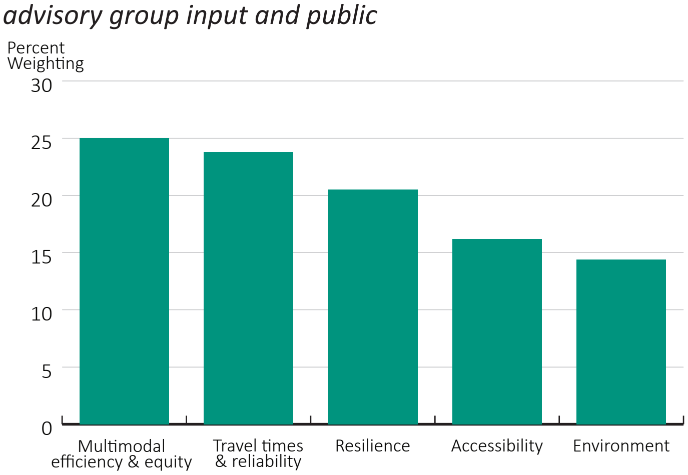
** Please note Exhibit 7-1 is an example, not an actual submission by an advisory group member.*

important. The first survey did not include the fifth study goal of network resilience, as this goal was added in response to feedback from that survey.

The study team used the rankings from the survey and averaged them for each goal area to create a group scoring, similar to the Technical Advisory Group process. As noted in Chapter 3, demographic groups were underrepresented in the survey responses (e.g. lower income households) that sometimes had different values and priorities for these study goals.

To create a final weighting that included input from both the Technical Advisory Group and general public, the study team averaged their overall results giving them equal weight to determine the final prioritization. This final weighting was presented to both advisory groups for a final opportunity to comment. Exhibit 7-2 reflects the combined rankings.

Exhibit 7-2: Overall advisory groups and public input ranked efficiency & equity highest among study goals
Study goal area by percent weighting calculated from advisory group input and public



Step two – Choose performance measures to assess scenario effectiveness

The study team developed an initial set of performance measures for each goal area. These measures, for the most part, have been used in prior WSDOT studies and reports or are currently coming into use such as the access to jobs and commercial services measures. The team also developed others specifically for this study like the traffic balance measure.

The Technical and the Executive Advisory Groups helped develop and refine the performance measures through multiple meetings. The study team presented an initial set of performance measures to the Technical Advisory Group who helped define aspects such as which roads would be used to measure travel times on alternate routes to I-5 or which populations would be considered in the environmental justice access to jobs measure. They also helped define the desired outcome and units of measure that would be used to score the effectiveness of each scenario. The study team also engaged with partners one on one as needed to refine performance measures and develop agreement with advisory group participants.

See Exhibit 7-3 on the next page for a list of performance measures. A detailed description of each measure can be found in Appendix G – Scenario and Performance Measures Report.

Exhibit 7-3: Performance measures organized by study goal area

Study goal area	Performance measures	Desired outcome
Travel Times and Reliability: Improve travel times on I-5 and make them more predictable	▪ Travel times along I-5 between SR 121 (exit 99) and Main Gate (exit 120)	Reduce travel times
	▪ Maximum throughput travel time index (MT^3I, average travel time divided by maximum throughput travel time) for I-5 in the study area for all traffic and HOV	Achieve an MT^3I of 1, this means the corridor is operating at peak efficiency for moving vehicles
Efficiency and Equity: Increase the transportation system's ability to efficiently and equitably move all people and goods	▪ Number of people moved during peak periods on I-5 for all traffic and HOV	Increase person throughput
	▪ Travel mode split in Thurston County between driving alone, carpooling, vanpooling, transit, walking, and biking	Decrease percent of trips made by driving alone
	▪ Total vehicle miles traveled in Thurston County	Decrease total vehicle miles traveled
	▪ Percent of traffic on I-5 traveling through the corridor rather than entering or exiting the highway	Increase the "through traffic" percentage on I-5
	▪ Access to jobs and commercial services for Environmental Justice[1] populations by driving alone, HOV, and transit	Increase access to jobs and commercial services for Environmental Justice populations
Accessibility: Improve access to job sites, commercial services, and industrial areas	▪ Access to jobs and commercial services by driving alone, HOV, and transit	Increase access to jobs and commercial services
	▪ Travel times on local roads that connect I-5 to industrial areas (freight access routes)	Decrease travel times on freight access routes
Environment: Protect and enhance the environment including reducing the transportation-related impact on wildlife habitat in the Nisqually River Delta.	▪ Total greenhouse gas emissions in Thurston County	Decrease greenhouse gas emissions
Resilience: Improve the transportation system's ability to operate during disruption and recover from it.	▪ Advisory group evaluation comparing which strategies "improve the availability and/or capacity of alternate routes to I-5.	Increase availability or capacity of alternate routes to I-5
	▪ Travel times on alternate routes to I-5 through the study area.	Decrease travel times on alternate routes to I-5

1 WSDOT's Environmental Manual Chapter 458.02 – Environmental Justice; https://www.wsdot.wa.gov/publications/manuals/fulltext/M31-11/458.pdf#page=3
WSDOT's Community Engagement Plan – "Environmental Justice at WSDOT"; https://www.wsdot.wa.gov/sites/default/files/2017/02/28/FinalCEP2016.pdf#page=15
The study team analyzed access to jobs and services for minority populations, households experiencing poverty, households with disabled individuals, and households with no vehicle.

WSDOT is working with Nisqually Tribe to address salmon and habitat measures

Readers may notice that there are no performance measures in the table above regarding salmon habitat or the Nisqually River delta. The study team initially proposed several measures to include with other environmental performance measures. However, based on feedback from the public, the study advisory groups, and natural resources staff from the Nisqually Indian Tribe, WSDOT will address these aspects of the legislative requirements for this study separately from transportation performance (see Chapter 5).

WSDOT expects the hydrologic study, discussed on page 33, to conclude by summer 2020. WSDOT will review the results of the hydrologic study being conducted by the Nisqually Indian Tribe and the US Geological Survey to inform development of performance measures for these environmental requirements and evaluation of the model scenarios and un-modeled strategies.

Step three – Determine how performance measures results will be scored

The study team initially developed and proposed a method for scoring the performance measure results from the modeling process. The technical advisory group reviewed and refined the initial method over multiple meetings. The final method consists of the following elements:

- For each performance measure, give the best performing scenario a score of 100 and then score all other scenarios relative to it. Basically, this calculates the score of the lower performing scenarios as a percentage of the best one. For the purposes of scoring, the study team compared performance measures for each scenario to one scenario prior in order to determine the incremental benefit of each strategy.

  The study team allowed for scenarios to have a negative score but used a “cap” of-100. This method allowed for consideration of both positive and negative tradeoffs of each scenario. For example, *Scenario Ten* (see on page 7-15) scored very positively on travel time measures but scored negatively for increasing vehicle miles traveled (VMT) and greenhouse gas emissions.
- Average each scenario’s performance measure scores within study goal areas. For example, the study goal area of “improving travel times on I-5 and making them more predictable” included three performance measures: 1) travel times on I-5; 2) the Maximum Throughput Travel Time Index for all traffic; and 3) HOV. Each scenario’s score for these three measures was averaged to create an effectiveness score for the goal.
- Apply the study goal weighting developed in Step One to the goal area effectiveness scores from the previous bullet. This yielded an overall effectiveness score.

Methods for calculating each step for each performance measure and goal area are described in detail Appendix I.

The study team and advisory groups used the effectiveness scores for study goal areas and the overall effectiveness score to compare how well each modeled scenario achieved desired outcomes. The scores informed discussions between the study team and stakeholders that led to recommendations. Other factors, such as planning-level estimates of the cost to construct and maintain projects, were also used when those data were available but were not used in scoring.

Results summary by study goal

The tables in this section provide a high-level look at the effectiveness scores for each model scenario by study goal area and overall. Further detail for each scenario is provided on the subsequent pages. The study team and stakeholder advisory groups used these results along with other factors such as planning-level cost estimates to facilitate discussions around final recommendations which are detailed in Chapter Eight of this report.

Most of the modeled scenarios included multiple improvement projects as outlined in Chapter 5 – Modeling and Strategy Development, except for *Scenario Five – Part Time Shoulder Use*. This is important to consider when looking at the planning-level cost estimates which reflect the cost for all improvements in a scenario that the study team was able to calculate. WSDOT and its partners will analyze individual improvements further in the next phase of planning called a Planning and Environmental Linkages (PEL) study. Through the PEL process, the team will determine which individual improvements provide the most system benefits and hone in on potential project design features.

Travel Times and Reliability

For the I-5 Travel Times and Reliability goal, capacity expansion type improvements on the highway or on interchanges had positive effects.

- *Scenario Ten – Widen I-5: Add General Purpose Lanes, Convert HOV Lanes to General Purpose* scored the highest when comparing performance to the prior modeled scenario.
- *Scenario Five – Part Time Shoulder Use* was a very close second. S*cenario Nine – Widen I-5: Add General Purpose Lanes, Retain HOV Lanes* also scored highly compared to other scenarios. One important thing

Some cautions about modeling results

Beyond the general cautions about models, the study team discussed several key considerations with advisory groups before developing final recommendations. These include:

- **Effectiveness scores are based on the best performing scenario, not a performance target like level of service.** So, while a score will tell us which scenario was the best at improving travel times or system efficiency, it won't answer the question of which improved those measures "enough." This is an important distinction for future cost/benefit calculations.
- **The model could not replicate congestion issues on northbound I-5 in the morning through the Nisqually Valley.** While the study team did not settle on an explanation, the issue may be seasonal changes in traffic volume as discussed in Chapter 4.
- **The Dynamic Traffic Assignment (DTA) model was very complex and sensitive to small changes.** In some cases, this could lead to "model noise," which is changes in performance due to how the model works as opposed to reflecting change due to improvements in the transportation system. The study team investigated this model noise and sometimes make judgement calls about correcting these issues. This was most common with local roadway changes, some as small as signal timing updates.

to note, particularly with *Scenario Nine*, is that each model scenario built off all the previously modeled scenarios. So, the effects of HOV lanes included in this scenario were already accounted for in *Scenario Six – HOV conversion*, when they were added to the model.

- Other approaches also showed benefit to I-5 travel times such as *Scenario Two – Sustainable Thurston Land Use* and *Scenario Four – Intercity Transit Long-Range Plan*. These two strategies allowed for travelers to either shift their trip to a different mode like transit or take shorter trips to achieve their needs which had some benefits for travel times on I-5 compared to the modeled scenarios.
- Only two scenarios exhibited negative effect on I-5 travel times and reliability measures: *Scenario Six – HOV Conversion* and *Scenario Seven – Regional Transportation Plan Local Projects.*

Scenario effectiveness score visualization scale

Most negative effect | Neutral effect | Most positive effect

Exhibit 7-4: I-5 Travel times and reliability goal effectiveness scores

Scenario	Score
Widen I-5 – All General Purpose	●
Part Time Shoulder Use	●
Widen I-5-- Add General Purpose, Retain HOV	◕
Sustainable Thurston Land Use	◔
Interchange Improvements	◔
Intercity Transit Long-Range Plan	◔
Operations improvements	○
Transportation Demand Management	○
HOV Conversion	◔
Regional Transportation Plan - Local Projects	◐

**Scenarios listed in order of highest to lowest score*

The I-5 Travel Times and Reliability goal area score was weighted at 23.8 percent when calculating overall effectiveness scores, per input from study advisory groups and the general public discussed on page 7-4. This was the second highest weighted goal.

Efficiency and Equity goal

For the Efficiency and Equity goal, a variety of scenarios showed positive effects. This may partly be due to the goal area including a variety of measures ranging from total VMT in Thurston County to access to jobs and commercial services for environmental justice populations, as shown in Exhibit 7-3.

- *Scenario Three – Transportation Demand Management* scored the highest among all the scenarios, mainly due to improvements in person throughput, mode split, and reduced VMT.
- The next two highest scorers, *Scenario Eight – Interchange Improvements* and *Scenario Four – Intercity Transit Long-Range Plan,* had different benefits.
- *Scenario Eight – Interchange Improvements* provided benefits particularly for person throughput measures and the balance of local, regional, and through traffic on I-5. *Scenario Four – Intercity Transit Long-Range Plan,* on the other hand, scored highly for mode split and access to jobs and services for EJ populations.

Exhibit 7-5: Efficiency & Equity goal effectiveness scores

Scenario	Score
Transportation Demand Management	●
Interchange Improvements	●
Intercity Transit Long-Range Plan	◕
HOV Conversion	◑
Operations improvements	◑
Widen I-5 – Add General Purpose Lanes, Retain HOV Lanes	◑
Sustainable Thurston Land Use	◑
Widen I-5 – All General Purpose Lanes Part	◔
Time Shoulder Use	◔
Regional Transportation Plan - Local Projects	◑

**Scenarios listed in order of highest to lowest score*

These tradeoffs between individual performance measures as well as between the study goals are important considerations when looking at summary-level scores like those provided here. Detailed scoring results can be found in Appendix J.

Two scenarios showed negative effects on this goal area overall. *Scenario Five – Part-Time Shoulder Use* had a slightly negative effect due to an increase in VMT and a decrease in the proportion of thru traffic on I-5. However, the scenario had positive effects on other efficiency measures like person throughput. *Scenario Seven – Regional Transportation Plan - Local Projects* had a negative effectiveness score mainly due to reduced person throughput on I-5 and decreased thru traffic on I-5.

The Efficiency and Equity goal score was weighted at 25 percent when calculating overall effectiveness scores, per input from study advisory groups and the general public discussed on page 7-4. This was the highest weighted study goal.

Access to jobs, services, and industrial areas

Similar to Efficiency and Equity, a variety of scenarios showed positive effects for the Accessibility goal. This is because access measures, like those used for this goal area, can be improved both by making travel by given modes faster (multimodal mobility) or by making the length of trips people need to take to meet their daily needs shorter (land use.

- *Scenario Two – Sustainable Thurston Land Use* (adopted regionally in 2013) scored the highest for this goal area as it improved access to jobs and commercial services by all three modes measured (single occupant vehicle, HOV, and Transit) as well as improving travel times on local freight access routes.
- *Scenario Four – Intercity Transit Long-Range Plan* improved access to jobs and commercial services for transit users and did so by a significant percentage compared to other scenarios.
- *Scenario Six – HOV Conversion* also improved access to jobs and services for HOV and transit users, almost two times more than Scenario Four. However, a negative effect on freight access route times mitigated those positive scores.
- Only *Scenario Three – Transportation Demand Management* exhibited a negative score - due to a negative result for travel times on freight access routes calculated in the model.

Exhibit 7-6: Accessibility goal effectiveness scores

Scenario	Score
Sustainable Thurston Land Use	●
Intercity Transit Long-Range Plan	◕
HOV Conversion	◕
Regional Transportation Plan - Local Projects	◑
Widen I-5 – All General Purpose Lanes	◑
Widen I-5 – Add General Purpose Lanes, Retain HOV Lanes	◔
Part-Time Shoulder Use	◔
Interchange Improvements	○
Operations improvements	○
Transportation Demand Management	◑

**Scenarios listed in order of highest to lowest score*

The Accessibility goal score was weighted at 16.2 percent when calculating overall effectiveness scores, per input from study advisory groups and the general public discussed on page 7-4. This was the second lowest weighted goal.

Environment

The environmental goal's only performance measure for the portion of the study focused on transportation was greenhouse gas emissions in Thurston County (see Chapter 5 for information on the Nisqually River and I-5). So, scenarios that served to either reduce travel or shift travel to modes that emit less greenhouse gases tended to score well.

- *Scenario Two – Sustainable Thurston Land Use* scored the highest. It was the best scoring scenario also for reducing total VMT and scored only second to *Scenario Four – Intercity Transit Long-Range Plan* for shifting travel away from single occupant vehicles.
- *Scenario Six – HOV Conversion* and *Scenario Three – Transportation Demand Management* also scored well for the Environment goal largely due to reduced VMT in Thurston County as well as some mode shift away from SOV travel.
- Several scenarios exhibited neutral effects on this goal area. The most interesting one was *Scenario Four – Intercity Transit Long-Range Plan* which did have positive scores in other goal areas for shifting travel away from SOV to transit. However, total VMT remained flat in that scenario and transit use as a proportion of overall travel remained small so the end result was a neutral effect on total greenhouse gas emissions.
- Scenarios that included larger capacity expansion on I-5 tended to exhibit negative effects because they resulted in more VMT and more travel occurring by SOV. *Scenario Nine* and *Scenario Ten* both increased emissions by a greater percentage than *Scenario Two – Sustainable Thurston Land Use* decreased them when comparing to the prior scenario. *Scenario Five – Part Time Shoulder Use* also increased emissions but not as much.

The Environment goal score was weighted at 14.4 percent when calculating overall effectiveness scores, per input from study advisory groups and the general public discussed on page 7-4. This was the lowest weighted study goal.

Exhibit 7-7: Environment goal effectiveness scores

Scenario	Score
Sustainable Thurston Land Use	●
HOV Conversion	●
Transportation Demand Management	◕
Interchange Improvements	◔
Operations improvements	○
Intercity Transit Long-Range Plan	○
Regional Transportation Plan - Local Projects	○
Part Time Shoulder Use	◑
Widen I-5 – Add General Purpose, Retain HOV	●
Widen I-5 – All General Purpose	●

**Scenarios listed in order of highest to lowest score*

Resilience

The resilience goal had two performance measures: travel times on local alternate routes to I-5 and the technical advisory groups scoring of how well each strategy improved the availability and capacity of alternate routes as discussed in Exhibit 7-3. The advisory group scoring also used a forced-choice pair comparison to create a group score for the scenarios like the exercise discussed on page 7-2 for establishing study goal priorities.

- *Scenario One – Operations* scored the highest for the Resilience study goal due a favorable evaluation from the advisory group and showing the best improvement for travel times on local routes.
- Other scenarios that scored well such as *Scenario Seven – Regional Transportation Plan* - Local Projects or *Scenario Five – Part Time Shoulder Use* also had positive evaluations from the advisory group and a positive effect on local route travel times.
- In some cases, a very high score for one measure offset a negative score for the other such as with *Scenario Eight – Interchange improvements* which received a positive advisory group evaluation but had a slightly negative effect on local route travel times.
- Only *Scenario Six – HOV Conversion* had an overall negative score for Resilience as it received the lowest advisory group evaluation and had a negative effect on local route travel times in the model.

The Resilience goal score was weighted at 20.5 percent when calculating overall effectiveness scores, per input

Exhibit 7-8: Overall effectiveness scores

Scenario	Score
Sustainable Thurston Land Use	●
Intercity Transit Long-Range Plan	◑
Transportation Demand Management	◑
Interchange Improvements	◑
Operations improvements	◑
HOV Conversion	◑
Part Time Shoulder Use	◑
Widen I-5 – All General Purpose	◔
Widen I-5 – Add General Purpose, Retain HOV	◔
Regional Transportation Plan - Local Projects	○

**Scenarios listed in order of highest to lowest score* from study advisory groups and the general public discussed on page 7-4. This was the third highest weighted study goal.

Overall effectiveness scores

To calculate the overall effectiveness scores, each scenario's scores for the study goals were multiplied by the weighting factors developed through the advisory groups and public input described on page 7-4. The result is an overarching figure that gives a high-level understanding of how a scenario's positive and negative tradeoffs balance the study goals and stakeholder priorities for performance outcomes.

- In terms of overall effectiveness, *Scenario Two – Sustainable Thurston Land Use* was the top performer by a fairly wide margin.
- This was followed by a clustering of scenarios with similar overall effectiveness scores including, in order of effectiveness, Transit, Transportation Demand Management, Interchange Improvements, Operations, HOV Conversion, and Part-Time Shoulder Use. While these scenarios had a similar overall score, they had different tradeoffs between the study goal areas. Some had negative effects on certain study goals, noted as light gray circles in Exhibit 7-8.
- Next, the two I-5 widening scenarios had similar levels of performance that was overall positive but not as high as the prior scenarios. As stated earlier, it is important to keep in mind with *Scenario Nine* that the benefits of HOV lanes were largely accounted for in *Scenario Six* so mainly we're seeing the benefit of added auxiliary lanes and a major interchange improvement at Exit 104.

Exhibit 7-9: Resilience goal effectiveness

Scenario	Score
Operations improvements	●
Regional Transportation Plan - Local Projects	◑
Part Time Shoulder Use	◑
Transportation Demand Management	◑
Intercity Transit Long-Range Plan	◑
Sustainable Thurston Land Use	◑
Interchange Improvements	◔
Widen I-5 – All General Purpose	◔
Widen I-5 – Add General Purpose, Retain HOV	○
HOV Conversion	◔

**Scenarios listed in order of highest to lowest score*

- Finally, *Scenario Seven – Regional Transportation Plan Local Projects* had an overall neutral effect resulting from positive scores in some goal areas being offset by negative scores in others.

Results summary by modeling scenario

Scenario One – Operations

The overall effectiveness score for *Scenario One* comparing performance to the prior model scenario was 20, the fifth highest score overall, roughly tied with *Scenario Six – HOV Lane Conversion*. When comparing scenario performance changes from the 2040 Baseline, the score was 17. While this was the lowest score when comparing to the 2040 baseline, it was the second highest increase in score only after *Scenario Two – Sustainable Thurston Land Use*.

Scenario One performed best on measures of system resilience, particularly improving travel times on alternate routes through the study area. The scenario also helped improve person throughput on I-5. Based on the study team's observations of the model, this may be because the improvements on alternate routes to I-5 made them more viable options for commuters and took some demand off

Exhibit 7-10: Effectiveness scoring results for *Scenario One - Operations*

Scenario One - Operations *Study goal area*	Scores comparing performance changes from *Prior Scenario*	 *2040 Baseline*
Travel times & reliability	**-11**	**-8**
I-5 Travel times	7	6
MT^3I – All Traffic	-15	-15
MT^3I – HOV	-25	-15
Efficiency & Equity	**26**	**20**
I-5 Person throughput – All Traffic	52	36
I-5 Person throughput-HOV	90	29
Mode split	0	0
Vehicle Miles Traveled	-10	-5
Traffic balance	25	61
EJ Population access to jobs and commercial services	-4	-2
Accessibility	**-4**	**-1**
Access to jobs	-5	-2
Access to commercial services	-6	-3
Freight access route travel times	0	0
Environment	**0**	**0**
Greenhouse gas emissions	0	0
System resilience	**80**	**67**
Advisory group score	60	60
Alternate route travel times	100	74
Overall Effectiveness Score	**20**	**17**

Note: All figures used to develop scores are available in Appendix J

Exhibit 7-11: Effectiveness scores by study goal area sorted from highest to lowest scoring scenario for each

I-5 Travel Times and Reliability		Efficiency and Equity		Accessibility	
Scenario	**Effectiveness**	**Scenario**	**Effectiveness**	**Scenario**	**Effectiveness**
Widen I-5 – All General Purpose	●	Transportation Demand Management	●	Sustainable Thurston Land Use	●
Part Time Shoulder Use	●	Interchange Improvements	●	Intercity Transit Long-Range Plan	●
Widen I-5 – Add General Purpose, Retain HOV	◕	Intercity Transit Long-Range Plan	◕	HOV Conversion	◕
Sustainable Thurston Land Use	◔	HOV Conversion	◑	Regional Transportation Plan - Local Projects	◕
Interchange Improvements	◔	Operations improvements	◑	Widen I-5 – All General Purpose	◑
Intercity Transit Long-Range Plan	◔	Widen I-5 – Add General Purpose, Retain HOV	◑	Widen I-5 – Add General Purpose, Retain HOV	◔
Operations improvements	○	Sustainable Thurston Land Use	◑	Part Time Shoulder Use	◔
Transportation Demand Management	○	Widen I-5 – All General Purpose	◔	Interchange Improvements	○
HOV Conversion	◔	Part Time Shoulder Use	◔	Operations improvements	○
Regional Transportation Plan - Local Projects	◑	Regional Transportation Plan Local Projects	◑	Transportation Demand Management	◑

Environment		Resiliency		Overall (weighting applied)	
Scenario	**Effectiveness**	**Scenario**	**Effectiveness**	**Scenario**	**Effectiveness**
Sustainable Thurston Land Use	●	Operations improvements	●	Sustainable Thurston Land Use	●
HOV Conversion	●	Regional Transportation Plan - Local Projects	◑	Intercity Transit Long-Range Plan	◑
Transportation Demand Management	◕	Part Time Shoulder Use	◑	Transportation Demand Management	◑
Interchange Improvements	◔	Transportation Demand Management	◑	Interchange Improvements	◑
Operations improvements	○	Intercity Transit Long-Range Plan	◑	Operations improvements	◑
Intercity Transit Long-Range Plan	○	Sustainable Thurston Land Use	◑	HOV Conversion	◑
Regional Transportation Plan - Local Projects	○	Interchange Improvements	◔	Part Time Shoulder Use	◑
Part Time Shoulder Use	◑	Widen I-5 – All General Purpose	◔	Widen I-5 – All General Purpose	◔
Widen I-5 – Add General Purpose, Retain HOV	●	Widen I-5 – Add General Purpose, Retain HOV	○	Widen I-5 – Add General Purpose, Retain HOV	◔
Widen I-5 – All General Purpose	●	HOV Conversion	◔	Regional Transportation Plan Local Projects	○

Notes: Weighting was developed with input from study advisory groups and the general public through surveys as described on pages 44-45. Weight by goal area was as follows: I-5 Travel Times & Reiliability 23.8%; Efficiency & Equity 25%; Accessibility 16.2%; Environment 14.4%; Resilience 20.5%.

of I-5, allowing it to operate a little better. This is reinforced by the positive score for traffic balance which means a higher percentage of traffic on I-5 was through traffic as opposed to local traffic getting on and off in the study area.

The study team estimated the overall cost to construct improvements included in this scenario at $35.2 million. This scenario's projects are estimated to cost an additional $120,000 annually beyond current maintenance needs to keep in a state of good repair. All data from modeling used to create these scores are available in Appendix J.

Scenario Two – Sustainable Thurston Land Use

The overall effectiveness score for *Scenario Two* compared to the prior model scenario was 42 and 36 when compared to the 2040 Baseline, respectively. This was the highest score comparing to prior scenario. Additionally, *Scenario Two* the largest single increase in overall effectiveness when comparing to the 2040 Baseline.

This scenario was the best performer in terms of greenhouse gas emissions and accessibility measures. This is likely due to more dense development resulting in reduced need to travel, shorter trips, and greater ability to travel by modes besides driving alone- as borne out by scores within the efficiency and equity goal. *Scenario Two* also positively affects all other goal areas.

Some performance measures reflected a negative effect including person throughput on I-5, travel times on local alternate routes to I-5, and traffic balance on I-5. However, these were more than offset by this strategy's positive effects on travel times and reliability measures.

The study team was not able to estimate the overall cost to implement this scenario. Costs will likely be different among the city and county governments near the study area. Fully implementing this scenario will likely require local policy and code changes outside WSDOT's purview. All modeling data used to create these scores are available in Appendix J.

Exhibit 7-12: Effectiveness scoring results for *Scenario Two - Sustainable Thurston Land Use*

Scenario Two - Sustainable Thurston Land Use	Scores comparing performance changes from	
Study goal area	*Prior Scenario*	*2040 Baseline*
Travel times & reliability	**24**	**10**
I-5 Travel times	15	18
MT³I – All Traffic	19	4
MT³I – HOV	38	7
Efficiency & Equity	**20**	**24**
I-5 Person throughput – All Traffic	-39	8
I-5 Person throughput-HOV	-52	11
Mode split	84	31
Vehicle Miles Traveled	100	45
Traffic balance	-11	34
EJ Population access to jobs and commercial services	39	15
Accessibility	**67**	**38**
Access to jobs	56	20
Access to commercial services	45	17
Freight access route travel times	100	76
Environment	**100**	**45**
Greenhouse gas emissions	100	45
System resilience	**31**	**75**
Advisory group score	90	90
Alternate route travel times	-28	61
Overall Effectiveness Score	**42**	**36**

Note: All figures used to develop scores are available in Appendix J

Scenario Three – Transportation Demand Management

The overall effectiveness score for *Scenario Three* was then compared to the prior scenario was 21 and 43 when compared to the 2040 baseline. This score comes in at the third most effective when comparing to prior scenario, nearly tying with *Scenario Eight - Interchange Improvements*. This TDM strategy performed particularly well on environmental and efficiency measures such as mode split, vehicle miles traveled, and person throughput.

Performance measures relating to travel times, on the other hand, tended to have slightly negative scores. It was unclear to the study team and technical experts from partner organizations why TDM as a strategy would have a negative effect on travel times. This may have been a case of "model noise" as described on page 7-5. Despite these negative results, TDM still performed well overall compared to other strategies.

Why are the scores comparing to the prior scenario and baseline different?

The two approaches to the overall effectiveness score show model scenarios' incremental (compared to prior scenario) and cumulative (compared to 2040 baseline) effects. The effectiveness scores for scenarios compared to the prior scenario and the 2040 baseline are different, even for *Scenario One*, because of how scoring was calculated. A scenario's score for a particular performance measure was based off the best performing scenario for that measure compared to the reference scenario (either the prior or the 2040 baseline). This results in a different set of scores that provide us with different information, both of which are useful for evaluating potential strategies.

The study team estimated the overall cost of this scenario at roughly $2 million. The cost information for this scenario reflects the funding provided for the 2019-2021 biennium (state Regional Mobility Grant- City of Olympia) and projected federal funding (STPBG TRPC 2021-2023). Projects from this scenario would also cost an estimated additional $120,000 annually beyond current maintenance needs to keep in a state of good repair. All data from modeling used to create these scores are available in Appendix J.

Exhibit 7-13: Effectiveness scoring results for *Scenario Three- Transportation Demand Management*

Scenario Three - Transportation Demand Management *Study goal area*	**Scores comparing performance changes from** *Prior Scenario*	*2040 Baseline*
Travel times & reliability	**-12**	**3**
I-5 Travel times	-13	13
MT^3I – All Traffic	-7	-3
MT^3I – HOV	-17	-1
Efficiency & Equity	**49**	**55**
I-5 Person throughput – All Traffic	51	43
I-5 Person throughput-HOV	87	41
Mode split	71	56
Vehicle Miles Traveled	62	75
Traffic balance	27	100
EJ Population access to jobs and commercial services	-4	13
Accessibility	**-27**	**23**
Access to jobs	-7	17
Access to commercial services	-4	15
Freight access route travel times	-71	36
Environment	**64**	**76**
Greenhouse gas emissions	64	76
System resilience	**34**	**67**
Advisory group score	50	50
Alternate route travel times	18	83
Overall Effectiveness Score	**21**	**43**

Note: All figures used to develop scores are available in Appendix J

COVID-19 implications for the results of this study currently unknown

WSDOT, TRPC, and their partners conducted this study between July 2018 and January 2020. Modeling used historic data on regional population, job growth and travel behavior to project future demand. This did not account for potential impacts of major disruptions such as COVID-19. While the near- and long-term effects of the pandemic are unknown, it will likely be different from the assumptions used in this study. *Scenario Three - TDM* is a good example of this, as expanded working from home has drastically reduced demand during the "Stay home, stay healthy" order.

Scenario Four – Intercity Transit Long-Range Plan

The overall effectiveness score for *Scenario Four* comparing to the prior scenario was 26 and 53 when compared to the 2040 baseline, respectively. This made it the second most effective scenario overall when comparing to the prior scenario after *Scenario Two – Sustainable Thurston Land Use*. Among the study goals, transit as a strategy benefited access to jobs and services most. In particular, access to jobs and commercial services for transit users increased by roughly five percent each. The only scenario to benefit measures of access more was *Scenario Six – HOV Conversion*. In addition to measures of access for the general population, this scenario had similar benefits for populations disproportionally impacted by environmental justice and accessibility issues in the study area such as low-income households or people with a disability.

Scenario Four had the highest benefit to mode split among all the strategies, mainly due to the assumptions used regarding how much transit ridership would increase as a result of improvements such as Intercity Transit

Exhibit 7-14: Effectiveness scoring results for *Scenario Four- Intercity Transit Long-Range Plan*

Scenario Four - Intercity Transit Long-Range Plan *Study goal area*	**Scores comparing performance changes from** *Prior Scenario*	*2040 Baseline*
Travel times & reliability	**14**	**13**
I-5 Travel times	1	11
MT^3I – All Traffic	15	13
MT^3I – HOV	27	15
Efficiency & Equity	**30**	**65**
I-5 Person throughput – All Traffic	10	50
I-5 Person throughput-HOV	13	46
Mode split	100	92
Vehicle Miles Traveled	0	75
Traffic balance	-6	86
EJ Population access to jobs and commercial services	62	41
Accessibility	**52**	**48**
Access to jobs	68	43
Access to commercial services	62	42
Freight access route travel times	26	60
Environment	**0**	**71**
Greenhouse gas emissions	0	71
System resilience	**33**	**77**
Advisory group score	80	80
Alternate route travel times	-15	74
Overall Effectiveness Score	**26**	**53**

Note: All figures used to develop scores are available in Appendix J

implementing a "Zero-Fare" rate structure. There were also moderate benefits for travel times on I-5 and efficiency measures. Resilience scored well, largely reflecting the advisory group forced pair comparison exercise.

While there were no overall negative scores, this scenario scored zero for the environmental goal as there was very little change in greenhouse gas emissions. This is likely due to the transit ridership being a small portion of the overall trips in the system. All data from modeling used to create these scores are available in Appendix J.

Based on information from Intercity Transit, the costs to implement their long-range plan total roughly $145 million. Of that cost, between $48 million and $55 million is capital costs (the figure shown in Exhibits ES-4 and 8-2) of building stops or buying buses and the remainder is operations costs of actually running service.

Scenario Five – Part-Time Shoulder Use

The overall effectiveness score for *Scenario Five* comparing to the prior scenario was 15, ranking seventh among the other scenarios, and 54 when compared to the 2040 Baseline. The greatest benefits of Part Time Shoulder Use were measures of travel time and reliability, scoring only second to *Scenario Ten* for this goal area (see page 7-15). The other study goal that showed benefits from this strategy was system resilience, mainly due to how the study technical advisory group scored it relative to other scenarios. There was also moderate benefit to accessibility measures.

Exhibit 7-15: Effectiveness scoring results for *Scenario Five Part-Time Shoulder Use*

Scenario Five Part-Time Shoulder Use *Study goal area*	**Scores comparing performance changes from** *Prior Scenario*	*2040 Baseline*
Travel times & reliability	**68**	**63**
I-5 Travel times	46	53
MT³I – All Traffic	57	68
MT³I – HOV	100	69
Efficiency & Equity	**-9**	**36**
I-5 Person throughput – All Traffic	40	78
I-5 Person throughput-HOV	42	59
Mode split	0	92
Vehicle Miles Traveled	-63	44
Traffic balance	-74	-97
EJ Population access to jobs and commercial services	3	42
Accessibility	**9**	**59**
Access to jobs	8	46
Access to commercial services	-3	41
Freight access route travel times	22	89
Environment	**-61**	**42**
Greenhouse gas emissions	-61	42
System resilience	**33**	**70**
Advisory group score	80	40
Alternate route travel times	-15	100
Overall Effectiveness Score	**15**	**54**

Note: All figures used to develop scores are available in Appendix J

Part time shoulder use did have negative effects, particularly to the environment goal, due to an increase in greenhouse gas emissions. There was also a slight negative score for efficiency measures like total vehicle miles traveled and the balance of through traffic versus local or regional traffic on I-5. Other efficiency measures, particularly person throughput, had a positive score.

The study team estimated the overall cost to construct improvements included in this scenario at $15.3 million. In addition, projects from this scenario would cost an estimated additional $340,000 annually beyond current maintenance needs to keep in a state of good repair. All data from modeling used to create these scores are in Appendix J.

Scenario Six – HOV Conversion

The overall effectiveness score for *Scenario Six* when comparing the prior scenario was 20, tying with *Scenario One - Operations*, and 58 when compared to the 2040 Baseline. However, HOV conversion as a strategy has different tradeoffs for performance than *Scenario One*. The strongest benefits for HOV Conversion were seen in the environment, efficiency and equity, and accessibility measures. The scenario scored the best of all strategies for multiple measures in these goal areas including HOV person throughput, access to jobs and commercial services for environmental justice populations, and access measures for the general population. These were due to the travel time benefits for transit and HOV travelers that allowed for greater access during congested periods. HOV conversion also scored second only to Land Use for improving emissions.

On the other hand, *Scenario Six* had negative effects on I-5 travel times and system resilience measures. Repurposing the left lanes for HOV use resulted in a 4- to 5-minute increase in travel times for general purpose traffic. Travel times also increased on routes providing access to industrial areas from I-5.

The study team estimated the overall cost to construct improvements included in this scenario at $35.1 million. Roughly $19.7 million of this would fund the actual lane conversion. The remaining $15.4 million would fund supporting improvements like HOV bypass lanes at on-ramps. In addition, projects from this scenario would cost an estimated additional $90,000 annually beyond current maintenance needs to keep in a state of good repair. All data from modeling used to create these scores are available in Appendix J.

Exhibit 7-16: Effectiveness scoring results for *Scenario Six- HOV Conversion*

Scenario Six - HOV Conversion	Scores comparing performance changes from	
Study goal area	*Prior Scenario*	*2040 Baseline*
Travel times & reliability	**-18**	**44**
I-5 Travel times	-51	17
MT³I – All Traffic	-64	20
MT³I – HOV	60	97
Efficiency & Equity	**26**	**51**
I-5 Person throughput – All Traffic	*-62*	*31*
I-5 Person throughput-HOV	*100*	*96*
Mode split	*21*	*100*
Vehicle Miles Traveled	*94*	*90*
Traffic balance	*-100*	*-100*
EJ Population access to jobs and commercial services	100	91
Accessibility	**46**	**78**
Access to jobs	100	87
Access to commercial services	100	87
Freight access route travel times	-61	58
Environment	**96**	**89**
Greenhouse gas emissions	96	89
System resilience	**-19**	**45**
Advisory group score	10	10
Alternate route travel times	-48	79
Overall Effectiveness Score	**20**	**58**

Note: All figures used to develop scores are available in Appendix J

Exhibit 7-17: Effectiveness scoring results for *Scenario Seven - Regional Transportation Plan - Local Projects*

Scenario Seven - RTP Local Projects	Scores comparing performance changes from	
Study goal area	*Prior Scenario*	*2040 Baseline*
Travel times & reliability	**-35**	**9**
I-5 Travel times	-39	-19
MT³I – All Traffic	-64	-55
MT³I – HOV	6	100
Efficiency & Equity	**-23**	**41**
I-5 Person throughput – All Traffic	-55	-8
I-5 Person throughput-HOV	-40	80
Mode split	-2	99
Vehicle Miles Traveled	-4	88
Traffic balance	-26	-100
EJ Population access to jobs and commercial services	-11	86
Accessibility	**25**	**88**
Access to jobs	-8	84
Access to commercial services	-14	81
Freight access route travel times	97	100
Environment	**0**	**87**
Greenhouse gas emissions	0	87
System resilience	**63**	**91**
Advisory group score	100	100
Alternate route travel times	-25	81
Overall Effectiveness Score	**3**	**58**

Note: All figures used to develop scores are available in Appendix J

Scenario Seven – Regional Transportation Plan - Local Projects

The overall effectiveness score for *Scenario Seven* was three when compared to the previous scenario, the lowest score among the different strategies, and 58 when compared to the 2040 baseline the same score as *Scenario Six – HOV Conversion*. The low score for this Local Network strategy is largely due to negative scores for measures in the travel times and reliability, and in the efficiency and equity study goals. Planned improvements to the local network, when implemented in the model, seemed to help traffic flow better on local roads which ultimately delivered vehicles faster to I-5 resulting in increased travel times. This affected person throughput on I-5 and increased the amount of local traffic on the highway.

The projects did have some positive effects for study performance measures. For system resilience, the scenario scored well in the advisory group scoring. For accessibility measures, travel times on freight access routes scored well while access to jobs and services were slightly negative.

These results make sense given the particular projects in local plans and their intended purposes. Most projects in this category aim to improve traffic flow and reduce crash potential related to a number of contributing factors on those roads. Based on figures from local plans, the overall cost to construct improvements included in this scenario was estimated at $433.2 million. WSDOT did not estimate annual costs to maintain these local system projects. All data from modeling used to create these scores are available in Appendix J.

Scenario Eight – Interchange Improvements

The overall effectiveness score for *Scenario Eight* when comparing to the prior scenario was 21, tying with *Scenario Three - Transportation Demand Management*, and 64 when compared to the 2040 Baseline. Improving interchanges in the study area had fairly evenly distributed benefits among the study goals with the exception of accessibility measures. The highest score for this strategy was for the efficiency and equity goal, particularly person throughput and traffic balance on I-5. Other performance measures that showed notable benefit from this scenario

Exhibit 7-18: Effectiveness scoring results for *Scenario Eight - Interchange Improvements*

Scenario Eight - Interchange Improvements	**Scores comparing performance changes from**	
Study goal area	***Prior Scenario***	***2040 Baseline***
Travel times & reliability	**21**	**35**
I-5 Travel times	32	11
MT³I – All Traffic	47	0
MT³I – HOV	-16	94
Efficiency & Equity	**33**	**52**
I-5 Person throughput – All Traffic	59	30
I-5 Person throughput-HOV	39	94
Mode split	-1	99
Vehicle Miles Traveled	24	100
Traffic balance	69	-100
EJ Population access to jobs and commercial services	6	89
Accessibility	**-3**	**88**
Access to jobs	5	86
Access to commercial services	9	85
Freight access route travel times	-24	94
Environment	**26**	**100**
Greenhouse gas emissions	26	100
System resilience	**23**	**68**
Advisory group score	70	70
Alternate route travel times	-25	65
Overall Effectiveness Score	**21**	**64**

Note: All figures used to develop scores are available in Appendix J

included travel times on I-5, emissions, and the advisory group score of system resilience benefits.

Scenario Eight had a slight negative score for the accessibility goal. This was due to an increase in travel times on local routes providing access to industrial areas. Travel times on other local routes measured under the system resilience goal had a similar increase in travel times.

The study team estimated the overall cost to construct improvements included in this scenario at $186.4 million. In addition, projects from this scenario would cost an estimated additional $2.4 million annually beyond current maintenance needs to keep in a state of good repair. All data from modeling used to create these scores are available in Appendix J.

Scenario Nine – Widen I-5: Add General Purpose Lanes, Retain HOV Lanes

The overall effectiveness score for *Scenario Nine* was eight when comparing to the prior scenario, outranking only *Scenario Seven - RTP Local Projects*, and 64 when comparing to the 2040 Baseline, the same as *Scenario Eight - Interchange Improvements*. However, this relatively low score reflects the tradeoffs between different study goals. Expanding capacity while keeping HOV lanes from *Scenario Six* had relatively strong benefits for travel times and reliability particularly. The scenario also benefited efficiency and equity measures with the greatest benefits among all strategies for person throughput and traffic balance on I-5. General benefits of HOV lanes were already accounted for in *Scenario Six*, which accounts in part for this scenario's relatively low score.

On the other hand, there were negative effects of this scenario, particularly for environmental measures. *Scenario Nine* was second only to *Scenario Ten* in terms of emissions increases. The scenario scored-100, the most negative score possible. The increase of 2.1% in GHG emissions resulting from this scenario was greater than the largest decrease of-1.6% which occurred in *Scenario Two – Sustainable Thurston Land Use*. This scenario also scored -100 for increasing total vehicle miles traveled in the county.

The study team estimated the overall cost to construct improvements included in this scenario at $987.4 million. Projects from this scenario would also cost an estimated

Exhibit 7-19: Effectiveness scoring results for *Scenario Nine - Widen I-5: Add GP Lanes, Retain HOV Lanes*

Scenario Nine- Widen I-5: Add GP Lanes, Retain HOV	**Scores comparing performance changes from**	
Study goal area	***Prior Scenario***	***2040 Baseline***
Travel times & reliability	**54**	**83**
I-5 Travel times	56	60
MT³I – All Traffic	90	90
MT³I – HOV	16	100
Efficiency & Equity	**21**	**59**
I-5 Person throughput – All Traffic	100	100
I-5 Person throughput-HOV	15	100
Mode split	-4	97
Vehicle Miles Traveled	-100	43
Traffic balance	100	-86
EJ Population access to jobs and commercial services	18	96
Accessibility	**15**	**89**
Access to jobs	23	95
Access to commercial services	22	95
Freight access route travel times	0	76
Environment	**-100**	**39**
Greenhouse gas emissions	-100	39
System resilience	**9**	**44**
Advisory group score	30	30
Alternate route travel times	-12	58
Overall Effectiveness Score	**8**	**64**

Note: All figures used to develop scores are available in Appendix J

additional $21.2 million annually beyond current maintenance needs to keep in a state of good repair. All data from modeling used to create these scores are available in Appendix J.

Scenario Ten – Widen I-5: Add general purpose lanes, Convert HOV lanes to general purpose

The overall effectiveness score for *Scenario Ten* when comparing to the prior scenario was 13, coming in eighth out of the ten strategies, and 63 when compared to the 2040 Baseline, one point lower than *Scenario Nine*. This scenario, while close to the previous in score, had different performance tradeoffs due to the lack of HOV lanes. Travel times and reliability metrics showed the strongest benefit, particularly for general purpose traffic. The scenario also showed benefits for some efficiency measures like overall person throughput on I-5 and traffic balance, with a higher percentage of through-traffic.

There was also some benefit to accessibility and system resilience measures. However, these benefits were offset by negative effects on HOV person throughput, increases in vehicle miles traveled, and a shift in mode split toward SOV travel resulting in a low score for efficiency.

This scenario, similar to the previous one, scored-100 for environment as emissions increased 2.7%. This was the largest increase in emissions among all of the scenarios modeled.

Construction and maintenance costs for this strategy are the same as *Scenario Nine*. All data used to create these scores are available in Appendix J.

Exhibit 7-20: Effectiveness scoring results for *Scenario Ten - Widen I-5: Add GP Lanes, Convert HOV Lanes to GP*

Scenario Ten- Widen I-5: All General Purpose Lanes	Scores comparing performance changes from	
Study goal area	*Prior Scenario*	*2040 Baseline*
Travel times & reliability	**72**	**100**
I-5 Travel times	100	100
MT³I – All Traffic	100	100
MT³I – HOV	16	100
Efficiency & Equity	**9**	**48**
I-5 Person throughput – All Traffic	81	86
I-5 Person throughput-HOV	-42	77
Mode split	-7	95
Vehicle Miles Traveled	-100	27
Traffic balance	94	-100
EJ Population access to jobs and commercial services	27	100
Accessibility	**24**	**88**
Access to jobs	37	100
Access to commercial services	34	100
Freight access route travel times	0	64
Environment	**-100**	**21**
Greenhouse gas emissions	-100	21
System resilience	**21**	**49**
Advisory group score	20	20
Alternate route travel times	22	77
Overall Effectiveness Score	**13**	**63**

Note: All figures used to develop scores are available in Appendix J

Chapter 8 - Provisional study recommendations and next steps

This chapter describes the provisional recommendations for the study. All study recommendations regarding transportation system needs and improvement strategies should be considered provisional until the Nisqually Indian Tribe/USGS study is completed to provide a full picture of risks posed to I-5 and the environmental impacts of the facility on the river and delta. This information will be incorporated into the Planning and Environmental Linkages (PEL) study, as described at the end of this chapter. The study team used performance data discussed in the previous chapters as a tool for guiding discussions of final recommendations with study advisory groups. The recommendations reflect the results of those final deliberations between the study team, study partners, and input from the public received through open house events.

Recommendations for strategies that were unable to be modeled

Using the evaluation of the 45 strategies that were not modeled (mentioned in Chapters 3 and 5, and detailed in Appendix H), the study team and advisory groups developed recommendations where applicable. In many cases, partners were already pursuing an idea, so no recommendation was needed. Recommendations fell into the following categories:

- **Recommended for further study** – This is the strongest recommendation the study team and advisory groups gave for ideas and strategies that were not modeled.
- **Consider for further study** – This recommendation means the study team and advisory groups thought ideas or strategies could be valuable but did not rise to the level of a full recommendation for further study.
- **WSDOT to review for implementation** – Some ideas were relatively small in scale and could be passed on to the relevant office within WSDOT to review for feasibility and potential for benefit.
- **Further study currently proposed** – Study has already been proposed by WSDOT or other agencies.
- **Not recommended for further study** – For a variety of reasons, these ideas and strategies should not be pursued further.
- **Already or currently being studied** – Some ideas are currently being studied or have recently been studied.
- **Outside scope** – Only one idea was given this designation as it is a question of state law more appropriately addressed by the state Legislature.

Exhibit 8-1 on page 8-2 sorts the ideas by the final recommendation made. These recommendations reflect the combined opinions of the study team and advisory groups and are based on group evaluation of each idea. Notes on why these recommendations were made are available in Appendix H. Please note, some of the original ideas that were similar have been combined in the table

Addressing the Nisqually River Bridges strategic plan requirement

One of the outcomes the legislature required for this study was "...a strategic plan for the Nisqually River Bridges..." Recommendations and information regarding this requirement can be found in Chapter 5. WSDOT helped fund a study of the current and expected future states of the Nisqually River and its delta near I-5 and any risks posed to I-5 from the river. WSDOT expects results in summer 2020 which will provide much needed data for additional recommendations. It will also be incorporated into the next steps of planning for this section of I-5 in the PEL study that will analyze the benefits of individual improvements within the modeled scenarios more in depth.

Exhibit 8-1: Recommendations for strategies that were not modeled organized by recommendation category

Recommendation	Idea or Strategy
Recommended for further study	Implement tolling or congestion pricing on all of I-5 through the study area
	Improve bicycle infrastructure – Establish active transportation routes between major destinations
	Develop mechanism for WSDOT to be involved in land use decisions that impact state-owned transportation facilities
	Evaluate alternate routes for, and impacts to the local system from, non-recurring congestion
Consider for further study	Improve access to Amtrak and Sounder services
	Provide shuttle services to the capitol campus
	Update signal timing and channelization on the local network
	Centralize local traffic management
	Keep the Mounts Road access gate to JBLM open longer
	Camera-based speeding enforcement on local network
	Complete refined origin/destination study to evaluate local system improvements
WSDOT to review for implementation	Improve signing to help distribute traffic
	Add signage and high-friction surfacing to northbound Exit 104
Further study currently proposed	Improve bicycle infrastructure – improve local bicycle facilities
	Offer childcare and/or schools at major employment sites
	Expand transit services – High Capacity Transit (commuter rail, light rail, etc…)
Not Recommended for further study	Expand transit services – direct shuttles/micro transit in rural areas
	Adjust pickup/drop off hours to off-peak times at ports
	Add capacity to Waddell Creek Road
	Move Thurston County's Waste and Recovery Center south to rail access station
	Reduce vertical and horizontal curves of I-5
	Close truck weigh station north of Mounts Road during peak periods
	Stripe/add a motorcycle lane
Already or currently being studied	Expand transit services – Ferry service
	Expand transit service – Rapid Transit Systems
	Study freight needs and origins/destinations
Studied previously	Air taxi service to Tacoma, Seattle, and Everett from Olympia Regional Airport
	Increase driver testing requirements
Outside study scope	Increase gas tax

Recommendations for strategies that were modeled

Exhibit 8-2 shows the overall effectiveness scores when comparing a scenario's performance to the prior scenario and compared to the 2040 baseline scenario as well as the planning level cost estimates. The scenarios are shown in the order they were modeled from left to right. Each scenario included all of the improvements from previous scenarios, building off of each other, so the order of modeling is important to keep in mind with two exceptions. In *Scenario Nine – Widen I-5: Add General Purpose Lanes, Retain HOV Lanes* and *Scenario Ten – Widen I-5: Add General Purpose Lanes, Convert HOV lanes to General Purpose*, shoulder use was converted to permanent auxiliary lanes and Scenario Ten the HOV lanes were switched to general use.

The overall effectiveness scores comparing to 2040 baseline further show that the two widening scenarios, while showing some incremental benefit, do not improve the cumulative benefit after the other smaller improvements had been implemented in the model. Furthermore, the last two scenarios are far and away the most expensive of the modeled scenarios costing $225 million more than all others that have an estimate combined. While planning-level cost estimates were note used to score scenarios, it was presented to advisory groups for consideration.

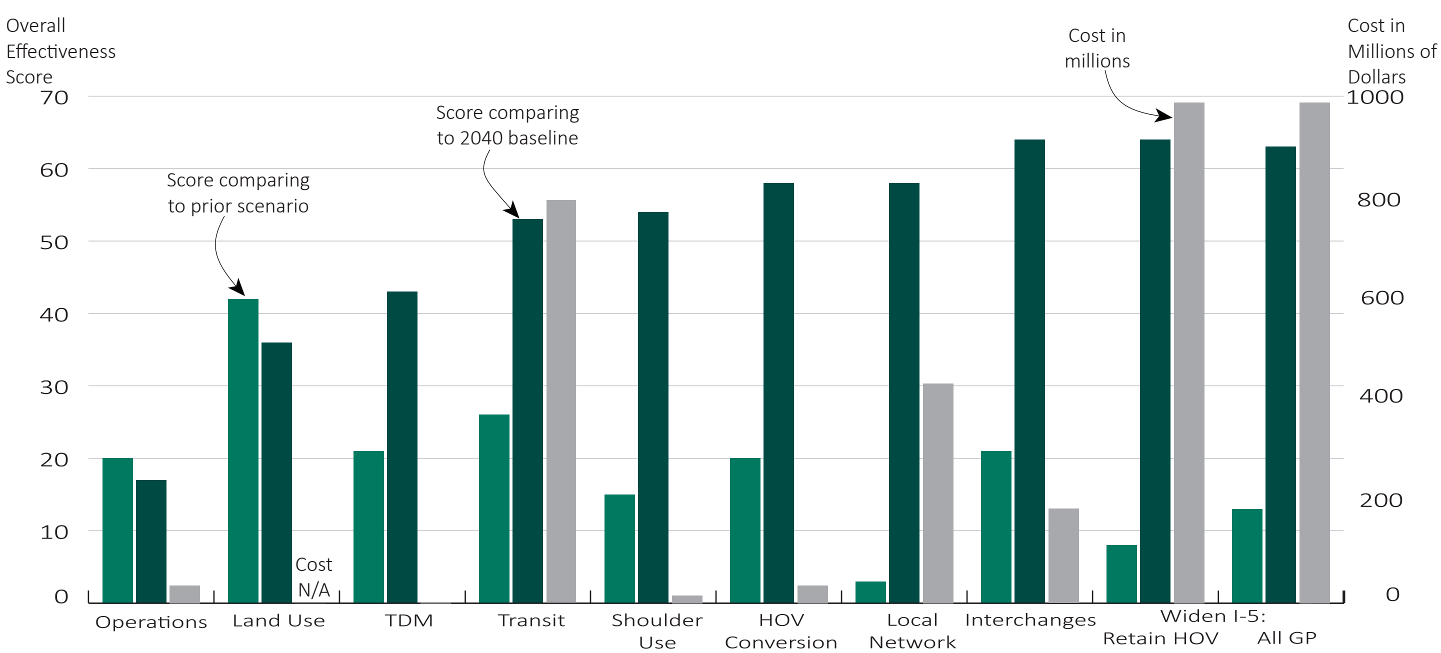
Using the performance data outputs from the modeling process and planning-level cost estimates (both described in Chapter Seven), the study team and study advisory groups developed recommendations for each scenario. As previously mentioned, these data were used as a tool to facilitate discussions between study stakeholders on the advisory groups, WSDOT, and TRPC. Most of the recommendations developed through this study will be investigated in further detail in the next phase of planning called a Planning and Environmental Linkages (PEL) study. Others, such as land use, are outside of WSDOT's authority to implement and will require active engagement with local partners who will be the lead agencies.

Exhibit 8-3 shows the recommended timelines for further planning and implementation of the various modeled scenarios as well as their planning-level cost estimates if available. No one strategy is going to address all study goals alone, for example I-5 Travel Times and Reliability. These scenarios were modeled building off of each other and some may need to be implemented in conjunction to achieve the performance results discussed in this study.

Exhibit 8-2: Overall effectiveness scores and planning-level cost estimates

Overall effectiveness scores compared to prior scenario and 2040 baseline show incremental and cumulative benefits of the modeled scenarios

Overall effectiveness scores from modeling results compared to prior modeled scenario and funded base; Planning-level cost estimates in millions of 2019 dollars



Recommendations require transportation system will be maintained in a state of good repair

As discussed in Chapter Four, WSDOT has maintained the majority of this section of I-5 in fair or better condition. Modeling conducted for this study assumed that WSDOT and its partners will continue to maintain and preserve the transportation system in a state of good repair so that roadway operations and capacity will be maintained. System-wide, Washington State is currently substantially under-investing in state of good repair. WSDOT has regularly communicated this Preservation gap to the Washington State Legislature – in early 2020, WSDOT estimated an annual gap of $690 million to preserve and maintain WSDOT's transportation assets. As this continues, there will be widespread failures in the state system, resulting in operational reductions such as speed reductions, weight limitations, etc.

Scenario	Planning-level cost estimates[1]	Recommended strategy timelines: Near term (0-5 years)	Mid term (5-10 years)	Long term (10-20 years)
#2 – Land Use	Currently N/A[2]			
#4 – Transit	$55 million			
#3 – Transportation Demand Management	$2 million			
#1 – Operations (state and local)	$35 million			
#5 – Part Time Shoulder Use	$15 million			
#8 – Interchange Improvements	$186 million			
#6 – HOV Conversions	$35 million			
#9 – Widen I-5: Add general purpose lanes, retain HOV lanes	$987 million[3]			
#7 – Local Network	$433 million	Does not appreciable contribute to study performance measures		
#10 – Widen I-5: Add general purpose lanes, convert HOV lanes to general use	$987 million[3]	Not recommended		

Notes: 1) While planning-level cost estimates were developed and presented for consideration to study advisory groups, it was not used as a factor for scoring the scenarios. Cost estimates are provided in 2019 dollars. 2) WSDOT was not able to calculate the cost of planning and implementing TRPC's Sustainable Thurston Land Use goals. Furthermore, any costs for implementing this strategy will likely be incurred by local agencies like city and county governments. 3) Cost estimate for Scenario Nine and Ten does not include an elevated causeway through the entire Nisqually River valley but does include replacing I-5 from the Nisqually River north/east to the BNSF train tracks with bridges. In general, there is a high level of uncertainty around costs for changes I-5 through the valley.

Recommendations for Scenario Two – Sustainable Thurston Land Use

Scenario Two – Sustainable Thurston Land Use was the highest scoring strategy overall, due to its large effect in overall system performance and its positive benefits across all study goal areas. The overall effectiveness score was twice as high as the next best scoring scenario.

Recommended timelines for implementation are the near-, mid-, and long-term. This essentially amounts to ongoing implementation. TRPC's Sustainable Thurston plan called for achieving the land use goals used in this scenario by 2035 . Fully implementing this scenario will likely require policy and code changes at the local level that are outside WSDOT's control. While authority to implement this strategy ultimately lies with local agencies, WSDOT should engage those local governments to support achieving Sustainable Thurston land use goals.

The study team was unable to calculate a cost of implementation. Any costs that are associated with achieving Sustainable Thurston land use goals will likely be incurred by local agencies and the costs will likely vary.

Recommendations for Scenario Four – Intercity Transit Long-Range Plan

Scenario Four – Intercity Transit Long-Range Plan was the second best scoring strategy for overall effectiveness. In addition to a high overall effectiveness score, the types of transit improvements included in this scenario, namely bus transit service, require minimal physical changes to the existing road network and can be adapted to changing future conditions. Recommended timelines for implementation are the same as Land Use, basically ongoing implementation starting in the near term. An important point to note about this scenario is that the improvements included in it are essentially Intercity

Transit's existing approved long-range plan. Further study of additional transit improvements, particularly high-capacity transit options (recommended in the previous section of this chapter) could support implementing this scenario.

Based on figures from Intercity Transit, this scenario would cost roughly $145 million in total, including $48 million to $55 million in capital costs and the rest as operations costs. These costs are spread over the 20-year planning period of this study. Roughly $28 million of this figure is unsecured.

Recommendations for Scenario Three – Transportation Demand Management

Scenario Three – Transportation Demand Management was the third highest scoring scenario, practically tying with *Scenario Eight – Interchange Improvements*. Recommended timelines for implementation are in the near-, mid-, and long-term similar to *Scenario Two* and *Scenario Four*. Based on figures from TRPC, the expected cost to implement the TDM strategy is approximately $2 million based on secured funding of $400,000 for 2019-2023. These costs are largely for creating, operating, and maintaining demand management programs.

While this strategy scored roughly the same as *Scenario Eight – Interchange Improvements*, it would not require much construction and would therefore reduce impacts to the traveling public while providing a similar overall benefit according to the study's performance measures. Furthermore, the TDM strategy costs significantly less than interchange improvements.

Recommendations for Scenario One – Operations

Scenario One – Operations was the fourth highest scoring scenario. Recommended timelines for further planning and implementation of the specific improvements included in this scenario are in the near and mid-term. While the individual projects included in this scenario range in their construction cost, they tend to be fairly small which is why the study team and advisory groups to recommend earlier implementation. Further analysis will be needed in the PEL study to determine which specific projects in this scenario provide the most benefits for their cost.

Operations scored roughly the same as *Scenario Six – HOV Conversion* for overall effectiveness and in total cost more than that scenario. However, because the operations scenario was made up of multiple small projects, the study team and advisory groups thought there was an opportunity to begin more detailed planning for these solutions in the near term while HOV conversion was a larger project that may take longer to implement.

Recommendations for Scenario Five – Part-Time Shoulder Use

Scenario Five – Part-Time Shoulder Use was the fifth highest scoring scenario for overall effectiveness. The recommended timeline for considering this strategy in additional planning is in the mid-term. The overall cost to build this scenario was estimated around $15 million.

While this scenario scored lower than some strategies, the study team and advisory groups thought the relatively low cost estimate and the fact that it only includes a single project supported recommending it for further consideration in the mid-term. Furthermore, this scenario would not expand the footprint of I-5 and has relatively low added life-cycle costs for maintenance and preservation.

Recommendations for Scenario Eight – Interchange Improvements

Scenario Eight – Interchange Improvements was the fourth highest scoring scenario, almost tied with *Scenario Three - TDM*. The recommended timeline for considering in further planning is in the mid- and long-term. The overall cost to construct this scenario was estimated at $186 million. However, like the *Scenario One – Operations* strategy, this scenario is made up of several smaller improvements that could be constructed independently. Further analysis will be needed to determine which of the individual projects provided the most system benefit.

Recommendations for Scenario Six – HOV Conversion

Scenario Six – HOV Conversion was the sixth highest scoring scenario in overall effectiveness, practically tied with *Scenario One - Operations*. The recommended timeline for considering improvements in this scenario in further planning is in the mid-term. The overall cost to construct improvements in this scenario was estimated at roughly $35 million. While there are several improvements included in this scenario- HOV bypass lanes at on-ramps, improved express transit service- the main improvement would be striping and signing the inside (left) lanes in each direction on I-5 for HOV use.

This scenario had relatively high overall effectiveness score, reflecting very good benefits for certain study goals like access to jobs and services and relatively small negative impacts for others, like travel times. The study team and advisory groups discussed the political feasibility of this scenario. However, they ultimately decided to rely on the study process and performance measures and let elected decision-makers grapple with the results.

This scenario assumes that an HOV lane will be present between Mounts Road and 38th Street in Tacoma. If this will not be the case, the performance benefits of this scenario should be re-evaluated.

Recommendations for Scenario Nine – Widen I-5: Add GP Lanes, Retain HOV Lanes

Scenario Nine was the second lowest scoring scenario in terms of overall effectiveness when comparing to the incremental benefits from the prior modeled scenario (Scenario Eight – Interchange Improvements). However, since each modeling scenario built on prior scenarios, the performance benefits of HOV lanes largely accounted for in *Scenario Six – HOV Conversion* When comparing this scenario's performance to the 2040 Baseline, it actually scored slightly better than *Scenario Ten – Widen I-5: Add General Purpose Lanes, Convert HOV to General Use*. Furthermore, *Scenario Nine* provided more balanced benefits for study goal areas (aside from environment), whereas *Scenario Ten* was heavily weighted toward benefits to travel time and reliability goal performance measures.

The recommended timeline for considering this scenario in further planning is in the long-term. A strategy like this would take years of planning and construction so the costs would likely be even higher at the time of actual implementation due to inflation and changes in cost of labor and materials. Furthermore, based on WSDOT's *Practical Solutions* approach to addressing transportation needs, other options should be exhausted before considering projects that expand mainline highway capacity. This strategy had relatively low incremental benefits after other less costly and invasive strategies had already been implemented in the model.

WSDOT may want to consider several improvements included in this scenario separately in further study. In particular, improvements to the ramp between northbound I-5 and US 101 (Exit 104) and auxiliary lanes at key locations along I-5 in the study area. The study team added these improvements to this scenario based on observations of performance at specific locations from previously modeled scenarios.

The cost estimate for *Scenario Nine* and *Scenario Ten* does not include an elevated causeway through the entire Nisqually River valley but does include replacing I-5 with a bridge from the Nisqually River north/east to the BNSF Railway tracks. In general, there is a high level of uncertainty around the design of any potential changes to I-5 through the Nisqually River valley as the results of the USGS/Nisqually Indian Tribe's hydrologic study of the river is not complete. Estimated costs for replacing I-5 through the Nisqually River valley could change if a different design is needed.

Other Recommendations and Observations

In addition to the recommendations detailed here for the modeled scenarios, the study team was able to glean some observations about how the system responded to different strategies. These will be useful for future planning efforts along the study corridor.

- Local network improvements near interchanges in urban areas had a strong influence on I-5 performance. Local agencies and WSDOT should work together to analyze future planned improvements' impacts to local roads and I-5.
- The braided ramp improvement on I-5 Southbound at Henderson & Plum (Exit 105) performed better with a permanent auxiliary lane. WSDOT should consider including the auxiliary lane as part of the braided ramp improvement if implemented.
- Roundabouts on Mounts Road and SR 507 made a more viable alternate route to I-5 and provided some congestion benefit.
- Some new local road connections reduced the proportion of local traffic on I-5 by giving local travelers alternate route options.

Recommendations for Scenario Seven – Regional Transportation Plan Local Projects

Scenario Seven – Regional Transportation Plan Local Network scored the lowest in overall effectiveness. While the study team and advisory groups did not recommend this scenario for consideration in further planning to meet the study goals, they recognize that these improvements meet other local goals, such as safety and multimodal mobility on local roads. While this scenario provided the least benefit relative to the study goals, there are still good reasons not directly related to I-5 that these projects are in local and regional plans.

Furthermore, the results for this scenario should not be construed to mean that local network improvements in general could not benefit the highway system. This study only modeled unfunded projects included in the 2040 RTP. Other possible local network improvements could benefit regional congestion management, including I-5.

Recommendations for Scenario Ten – Widen I-5: Add General Purpose Lanes, Convert HOV Lanes to General Use

Scenario Ten ranked seventh, third from last, among the other scenarios in terms of overall effectiveness when compared to the prior modeled scenario (Scenario Eight – Interchange Improvements, Scenario Nine and Ten were mutually exclusive). When comparing performance of this scenario to the 2040 Baseline, it performs about the same as Scenario Nine. For this reason, and others outlined in the section discussing Scenario Nine, the study team and advisory groups did not recommend Scenario Ten for further consideration in future planning efforts as Scenario Nine provided broader benefits to study goals. However, if HOV lanes are not developed on I-5 between S 38th Street in Tacoma and Mounts Road in DuPont, then this scenario may warrant consideration. WSDOT completed a feasibility study of HOV lanes between JBLM and S 38th St in Tacoma in 2017. Additional analysis and coordination is currently in progress.[1]

Next steps

There are several ways WSDOT and its partners can move the recommendations of this study forward. There is currently no funding identified for the strategies recommended in this study.

- **Prepare for federal documentation requirements with a "Planning & Environmental Linkages" study**.
  In late 2019, WSDOT began a process to continue work to study this corridor based on direction from the state legislature; WSDOT will build upon the goals and strategies developed in this study to develop a PEL report. This will involve more in depth analysis of individual components of recommended scenarios to evaluate which improvements provide the most benefit to the transportation system. Preliminary work on this phase of the planning process has already begun. The environmental, community, and economic goals defined by the public and stakeholders early, in this transportation study, work will easily transitions into PEL.

  The PEL report will be a precursor to National Environmental Policy Act (NEPA) documentation which is needed to get federal approval. Guidance from the Federal Highway Administration[3] requires WSDOT to obtain input from federal and state agencies, tribal governments, and the public. A PEL process documents analysis, methods, and relevant decisions. This process streamlines the approval timeline, in compliance with One Federal Decision.[4]

- **Engage partners to help deliver strategies outside WSDOT's authority.**
  A unique aspect of this study is that the top three recommended strategies are largely outside WSDOT's purview to implement. Land use policy is under the authority of local city and county governments. Restrictions in how WSDOT can spend funds based on previous rulings from the state Supreme Court, also restricts how WSDOT can help implement the transit strategy.[5] So, to ensure that the three highest priority strategies are actively implemented, WSDOT will need to engage with its partners. In addition, agency leadership should work with the legislature to develop mechanisms for WSDOT to have greater involvement in these strategies. This could help in implementing WSDOT's Practical Solutions approach as these strategies can be lower cost and don't require costly expansion of highway right-of-way

- **Work with the Nisqually Indian Tribe to analyze results of hydrologic study and develop recommendations**.
  As stated in Chapter 5, the legislature required that this study develop a strategic plan for the Nisqually River Bridges and address ecosystem benefits to the Nisqually River estuary for salmon productivity and flood control. The Nisqually Indian Tribe is currently conducting a study of the river channel near the I-5 bridges and sediment delivery past the bridges. WSDOT should engage with the Nisqually Indian Tribe and other stakeholders to incorporate information from their study and finalize priorities and recommendations from the rest of this report through the PEL study process.

- **Communicate corridor and WSDOT priorities to stakeholders**.
  This report discusses how the needs of this corridor, in terms of system performance and facility conditions, fit into the State's wider transportation priorities. There are sizable maintenance and preservation needs that are currently underfunded.[6] There are segments of the state highway system that experience significantly greater performance issues like congestion.[7]

  WSDOT should take proactive steps to communicate with stakeholders about how projects and programs included in this study are ultimately prioritized and funded to manage expectations about what may actually be constructed and when.

1 WSDOT HOV Feasibility Study I-5: JBLM to S 38th St; https://www.wsdot.wa.gov/publications/fulltext/LegReports/15-17/I5_JBLM_HOV_LaneFeasibility-Study_SummaryReport.pdf

3 FHWA Planning and Environmental Linkages website; https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/PEL.cfm

4 FHWA One Federal Decision webpage; https://www.environment.fhwa.dot.gov/nepa/oneFederal_decision.aspx

5 "18th Amendment to the Constitution"; the Washington State Legislature's Transportation Resource Manual; http://leg.wa.gov/JTC/trm/Documents/TRM%202017%20Update/7%20-%2018th%20Amendment-Final.pdf

6 State of Transportation 2020 presentation, slide 12; https://www.wsdot.wa.gov/publications/fulltext/state-of-transportation/files/2020-state-of-transportation.pdf#page=12

7 WSDOT 2018 Corridor Capacity Report "Statewide Congestion Indicators", page 8; https://www.wsdot.wa.gov/publications/fulltext/graynotebook/corridor-capacity-report-18.pdf#page=8

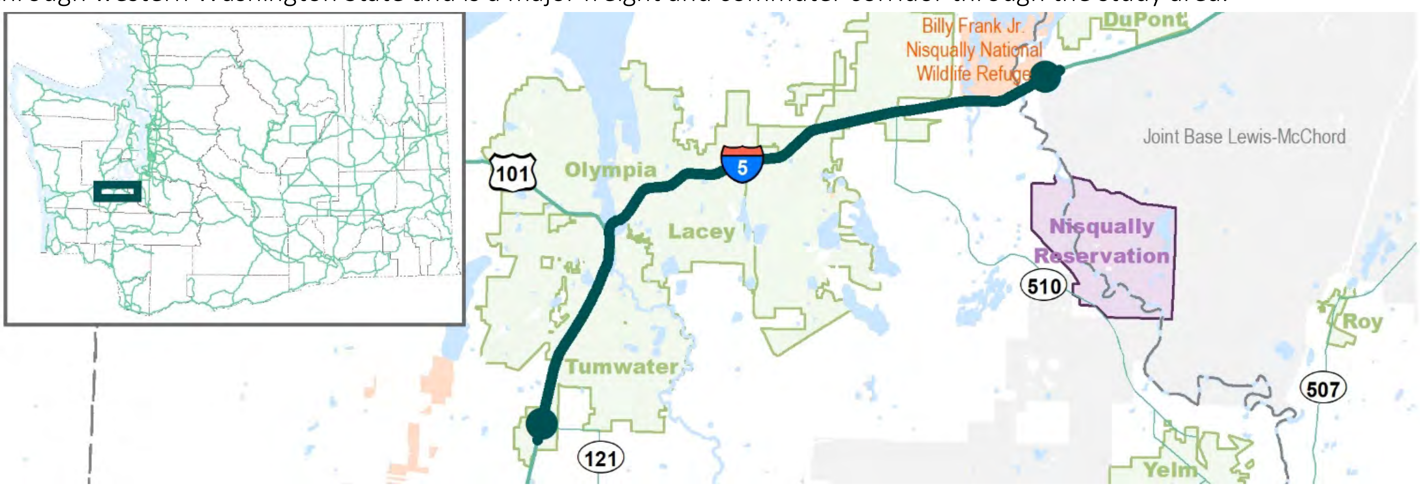
Appendix A – Communications and Community Engagement Plan

Washington State Department of Transportation

I-5: TUMWATER TO MOUNTS ROAD MID- AND LONG-RANGE STRATEGIES

Communications Plan

WSDOT and Thurston Regional Planning Council (TRPC) will be developing strategies to manage system performance while supporting local agency goals in the next 10-20 years along Interstate 5 between Tumwater Boulevard and Mounts Road (including the US Route 101 interchange to Black Lake Boulevard). I-5 is the major north-south highway through western Washington State and is a major freight and commuter corridor through the study area.



WSDOT and local agencies expect travel demand in the area to increase due to increasing population, employment, and freight activity. This will likely result in increased performance gaps. Any strategies WSDOT implements to manage performance on I-5, will affect communities along the study area and the greater region. As such, the study team plans on collecting input from stakeholders and the community-at-large to ensure recommended strategies reflect community priorities and support local development visions.

WSDOT's Olympic Region Multimodal Planning Office will lead communications and co-facilitate community engagement work with TRPC. The study team will have three main areas of responsibility in regards to communication and community engagement including:

- Engaging stakeholders and the general community to develop recommended strategies,
- Communication and coordination with study team, WSDOT offices, and management, and
- Documenting study outputs and processes.

Olympic Region Multimodal Planning Office Contacts

- Dennis Engel, WSDOT Olympic Region Multimodal Planning Manager, (360) 357-2651
- Bradley Bobbitt, WSDOT Olympic Region Study Lead, (360) 357-2790

Community Engagement

As an agency, WSDOT's general goal for community engagement is to include all perspectives, disciplines and backgrounds in outreach and decision making. With regards to this study that will mean working collaboratively with local communities and government partners to develop and refine strategies for managing this segment of I-5. WSDOT is also seeking to achieve the following general outcomes through community engagement for this study:

- Increase awareness around WSDOT's planning efforts for this stretch of I-5.
- Collect and document community members' preferred performance outcomes, priorities, and concerns.
- Ensure WSDOT is aware of potential effects of different strategies on communities.
- Inform communities that will be affected by the strategies the study will recommend.

The study team's general approach to community engagement will be to proactively reach out to affected and interested communities and work with community members, volunteers, businesses, and leaders to find out their priorities and perspectives. The study team will give particular focus to seeking out input from communities historically excluded from or underrepresented in the planning process. See WSDOT's Community Engagement Plan for the agency's guiding principles on this topic[1]. To do this, the study team will implement the following strategies for community engagement:

- **Hold regular meetings with advisory local technical expert and local elected official/executive groups to provide input throughout the process.** Over the course of the study, the study team will hold roughly six technical advisory group (TAG) and five elected official/executive group (EG) meetings. These groups will be made of staff and executives from agencies in the study area, including Tribal Governments, who will advise on study purpose, need, and goals. The study team will use these meetings to present findings, gather feedback, and brainstorm.
- **Engage affected or interested agencies and groups not on the stakeholder team through one-on-one interviews.** The study team will meet with groups and agencies that may be affected or have an interest in one-on-one interviews to make sure their concerns are being addressed through the process.
- **Engage with communities in the study area through existing community events and interviews to collect input on their priorities.** The study team will collect input from communities by attending existing community events where affected populations may be in attendance and engaging groups that represent these communities to ensure they are being represented in the process.
- **Solicit general community input through stand-alone events and online engagement methods.** The study team will hold up to two online surveys to collect input from any interested community member on their priorities and concerns for the study area. The team will also hold an open house with an online component to provide an opportunity for the community to review the final study recommendations.
- **Provide information regarding study progress, results, and important dates through a dedicated study web page.**

WSDOT is required to protect the civil rights of all people affected by the agency's projects by making a concerted effort to engage minority, low-income, and Limited English Proficient (LEP) populations. Based on analysis of populations in the study area, the study team will use the following strategies to engage populations with barriers to participation:

- Working with existing community organizations and schools to reach minority and low-income households.
- Hold some community engagement efforts in areas where these populations are located.
- Select sites for community engagement that are accessible by transit, walking, and biking and are ADA accessible.
- Use online open-houses and surveys and attend existing community events to reduce time constraint barriers.

1 WSDOT Community Engagement Plan; https://www.wsdot.wa.gov/sites/default/files/2017/02/28/FinalCEP2016.pdf

- Provide engagement materials in Spanish, Vietnamese, and other languages as requested.

Stakeholder engagement

To effectively work with a variety of stakeholders, the study team will assemble stakeholder groups and identify additional partners for one-on-one engagement. Stakeholder engagement will be split into two groups; a technical advisory group, and an executive group. These groups will be made of representatives from government agencies that would be affected by or interested in strategies WSDOT would implement as a result of this study. In addition the study team may reach out to organizations that represent substantial user groups in the study area such as business and neighborhood associations. The lists below provide potential organizations to be part of the stakeholder team and to engage one-on-one.

Potential stakeholder advisory group members

Tribal Governments
- Chehalis
- Cowlitz
- Nisqually
- Puyallup
- Squaxin Island
- Yakama

Federal Agencies
- Federal Highways Administration

Others
- Joint Base Lewis McChord
- South Sound Military Community Partners

Local Governments
- City of DuPont
- City of Lacey
- City of Lakewood
- City of Olympia
- City of Tumwater
- Town of Steilacoom
- Pierce County
- Thurston County

Special Districts
- Port of Olympia
- Pierce Transit
- Sound Transit
- Intercity Transit

Roles and responsibilities

The role of the study stakeholder groups will be to work with WSDOT to develop a shared vision and goals for the study area, providing insight and data to support study analysis, reviewing study documents, brainstorming strategies, and helping to screen potential strategies. The stakeholder groups will serve an advisory role in the process. Participants of the stakeholder groups will be responsible for attending all meetings or providing an informed alternate and contributing in a constructive and timely manner to team tasks. Participants of the technical advisory group are expected to keep their elected officials and management informed of study progress. The study team will convene and facilitate meetings.

Study team	
Olympic Region Multimodal Planning	*Dennis Engel* *Bradley Bobbitt*
Thurston Regional Planning Council	*Marc Daily* *Karen Parkhurst* *Veena Tabbutt*

WSDOT management & executives	
Olympic Region Administrator	*John Wynands*
Olympic Region ARA for Multimodal Design and Development	*JoAnn Schueler*
Olympic Region Program and Planning Manager	*Joseph Perez*
Multimodal Planning Director	*Kerri Woehler*

Study team communication and coordination

The study lead will manage communications with three groups within WSDOT; the study team, subject matter experts, and agency management. The study technical team will consist of staff from WSDOT Olympic Region Planning Office and Traffic, Thurston Regional Planning Council, and a WSDOT Headquarters Liaison. In addition, the study team may consult with subject matter experts within the agency on an as-needed basis. Finally, certain agency management and executives will need to sign-off on the final study products and provide input. The draft lists below provide potential offices and points of contact to be part of the study team and relevant agency management. Subject matter experts will be contacted on an as-needed basis.

Roles and responsibilities

The study team will be responsible carrying out the day-to-day tasks of managing the study. The study lead will hold meetings on an as-needed basis. The study team will provide materials before these meetings with adequate time for team members to review. See the project timeline below.

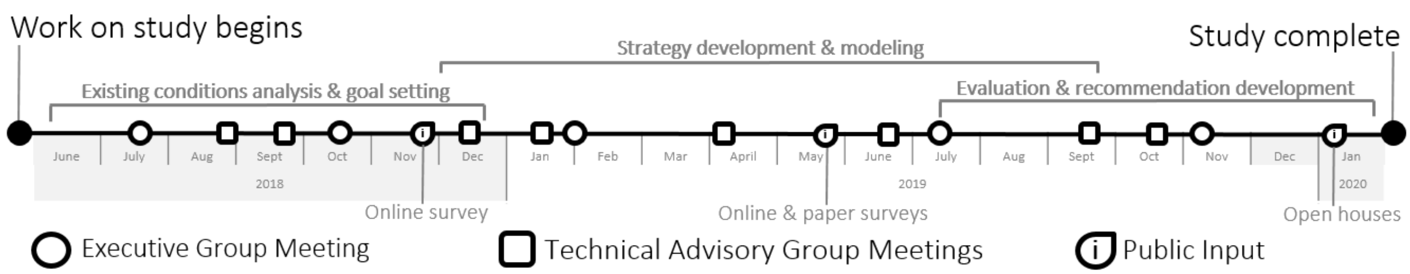
WSDOT management and executives will be responsible for providing timely review of study products, comments and guidance, and approval of final study documentation. The Multimodal Planning Manager will be responsible for keeping agency management and executives up-to-date on study progress.

The study lead may call upon members of either group for their assistance in collaboration with external partners and/or community engagement if appropriate.

Timeline

The study team will break the process into sprints to produce, review, and refine key deliverables (see below). In each sprint, the study team will coordinate with stakeholders and appropriate offices within the agency. The study team will also carry out community engagement at specific times to inform study direction. The graphic and table below give a rough timeline for the study including meetings, dates, and desired engagement outcomes.

General community engagement represents a period of effort as opposed to a single event. Engagement may take on multiple forms within a single sprint. Generally speaking, engagement is timed before significant stakeholder technical advisory groups in order to provide input.



Community Profile

According to TRPC's report, *The Profile*, Thurston County's population was approximately 252,000 as of the 2010 census, with most people living in unincorporated areas. TRPC forecasted a population of roughly 371,000 by 2040, an increase of 119,000 or 47%. Furthermore, TRPC forecasts the balance of population will shift to incorporated cities and urban growth areas. Employment is similarly expected to increase about 50% from 129,000 to 194,000 during the same time period.

The study analysis area includes census block groups within one mile of I-5 between SR 121 and Mounts Road.

Population dynamics in Thurston County are changing. The area is becoming more diverse. As of the 2010 Census, more than 7% of the population identified as having Hispanic or Latinx heritage and more than 5% identified as either Asian or two or more races. The number of individuals with limited English proficiency is also growing. Commuting patterns are also changing, albeit more slowly. People are leaving earlier and experiencing longer commutes. At the same time, more people are not commuting but rather working from home. Other modes including biking, walking, transit, and carpooling have remained relatively stable in terms of the proportion of commuters but are all growing in terms of total number.

Demographics within the study analysis area (shown in gray above) generally include a higher proportion of minority, limited English proficiency, and disability populations than the county as a whole. The table to the right gives a demographic profile for the study area based on analyses conducted for Title VI and NEPA. The table also gives two measures of transit-dependency in the study area.

In addition to the summary data in the table, there are three block groups that meet Title VI criteria for limited English proficiency. Two for Spanish Language speakers and one for Asian and Pacific Island Languages speakers.

Study Analysis Area Demographics

2012-2016 average, 2016 ACS

	Total	Percent
Population	107,861	-
Households	42,984	-
Minority Populations		
Black/African American	*4,281*	*4.0%*
Native American	*1,518*	*1.4%*
Asian	*7,700*	*7.1%*
Hawaiian/Pacific Islander	*959*	*0.9%*
Some Other Race	*988*	*0.9%*
Two or More Races	*6,800*	*6.3%*
Hispanic/Latinx Origin (Any Race)	*8,988*	*8.3%*
Total Minority Population	*28,848*	*26.7%*
Senior Population		
65 or Older	*16,538*	*15.3%*
Poverty Status		
Income below poverty in last 12 months	*11,862*	*11.0%*
Limited English Proficiency		
Spanish	*717*	*0.7%*
Other Indo-European Language LEP	*94*	*0.1%*
Asian and Pacific Island Languages LEP	*1,239*	*1.1%*
Other Languages	*132*	*0.1%*
Total	*2,182*	*2.0%*
Disability Status		
Population with a disability	*12,376*	*15.4%*
Transit Dependency		
Transit Dependent Population	*15,910*	*14.8%*
Households without a car	*3,014*	*7.0%*

Data from the Office of the Superintendent of Public Instruction for the 36 schools in the area shows comparable proportions of minority students with the exceptions of Hispanic/Latinx and two or more races which were both higher than American Community Survey data showed (7.6 and 5.0 percentage points higher, respectively). The number of children on free and reduced lunches was 34.3%, significantly higher than the proportion of people with incomes below poverty. Similarly, the 4.3% of students were categorized “transitional bilingual”, more than twice the limited English proficiency population in the study area.

Appendix B – Geometric Elements Review

In accordance with WSDOT's guidance document *Planning Study Guidelines and Criteria*[1], WSDOT reviewed how I-5 in the study corridor was designed and laid out, called the geometric elements, and did this analysis for informational purposes. The comparison is done using the generic design criteria and does not mean that the geometric design needs to be modified. WSDOT design decisions require thorough engineering analysis that is outside of the scope of this review. In addition, the study team analyzed what structures might undergo modification if the planning level modification assessment were implemented, such as widening I-5. This information is provided below organized by interchange followed by a review of bridges on the study corridor. The following is not to be construed as a full, nor final engineering analysis. The fact that a design element may not meet current design criteria does not indicate that modification is necessary.

<u>US 101 Interchange:</u>

- The reduction of the three northbound on-ramp lanes to a single auxiliary lane is a single 50:1 taper. Current base criteria for a reconstruction project would have a short tangent distance between the tapers.

<u>Pacific Interchange:</u>

- The merge of the two southbound on-ramps has a 394' length. Current base criteria for reconstruction would have a 400' minimum length.
- The northbound on-ramp has a 775-foot acceleration length (519+88.45 to 527+63). A distance of 1020 feet is is a common design for a 25-mph approach curve (200-foot radius, 2% super) to a 60-mph mainline.
- The northbound outer lane between the northbound Pacific on-ramp and the northbound Sleater-Kinney off-ramp is an exit-only lane at Sleater-Kinney. The available weaving distance after the Pacific on-ramp is approximately 575' prior to the off-ramp striping. The weave would likely be assessed as part of any restriping or reconfiguration.

<u>Sleater-Kinney Interchange:</u>

- The southbound on-ramp has a 625-foot merge taper (532+29 to 538+53.59, 14' width, 45:1). The current base criteria rate for a tapered on-ramp is 50:1.

<u>Martin Way Interchange:</u>

- The existing southbound off-ramp merge taper is approximately 10:1. Current base criteria is for a 15:1 taper.
- The existing northbound on-ramp merge taper is approximately 40:1 existing. Current base criteria is for a 50:1 taper.
- It would be appropriate to consider lengthening the two-lane section of the southbound off-ramp due to the high volume of right-turning vehicles, particularly during the evening commute.

<u>Nisqually Interchange:</u>

- The existing northbound off-ramp merge taper is approximately 13:1. Current base criteria is 15:1 minimum.
- The existing southbound off-ramp merge taper is approximately 10:1 existing. Current base criteria is 15:1 minimum.

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1 WSDOT Planning Studies Guidelines and Criteria, page 133; https://www.wsdot.wa.gov/publications/manuals/fulltext/M3033/PSGC.pdf

- It would be appropriate to consider allowing through movements from the outside eastbound Martin Way approach lane during peak hours, or widening the ramp to two lanes and making the outer approach lane full-time through-right. This would be to address queuing on the eastbound approach during the morning commute.

Mounts Road Interchange:

- The existing southbound on-ramp merge taper is less than the current design criteria (approximately 23:1 existing; 50:1 required).
- The existing northbound off-ramp merge taper is less than the current design criteria (approximately 10:1 existing; 15:1 minimum).

Existing Geometric Elements Which Could Impact Design

Capital Lake to Martin Way: the original concrete pavement had a 12-foot median (5' shoulders, 2' barrier) with less concrete depth. The existing median in this area is 22 feet (9' shoulders, 4' barrier). Reduction of the median width to accommodate more lanes could mean replacement of the median pavement for a median width of less than 12 feet.

Bridge Evaluation

The following bridges over I-5 may need modification or replacement if I-5 is to be widened:

- US 101 E/B to I-5 N/B
- Capital Blvd.
- 14th Street
- Eastside Street
- Boulevard Road
- Lilly Road
- Chehalis-Western Trail
- Sleater-Kinney Road
- S/B Off-ramp at Nisqually Interchange
- BNSF tracks
- Tacoma Rail tracks
- Mounts Road

The following I-5 bridges over other roadways or waterways may need modification or replacement if I-5 is widened:

- Henderson Blvd.
- Pacific Avenue
- Martin Way
- Nisqually Interchange

The following bridges are considered functionally obsolete:

- Capitol Blvd
- S/B On-ramp over Henderson
- S/B Off-ramp over Henderson
- Pacific Avenue
- S/B On-ramp over Pacific Avenue
- College Street
- Martin Way (N/B mainline)

- Carpenter Road
- Meridian Road
- McAllister Creek (mainline bridges only)
- Mounts Road (both over I-5 and over railroad)

According to the Washington State Bridge Inspection Manual, bridges are considered Functionally Obsolete (FO) when the deck geometry, load carrying capacity (comparison of the original design load to the current State legal load), clearance or approach roadway alignment no longer meet the usual criteria for the system of which it is an integral part. In general, FO means that the bridge was built to design criteria that are not used today.[2]

The following bridges are considered structurally deficient:

- N/B On-ramp over Eastside

Bridges are considered Structurally Deficient (SD) if significant load carrying elements are found to be in poor condition due to deterioration and/or damage, or the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing overtopping with intolerable traffic interruptions[3].

The following I-5 bridges over other roadways or waterways would be replaced if I-5 is to be widened:

- Northbound Nisqually Delta trusses
- Southbound Nisqually Delta trusses

2 Washington State Bridge Inspection Manual; P. 121 (2-C-69); https://www.wsdot.wa.gov/Publications/Manuals/M36-64.htm

3 Washington State Bridge Inspection Manual; P. 121 (2-C-69); https://www.wsdot.wa.gov/Publications/Manuals/M36-64.htm

Appendix C – Environmental Assessment

Environmental Services Office Memo

To: Bradley Bobbitt
Through: Carol Lee Roalkvam
From: Justin Zweifel
Date: 7/31/2019

Re: I-5 Tumwater to Mounts Rd Planning Study (MP 99.00 to 116.00) Environmental Asset Evaluation

Subject matter experts from the WSDOT Environmental Services Office (ESO) assisted the region planners in their effort to identify environmental asset information. The planning-level environmental review focused on select environmental assets that have the potential to influence the scope of future investments, or are existing assets that need to be protected. This evaluation is a desk review, representing only a snapshot of the information that was available at the time using GIS resources. The review did not examine the full range of environmental and social issues that will be addressed during site specific project development.

ESO staff reviewed the following environmental assets for the study area I-5 MP 99.00 to 116.00, and summarized issues that provide environmental context for the study team in the attached report:

- Climate vulnerability impacts — Justin Zweifel
- Chronic environmental deficiencies — Jenni Dykstra
- Fish passage barriers — Susan Kanzler
- Habitat connectivity priorities — Kelly McAllister
- Noise reduction — Victoria Book
- Stormwater retrofits — Cory Simon
- Wetland mitigation sites — Victoria Book
- Historic bridges — Stephen Austin

Once potential project locations and solutions become clearer, the environmental data should be further analyzed to determine if information rises to a baseline or contextual need. This information can then be used to refine the purpose and need statement and develop strategy solutions to address the needs.

For more information please contact Justin Zweifel at (360) 705 – 7492 or zweifej@wsdot.wa.gov

Attachment: Environmental Asset Evaluation for I-5 Tumwater to Mounts Rd Planning Study

I-5 Tumwater to Mounts Rd Planning Study (MP 99.00 to 116.00) Environmental Asset Evaluation

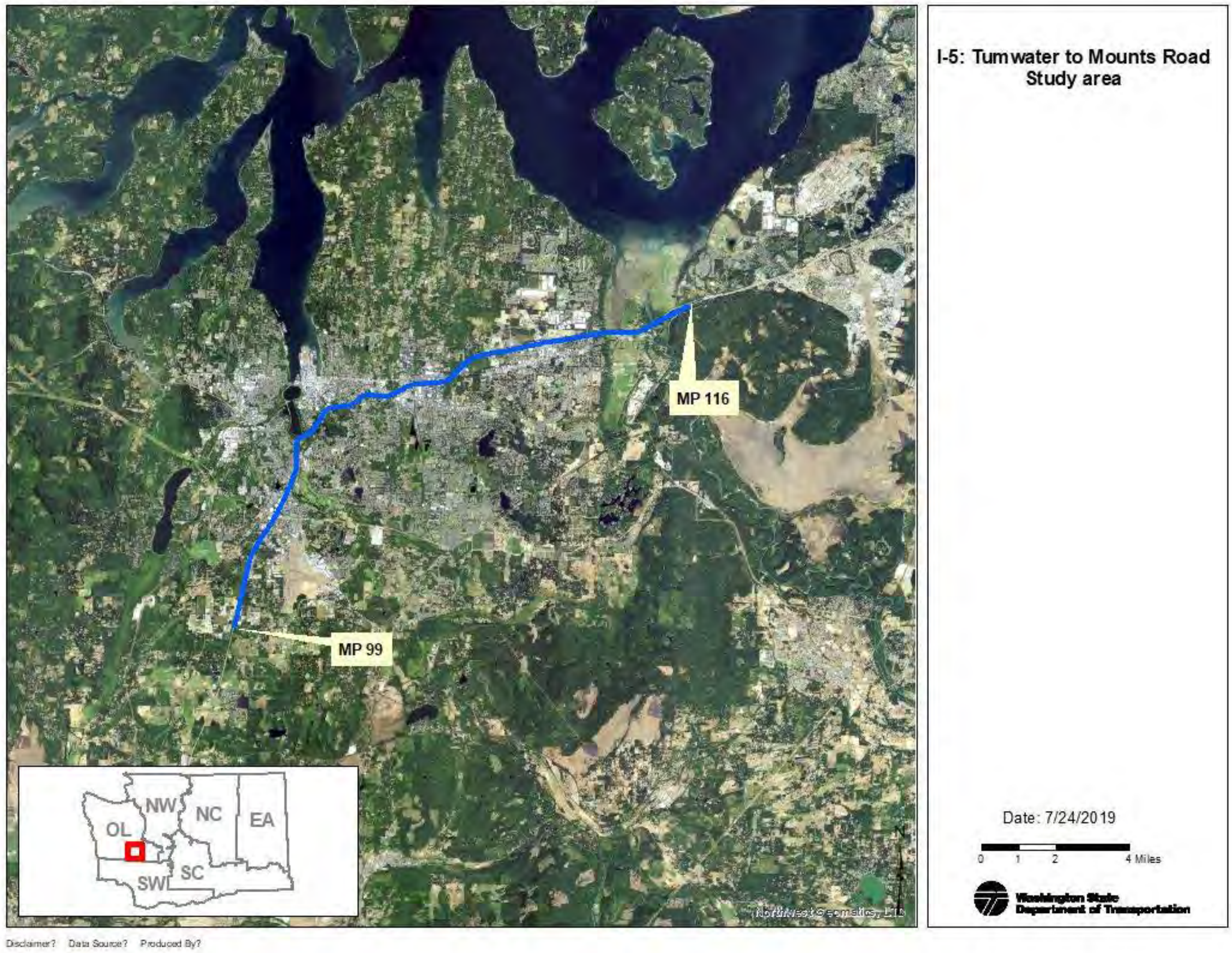


Figure 1. Aerial map of study area

Climate Vulnerability Impacts

WSDOT relies on the University of Washington Climate Impacts Group (CIG) as its primary source for climate information. The CIG's Washington Climate Change Impacts Assessment provides sufficient information to enable planning-level considerations of Washington's forecasted climate impacts. WSDOT used this information from CIG as the basis for scenario planning in the development of a Climate Impacts Vulnerability Assessment (2011) - a qualitative assessment of risks to the state's transportation infrastructure from climate change.

Climate impacts were assessed at the baseline sea level rise - about two feet. The agency's assessment of climate impacts in this study area found it to be an area of low vulnerability (Figure 1).

The assessment breaks the study area into 5 sections:

- Section 1 - milepost 85.5 to 114.0 – Lewis County Line to Lacey
- Section 2 - milepost 114.0 to 114.9 – McAllister Creek Bridge
- Section 3 - milepost 114.9 to 115.4 – Nisqually River
- Section 4 - milepost 115.4 to 115.5 – Nisqually River Overflow
- Section 5 - milepost 115.5 to 135.3 – Mounts Rd to Clover Creek Bridgeport

Section 1: The assessment notes that there are no real flooding issues, as this section of I-5 is far above sea level and floodplains. This section of I-5 would be a detour for other routes. There are no issues at Scatter Creek.

Section 2: The assessment notes that the ramp bridges could be affected. WSDOT owns and maintains dikes to Martin Way. Ongoing dike maintenance is advised.

Section 3: The assessment notes that the bridge is high over the river on piles. The east bridge is the older of the structures.

Section 4: The assessment notes that this is a wetland area.

Section 5: The assessment notes that flooding has come close to the roadway and should be monitored. Flooding has the potential to back up traffic 10 to 20 miles, however the velocities would not be enough to washout the roadway.

Please note that SR 121 (near I-5 Exit 99) has been assessed as an area of moderate vulnerability (Figure 1). The assessment notes that along SR 121, from I-5 to Millersylvania Park, there are wind and flooding issues. Flooding occurs near the park on the north end. Fallen trees may impact power lines.

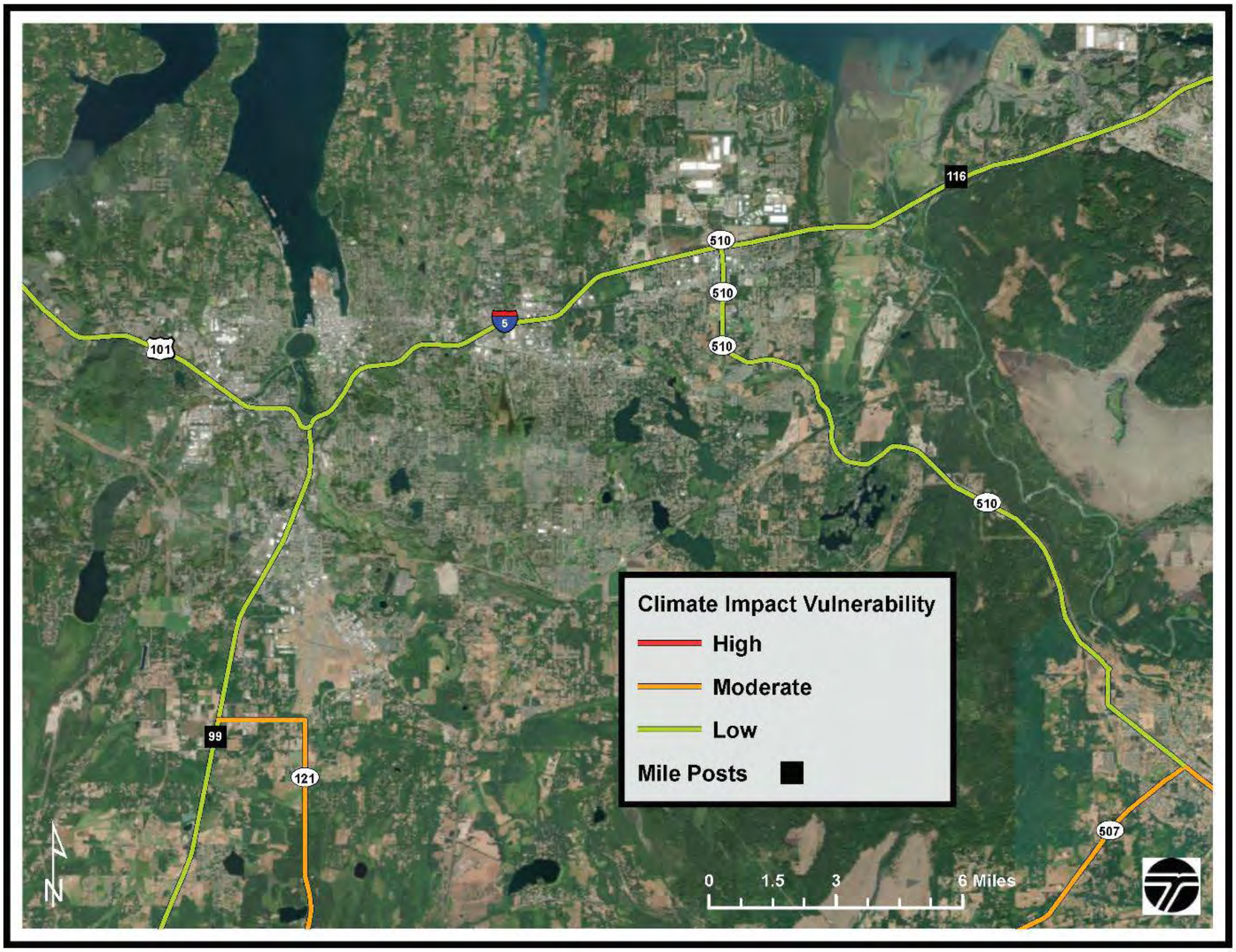


Figure 2. Highway climate impact vulnerability

Chronic Environmental Deficiencies

A Chronic Environmental Deficiency (CED) is a location along the state highway system where recent, frequent, and chronic maintenance to WSDOT infrastructure from changing hydrologic conditions is causing impacts to fish or fish habitat. CED projects are constructed to improve maintenance and environmental conditions of these locations.

There are no CED issues identified within this corridor.

Fish Passage Barriers

The WSDOT ESO/Stream Restoration Program coordinates with WDFW and Tribal governments to inventory culverts on fish-bearing streams within the jurisdiction of WSDOT and assess how well those structures are allowing fish passage. Much of this corridor has not been surveyed for fish passage barriers in several years. As of July 24, 2019, there are ten known culvert crossings on fish-bearing streams within the study corridor, of which:

- 6 are documented fish passage barriers,
  - MP 104.13 – unnamed tributary to Deschutes River
  - MP 105.52 – Moxlie Creek

- MP 105.85 – Indian Creek
- MP 109.19 – College Creek
- MP 109.62 – College Creek
- MP 115.77 – unnamed tributary to red Salmon Creek tributary

- 1 has an 'unknown' barrier status, and
  - MP 115.79 – unnamed tributary to Red Salmon Creek tributary

- 3 were evaluated as passable for fish during WDFW's last assessment.
  - MP 106.83 – Indian Creek
  - Northbound Exit 107 – Woodard Creek
  - MP 110.16 – Woodland Creek

WSDOT contracts with WDFW to resurvey stretches of roads within transportation projects to make sure all fish-bearing road crossings have been identified and assessed for fish passage within the project limits. As the I-5 project advances, please coordinate with ESO's Stream Restoration Program to have the fish passage inventory updated.

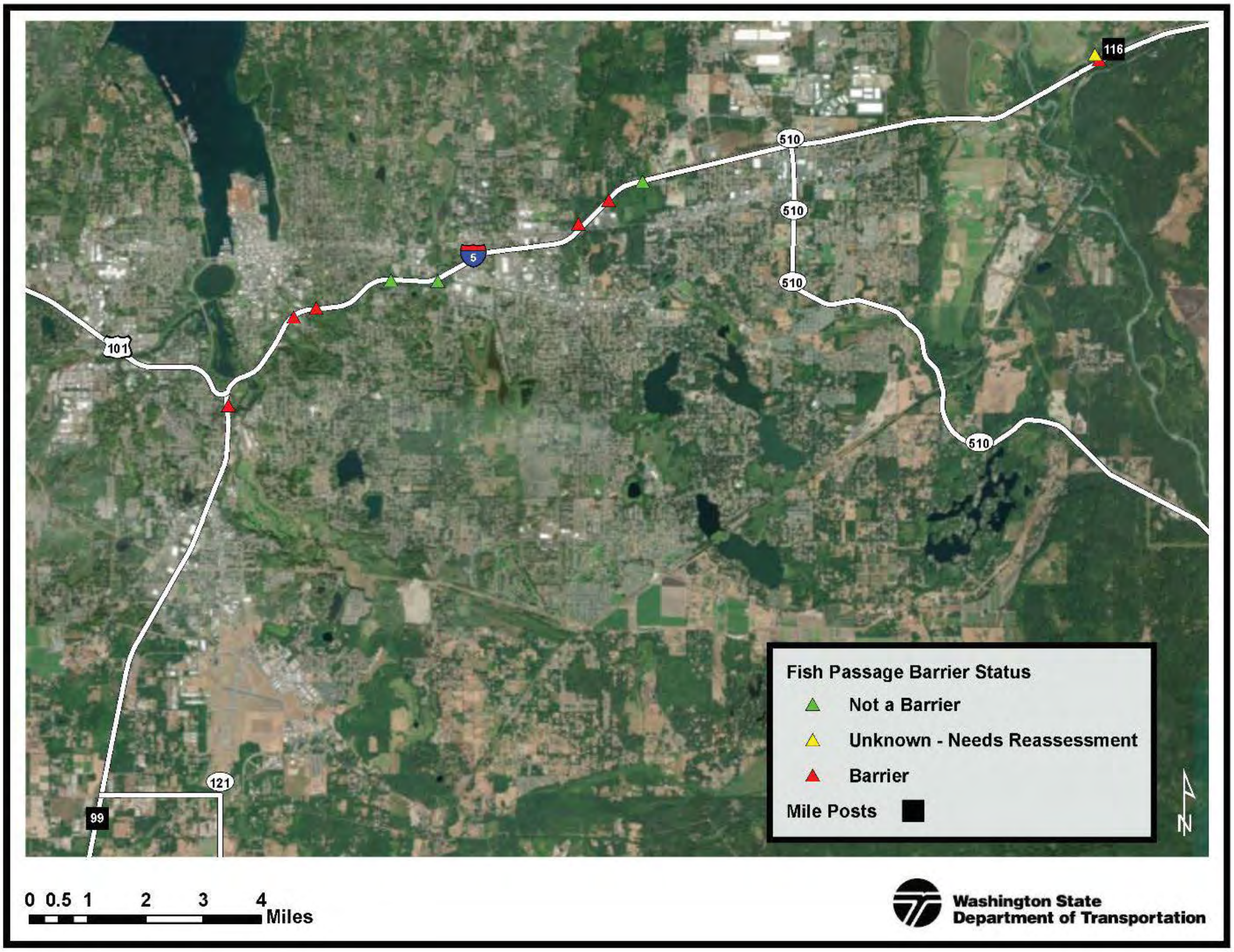


Figure 3. Documented culverts on fish-bearing streams

Habitat Connectivity Priorities

The ESO has ranked and mapped highway segments for levels of investment priorities. We qualified some segments as high priorities for investments to benefit wildlife habitat connectivity or pollinators. Contact ESO if your project will alter highway geometry or affect the non-operational portion of the right-of-way and touches a high priority highway segment. They can help determine if practical approaches to improving conditions for wildlife or pollinators could be part of the project.

Note: Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

This corridor, based on 5-year accumulations of deer-vehicle collision data, has three one-mile long segments that rank as a high priority for investing in improvements to reduce collisions with wildlife (Tables 1 and Figures 1, 2 & 3).

Table 1. Summary of deer carcass removal and deer-vehicle collision data for the I-5 Tumwater to Mounts Road study area, 2014-2018

Begin MP	End MP	# of deer carcass removals[1]	# of deer-vehicle collisions[2]	Collision Rank[3]
98.6	99.5	5	3	Medium
99.6	100.5	7	4	Medium
100.6	101.5	11	6	High
101.6	102.5	6	1	Low
102.6	103.5	9	4	Med
103.6	104.5	9	1	Med
104.6	105.5	18	4	Med
105.6	106.5	6	3	High
106.6	107.5	16	5	Med
107.6	108.5	7	3	Med
108.6	109.5	6	3	Med
109.6	110.5	6	4	High
110.6	111.5	4	4	Med
111.6	112.5	4	3	Med
112.6	113.5	5	0	Low
113.6	114.5	6	4	Med
114.6	115.5	5	0	Med
115.6	116.5	1	3	Low
Totals	All	131	55	

1 Deer carcass removals are mostly records from WSDOT Maintenance, most recently, from the Highway Activities Tracking System. Starting July 1, 2017, records of animals salvaged by citizens and reported via the Washington Department of Fish and Wildlife permit system, have been incorporated in this database.

2 Deer-vehicle collisions are a subset of records extracted from WSDOT’s Collision Data, managed by the Collision Data & Analysis Branch.

3 See Appendix for Rank criteria.

Figure 4. Habitat Connectivity Investment Priority Collision-related Ranks for one mile highway segments within the corridor. High (red), Medium (orange) and Low (blue) ranks (numbers represent mile posts)

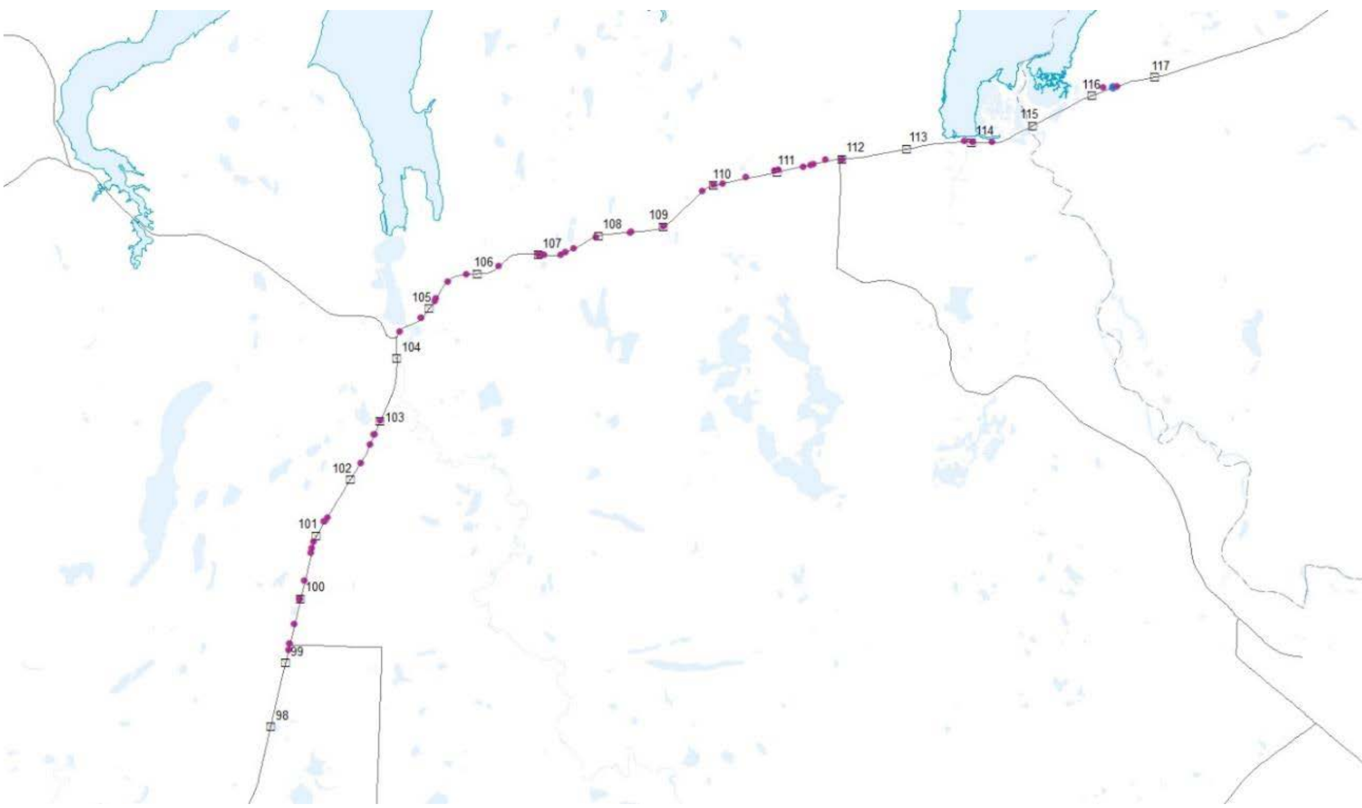


Figure 5. Map image showing locations of deer-vehicle crashes, 2014-2018, based on officer collision reports (numbers represent mile posts)

Figure 6. Map image showing locations of deer carcass removals, 2013-2017, based on WSDOT HATS data and WDFW Citizen Salvage reports (numbers represent mile posts)

Figure 7. Habitat Connectivity Investment Priority Ecological Stewardship Ranks for one mile highway segments within the corridor. High (red) 1, Medium (orange) and Low (blue) ranks (numbers represent mile posts)

1) In this corridor, High Ecological Stewardship ranks represent a highway segment's position relative to the wildlife habitat networks, proximity to public lands and high traffic volumes

Pollinator Priorities - The entire Washington State highway system has been ranked, by half mile segment, for pollinator habitat enhancement potential. Relevant to I-5 Tumwater to Mounts Road, there are high ranking segments for both pollinators and urban gateway pollinator enhancement. For the pollinator rank, proximity to pollinator-dependent agricultural was very influential though proximity to protected natural areas was also an important factor. The Urban Gateway pollinator rank was intended to complement WSDOT's interest in partnering with local communities to increase the aesthetic or functional values of the highways that enter their communities. This rank applies to urban locations where landscape features suggest there are good opportunities to meaningfully increase pollinator populations. This can be accomplished through pollinator-friendly highway maintenance practices or purposeful enhancements through plantings, such as would occur after a ground-disturbing activity like a construction project. The Urban Gateway rank only applies to highways in urban areas and is intended to identify opportunities to do outreach and education as well as provide pollination services to urban gardens and natural areas.

Figure 8. Pollinator Habitat Investment Priority Ranks for one half mile highway segments within the corridor. Very High (red), High (orange), Medium (orange), and Low (blue) (numbers represent mile posts)

Figure 9. Urban Gateway Investment Priority Ranks for one half mile highway segments within the corridor. High (red), Medium (orange), and Low (blue) ranks (numbers represent mile posts)

Noise walls

Several existing noise walls in the study area (Figure 10). Table 2 provides more detail.

No proposed retrofit noise or non-WSDOT walls are mapped in the study area.

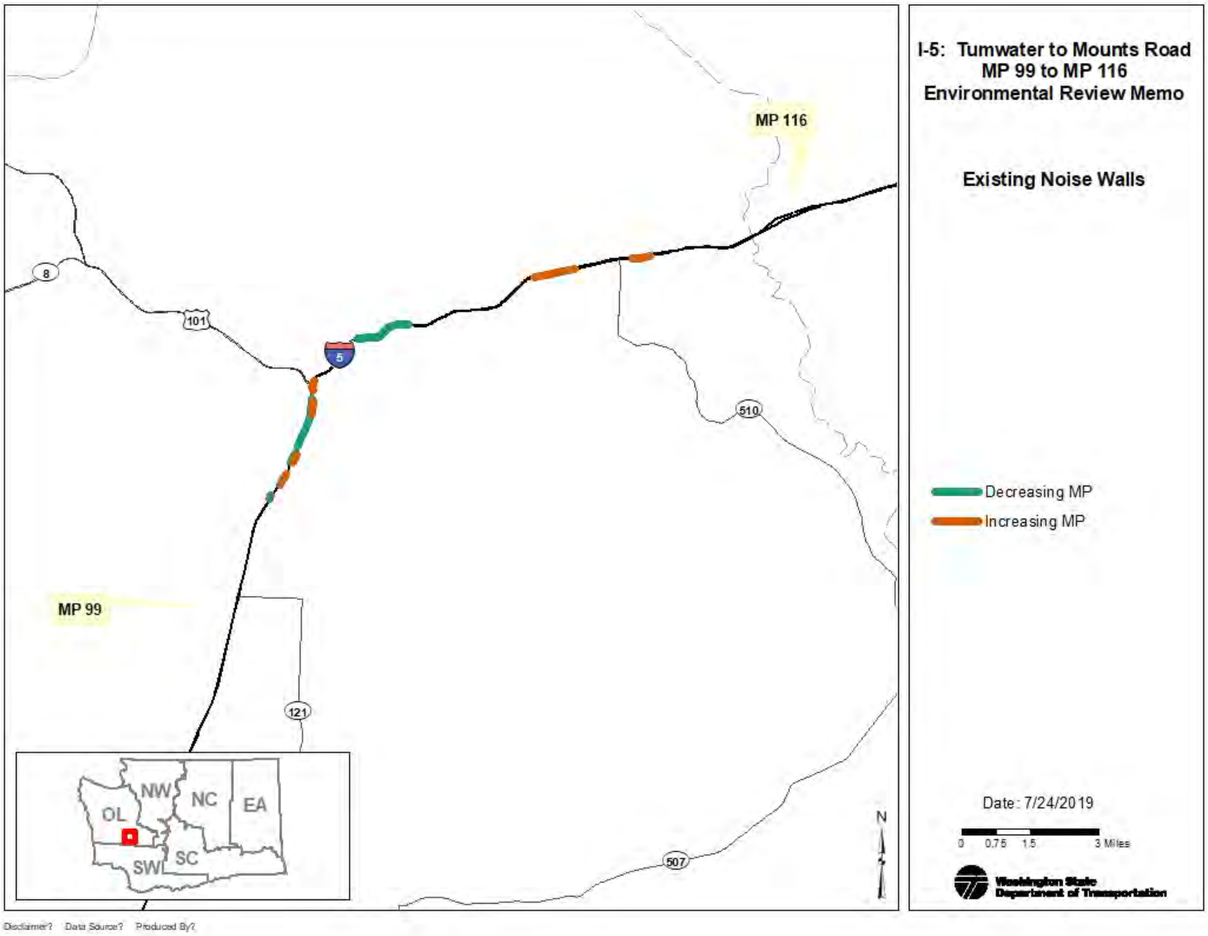


Figure 10. Existing noise walls

Table 2. Details of noise walls in the study area

Route	BEG_ARM	END_ARM	MATERIAL	TYPE	LENGTH (FT)
5	101.61	101.7	Concrete/Unspecified	I	456
5	105.81	107.02	Wood/Unspecified	I	8331
5	102.56	102.8	Concrete/Precast	I	1364
5	102.94	104.03	Concrete/Precast	I	5602
5	103.7	103.98	Concrete/Unspecified	I	1512
5	102	102.28	Concrete/Unspecified	I	1440
5	112.3	112.69	Precast Concrete	II	3117
5	102.57	102.75	Concrete/Unspecified	I	1050
5	104.23	104.43	Concrete/Unspecified	I	1214
5	110.1	111	Precast Concrete	II	3520

Stormwater and Total Maximum Daily Load (TMDLs)

Stormwater BMPs - There are 20 pond type BMPs, 40 Roadside slope type BMPs, and 16 ditch type BMPs.

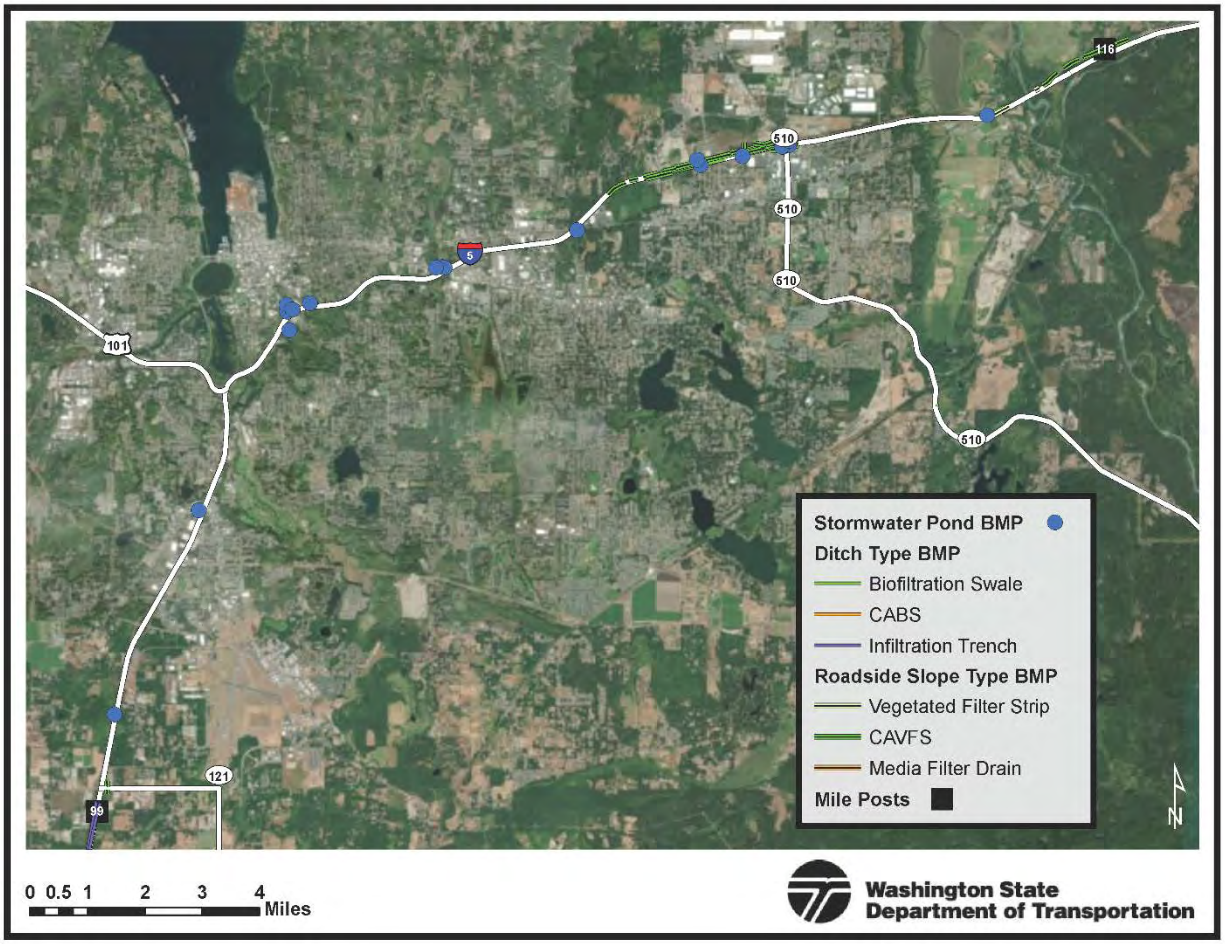


Figure 11. Stormwater BMPs

Stormwater Retrofit Priorities – There are multiple high and medium priority stormwater retrofits within the study area:

- There are 5 segments that are high priority for stormwater retrofit, and
  - I-5 MP 107.3 - 107.4
  - I-5 MP 107.5 -108.0
  - I-5 MP 110 - 110.2
  - I-5 MP 114 - 114.2
  - I-5 MP 116.7 – 117.3
- There are 2 segments that are medium priority for stormwater retrofit.
  - I-5 MP 106.7 – 106.8
  - I-5 MP 116 – 117.5

Also note, there is 1 medium priority segment just outside the study area, at I-5 MP 117.5 – 117.8.

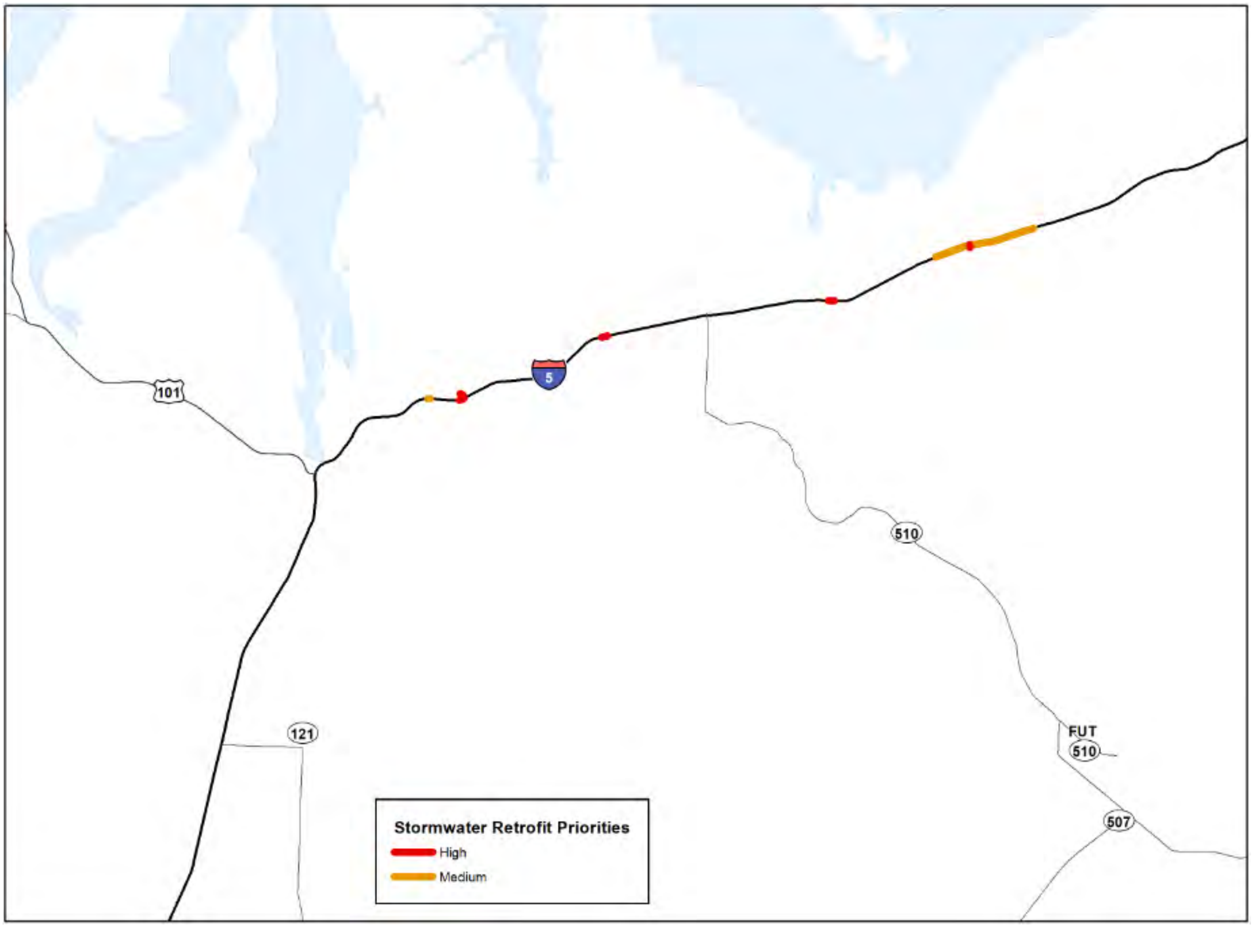


Figure 12. Stormwater retrofit priorities

TMDLs – There are multiple TMDLs and 303(d) listed waters within the study area (Figure 13).

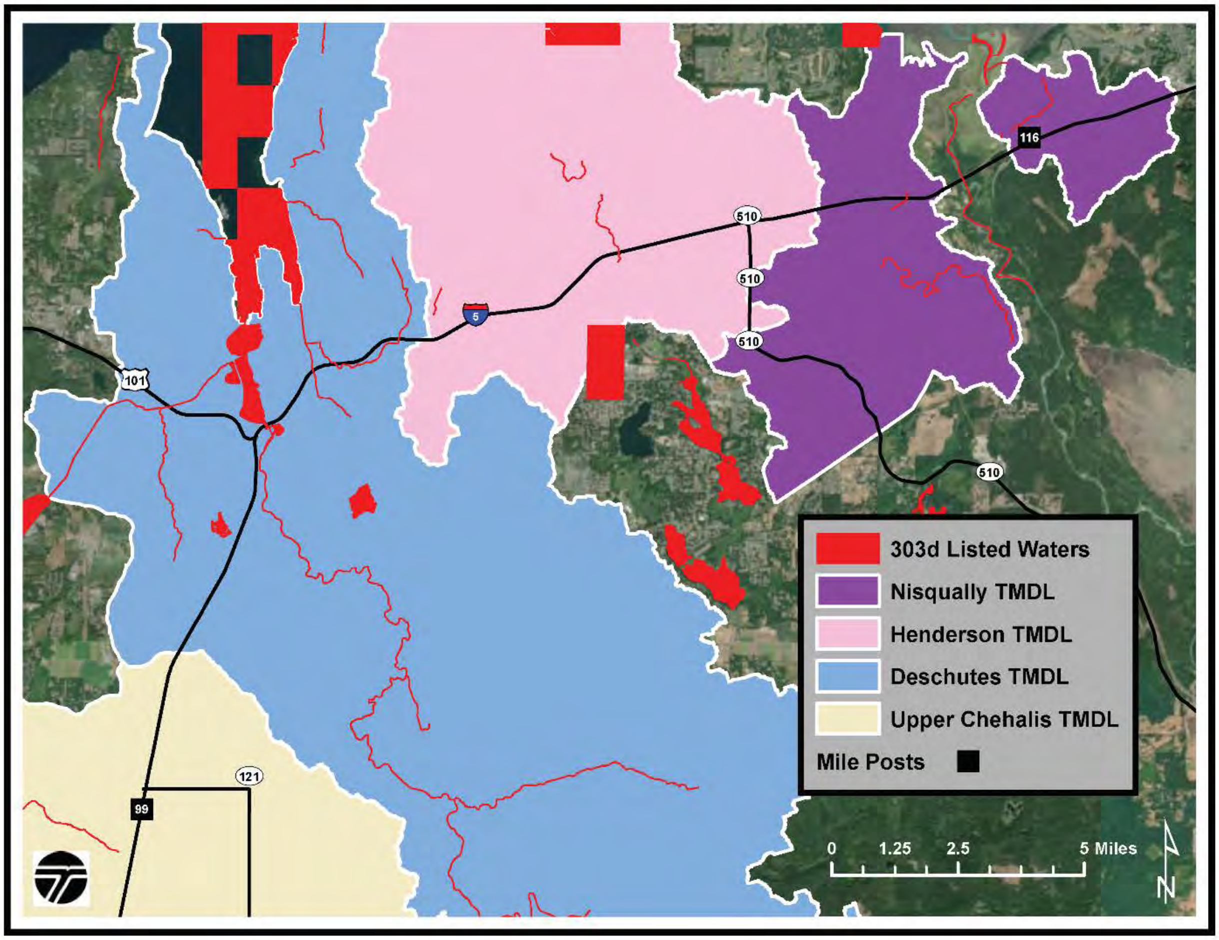


Figure 13. All TMDL boundaries and 303(d) listed waters within study area

The farthest north section ('Nisqually TMDL' in Figure 13) is within the Nisqually Watershed bacteria and dissolved oxygen TMDL. This TMDL is in WSDOT's Municipal Permit Appendix 3 Part 1. Our specific actions beyond applying the HRM include:

<u>Nisqually River Tributaries Fecal Coliform and Dissolved Oxygen TMDL (Ecology publication #07-10-016 and #05-10-040)</u> - *Provide replacement bags at pet waste station on the dike at McAllister Creek or close public access to the dike (as needed), and participate in adaptive management meetings (as needed)*.

Within this area there are also 303(d) listed waters that intersect with I-5:

- Mcallister Creek; pH and temperature
- Nisqually River; temperature

The next TMDL moving south ('Henderson TMDL' in Figure 13) is the Henderson Inlet Watershed Fecal Coliform (bacteria) TMDL. This TMDL is in our Municipal Permit Appendix 3, Part 2, so WSDOT must apply the HRM and permit requirements that address the TMDL-listed pollutants (bacteria).

Within this area, there are also 303(d) listed water that intersect with I-5:

- Woodland Creek; dissolved oxygen

The next TMDL moving south ('Deschutes TMDL' in Figure 13) is the Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL. It was added to WSDOT's 2019 Municipal Permit Appendix 3, Part 1. Our specific actions beyond applying the HRM include:

<u>Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform</u>

<u>Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL (Ecology publication # 15-10-012)</u> -

Within NPDES Phase II areas, implement permit obligations that address the TMDL-listed pollutants, and participate in adaptive management process (as needed).

Within this area, there are also 303(d) listed waters that intersect with I-5:

- Indian Creek; bacteria
- Moxlie Creek; bacteria
- Capitol Lake; total phosphorus

The most southern TMDL ('Upper Chehalis TMDL' in Figure 13) for this section of I-5 is the Upper Chehalis River Bacteria, Temperature, and Dissolved Oxygen TMDL. None of these TMDLs are in WSDOT's 2019 Municipal Permit, and no additional 303(d) listings are identified.

Wetland Mitigation Sites

There is one wetland monitoring site located in the study area -- SR 5 Woodard Creek 1 between MP 107 and 108 (Figure 14). No wetland mitigation bank sites are mapped in the study area. WSDOT manages wetland mitigation sites as environmental assets when impacts to wetlands require the agency to mitigate Clean Water Act regulations. Any development proposal may require additional mitigation if wetlands are impacted. Impacts to managed wetland mitigation sites require further negotiation with regulating agencies.

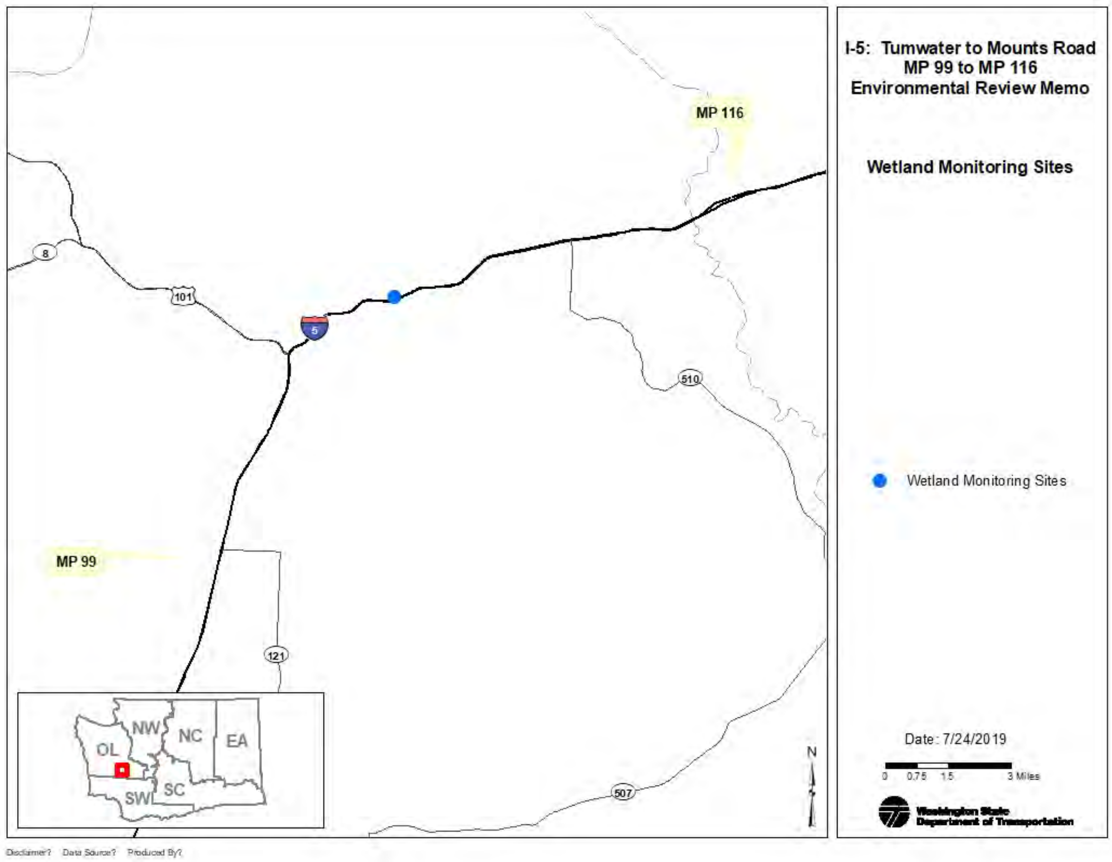


Figure 14. Mapped wetland monitoring sites

Historic Bridges

The segment of highway identified in the Interstate-5 Tumwater to Mounts Road planning study contains two historic resources that have been identified as eligible for inclusion in the National Register of Historic Places.

Though the majority of the Interstate Highway System was exempt from Section 106 review by the Federal Highway Administration in 2005, a five-mile segment known as the Olympia Freeway was listed as an exceptional feature of the highway system and is exempt from FHWA's 2005 exemption. The Upper Custer Way Overcrossing is the only historic bridge within the project study area.

The **Upper Custer Way Bridge (5/316)** is an overcrossing located at milepost 103.98. Originally constructed in 1956 as a single span concrete spandrel arch bridge with three prestressed concrete T-beam approach spans, the 530-foot long bridge received new concrete box approaches in the early-1990s. These change did not adversely affect the bridge's concrete arch span which is its primary character-defining feature. The bridge is currently rated in moderate condition (64.28 out of 100) and remains unaltered since the 1990s.

The **Olympia Freeway** was determined to be an exceptional feature of the Interstate Highway System by the Federal Highway Administration (FHWA). The designation of this five-mile segment (MP 104.2 – 109.2) was part of the Agency's efforts to exempt the majority of the highway system from Section 106 review. The segment begins at Trosper Road and ends at Martin Way. It was determined significant for its engineering and social history. The segment also contains the Capitol Blvd. Undercrossing (5/332) and the Sleater-Kenny Undercrossing (5/335), both award-winning bridge that are currently too young to be considered historic resources.

Sources - Federal Highway Administration. Interstate Highway System Exemption. https://www.environment.fhwa.dot.gov/env_topics/historic_pres/roads.aspx, and Advisory Council on Historic Preservation. Exemption Regarding Historic Preservation Review Process for Effect to the Interstate Highway System. https://achp.gov/digital-library-section-106-landing/exemption-regarding-historic-preservation-review-process.

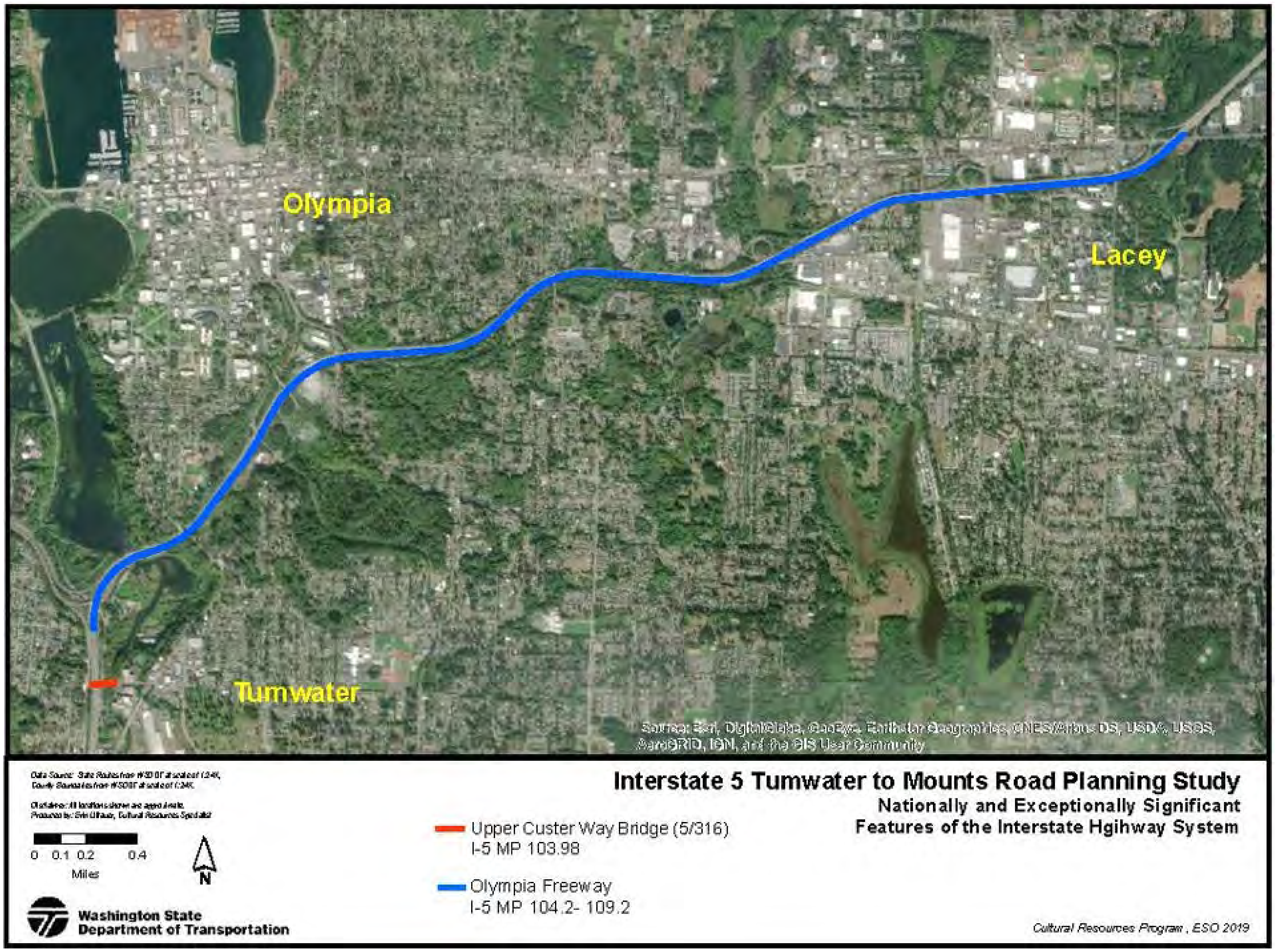


Figure 15. WSDOT historic resources

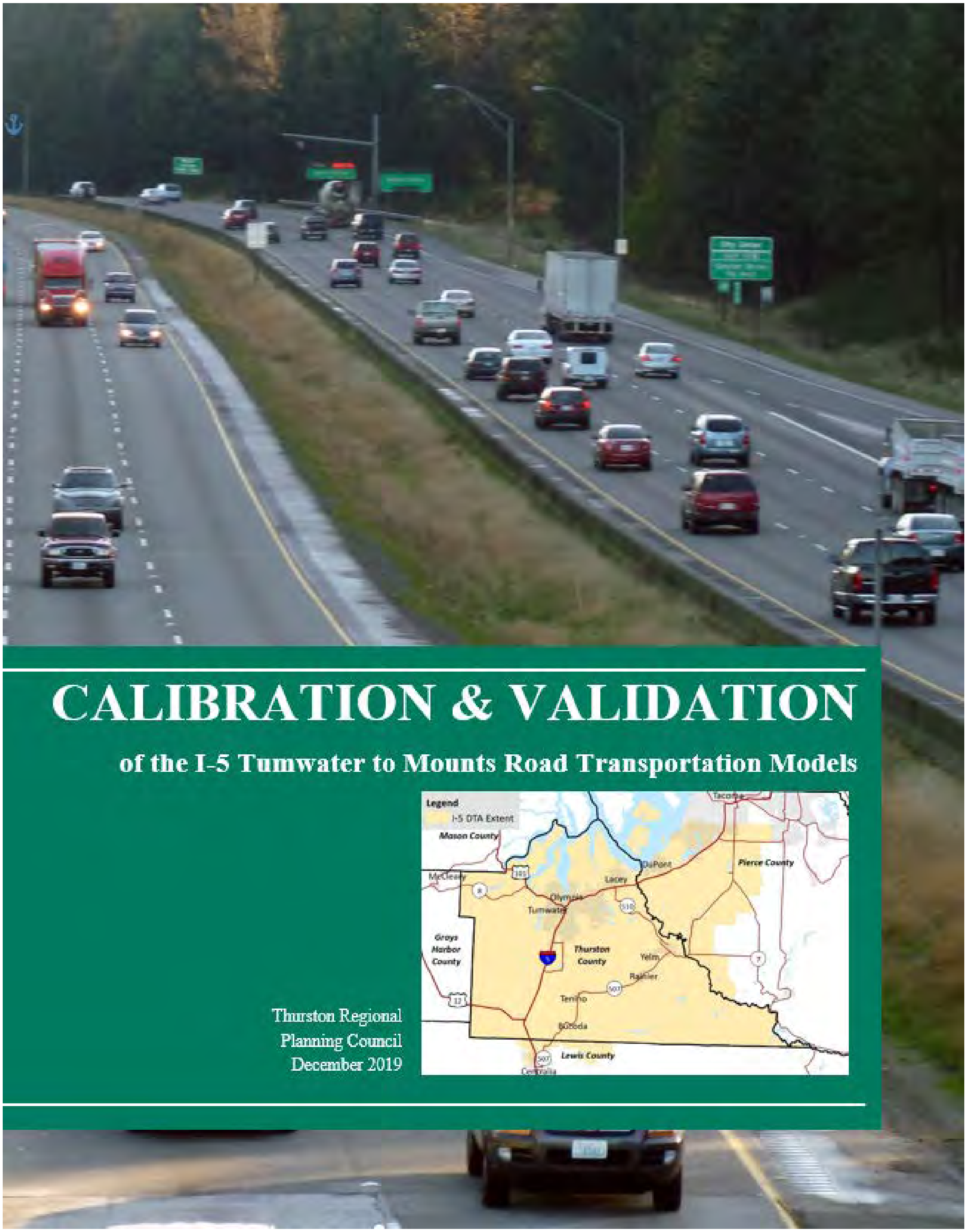
Wildlife-related safety ranking

Derivation of wildlife-related safety ranks applied to one-mile highway segments using geographic ranges and 5 year (2012-2016) accumulations of carcass removals and collisions. Assignment of rank is hierarchical. Each highway segment gets the highest rank it qualifies for.

Carcass Removals	Low	Med	High
Deer	w/in range, 1-5	5-14	15 or more
Elk	w/in range, 1	2	3 or more
Bighorn Sheep	w/in range	1	2 or more
Black Bear	w/in range	1	2 or more

Collisions	Low	Med	High
Deer	w/in range, 1	2-5	6 or more
Elk	w/in range, 1	2	3 or more

Appendix D – Model Calibration and Validation Report



THURSTON REGIONAL PLANNING COUNCIL STAFF

Clyde Scott	Senior Transportation Modeler
Aaron Grimes	Senior Transportation Modeler
Scott Carte	GIS Coordinator
Michael Ambrogi	Senior GIS Analyst
Steve Xu	Planning Technician
Veena Tabbutt	Deputy Director
Sarah Selstrom	Communications & Outreach Specialist II
Marc Daily	Executive Director

TABLE OF CONTENTS

INTRODUCTION

In 2018, the Washington State Department of Transportation (WSDOT) Headquarters and Olympic Region and Thurston Regional Planning Council (TRPC) entered in partnership to develop a transportation modeling framework for the Thurston Region and adjacent areas, with emphasis on the I-5 corridor between 93rd Avenue in Tumwater to Mounts Road and SR-101 from I-5 to Black Lake Boulevard. The modeling framework includes integrated Travel Demand Model (TDM) and Dynamic Traffic Assignment (DTA) model platforms.

This report documents the calibration/validation for the updated TDM and new DTA model (I-5 DTA), with emphasis on the I-5 corridor.

The modeling framework will be used to analyze near-term actions identified in the Near-Term Action Agenda for I-5 (WSDOT) as well as mid- and long-term actions identified in the Tumwater to Mounts Road Study (WSDOT Olympic Region and TRPC).

MODEL FRAMEWORK OVERVIEW

The integrated modeling framework includes enhancements to the existing Regional Travel Demand Model as well as the development of the I-5 DTA.

Regional Travel Demand Model

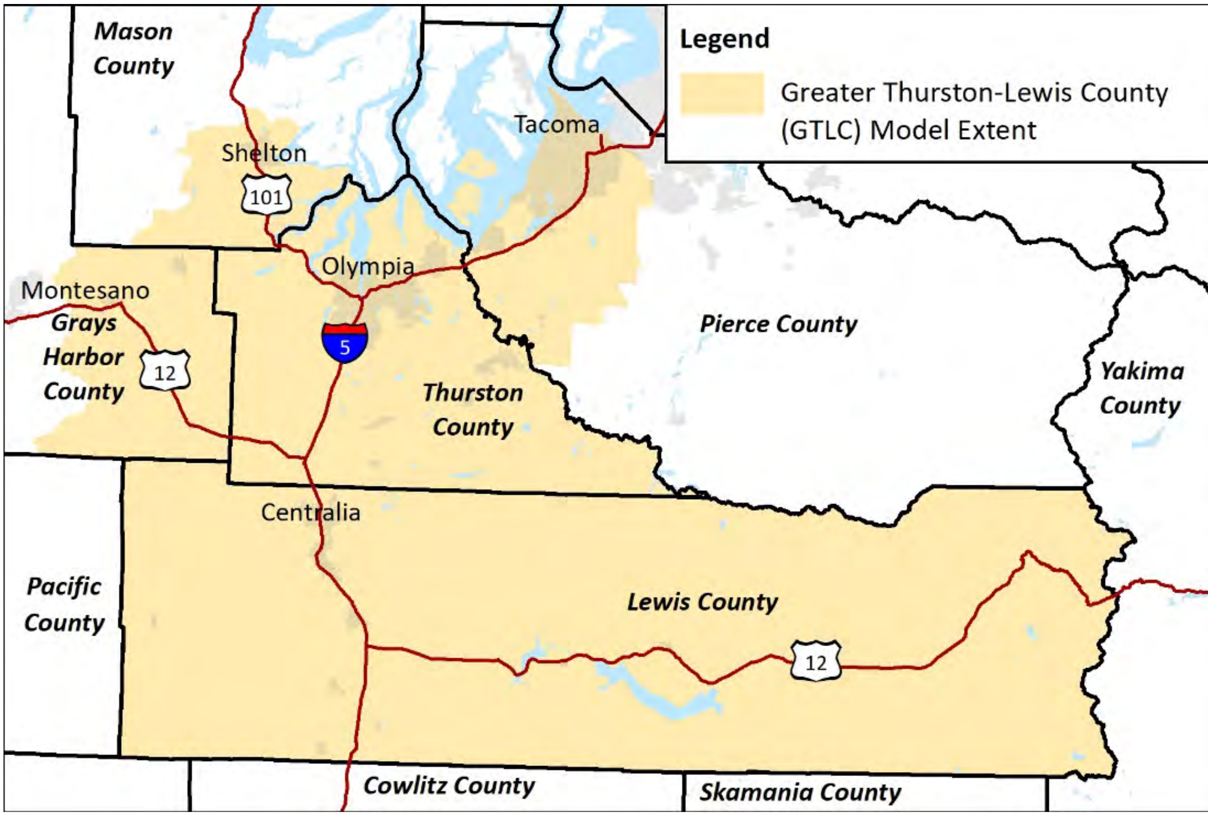
TRPC's Greater Thurston-Lewis County (GTLC) Model, a macro model developed in the EMME modeling platform, covers all of Thurston and Lewis counties, and parts of Pierce, Mason, and Grays Harbor counties (Figure 1). Macro models are typically used to evaluate the impacts of future changes in either transportation facilities (supply) or land use location and/or quantity (demand) on the regional transportation system's level of service.

The GTLC model provides estimates of trips (volume) and speeds (delay) in the peak hour by various modes of travel such as vehicles, trucks, transit, school buses, bicycles, and pedestrians on all major roadways and paths within the model area. The trip tables generated in the travel demand model are used as inputs into the I-5 DTA.

While a macro model can quickly forecast impacts of significant changes in supply and demand, many more location-specific policy decisions require analytics that stretch the applicability of macro models, such as measuring the impact of intersection controls, presence of turning bays at intersections, impact of buses stopping in the roadway, and response to other traffic through car following, and lane changing. These shortcomings can be overcome by using a DTA model in conjunction with the regional model.

Full documentation of the GTLC is available on TRPC's website: http://www.trpc.org/860/Regional-Travel-Demand-Model.

FIGURE 1: Geographic extent of the Greater Thurston-Lewis County model



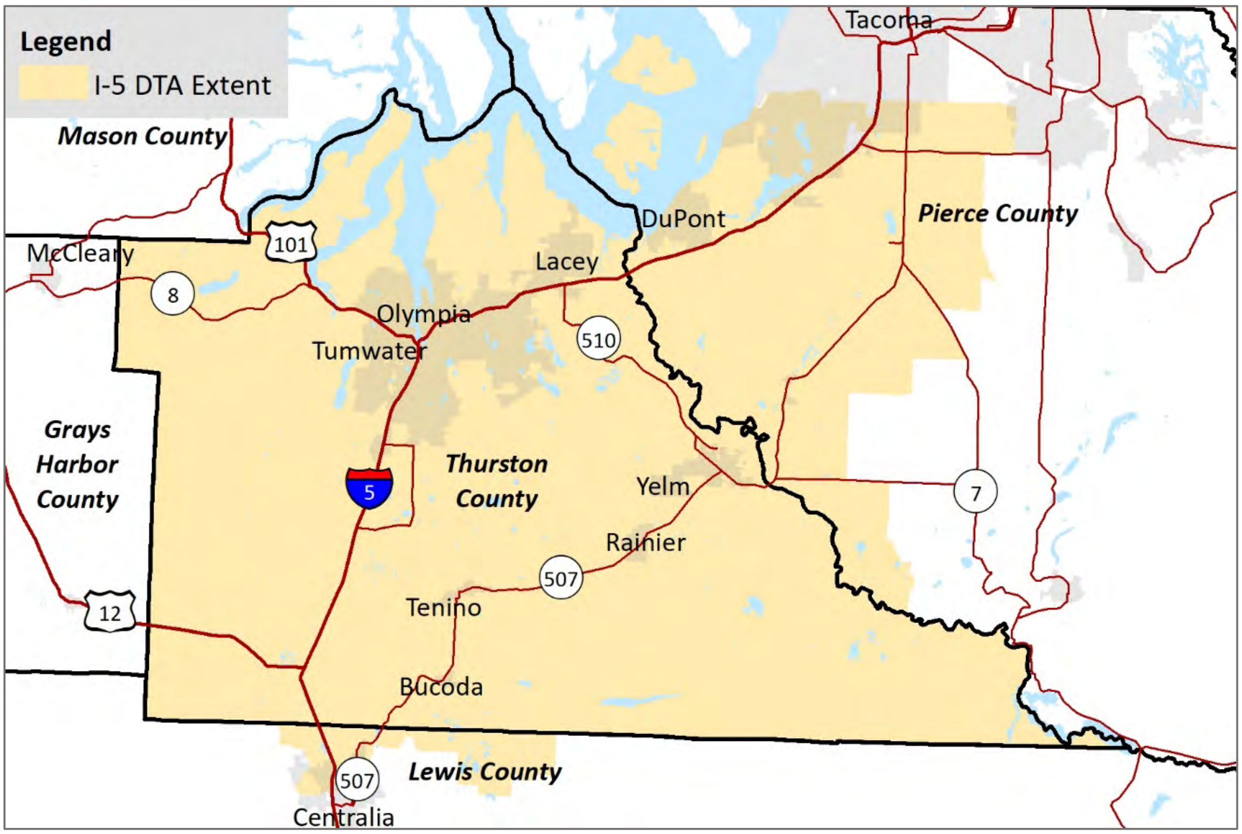
ameq modeling
icles on lanes,
associated with

Dynamic Traffic Assignment Model

The DTA model developed for the study (I-5 DTA) is a subarea mesoscopic traffic model built in the Dynameq modeling platform. The Dynameq modeling platform allows for the simulation of the movement of individual vehicles on lanes, with car-following models, gap-acceptance models, and explicit signal timings normally associated with conventional microscopic models such as Synchro. The I-5 DTA will be used to model traffic flows, intersection movements, and traffic delay.

The I-5 DTA model extends from Pierce County (SR-512) to Lewis County (including Centralia), and covers all of Thurston County (Figure 2).

FIGURE 2: Geographic extent of the I-5 DTA model



I-5 DTA MODEL DEVELOPMENT

Updates to the Regional Travel Demand Model

The GTLC model underwent several updates to facilitate development of the I-5 DTA model. They included:

- Updating the base year data (land use and transportation network) to 2017 using building permits.
- Developing a mid-range future year projection (2025) and updated future year (2040)
- Adding a morning peak (AM) component
- Adding zonal detail (266 additional transportation analysis zones were added to the model, increasing the number of zones to 1,500)
- Development of a sub-area model with the I-5 DTA model extents

Model Validation/Calibration

The GTLC model was re-validated/calibrated after the updates. Validation/calibration consisted of two components, calibrating mode choice to the regional household travel survey, and validating the model to 2017 traffic counts. The mode-split comparison with household travel survey is shown in Table 1. The correlations (R squared values) of 2017 model volumes to traffic counts at the peak hour are shown in Figure 3.

TABLE 1: Mode Choice for Thurston County, GTLC model versus Household Travel Survey

	MODEL		HOUSEHOLD TRAVEL SURVEY	
Mode Choice	**Daily Trips**	**Percent**	**Daily Trips**	**Percent**
Single Occupancy Vehicle	552,602	51.1%	558,082	51.6%
High Occupancy Vehicle	393,000	36.3%	389,820	36.0%
Walk	86,844	8.0%	86,855	8.0%
Bike	16,875	1.6%	16,761	1.5%
Transit	21,174	2.0%	20,881	1.9%
School Bus	9,542	0.9%	7,664	0.7%
Vanpool	2,197	0.2%	2,172	0.2%
Total	**1,082,235**	**100.0%**	**1,082,235**	**100.0%**

FIGURE 3A: R squared correlation between GTLC model volumes and traffic counts – AM Model

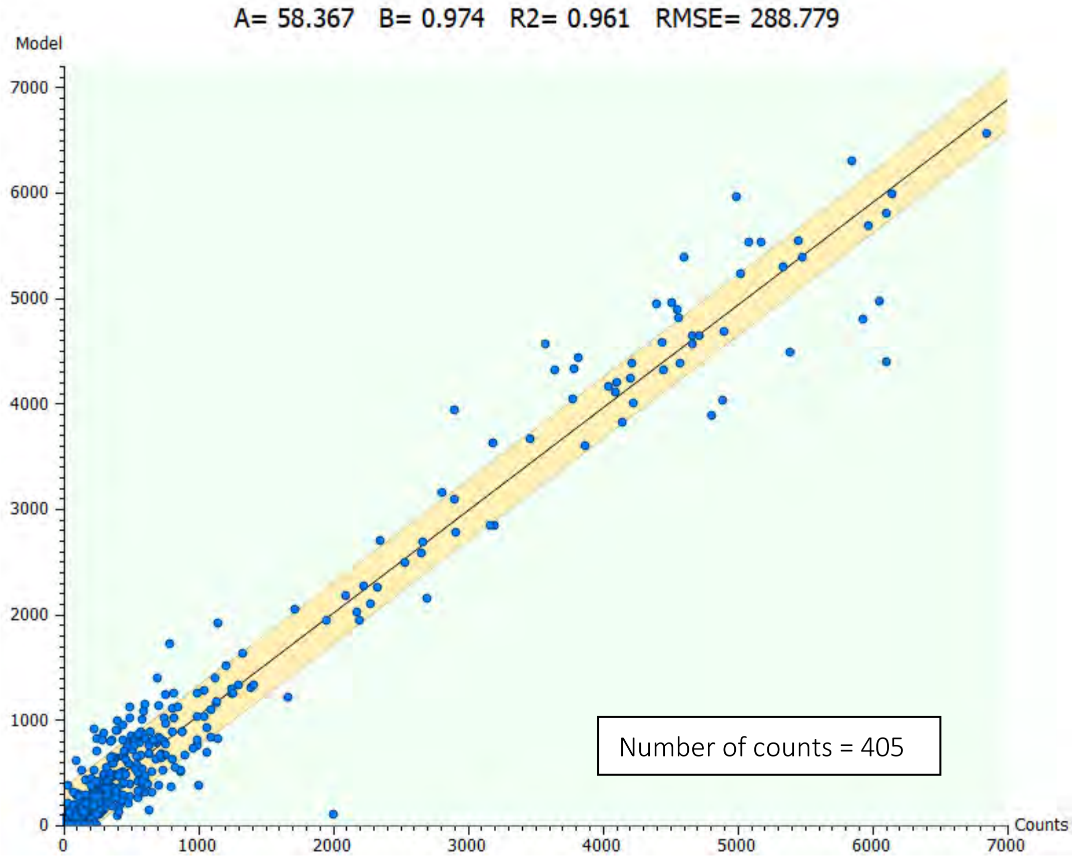
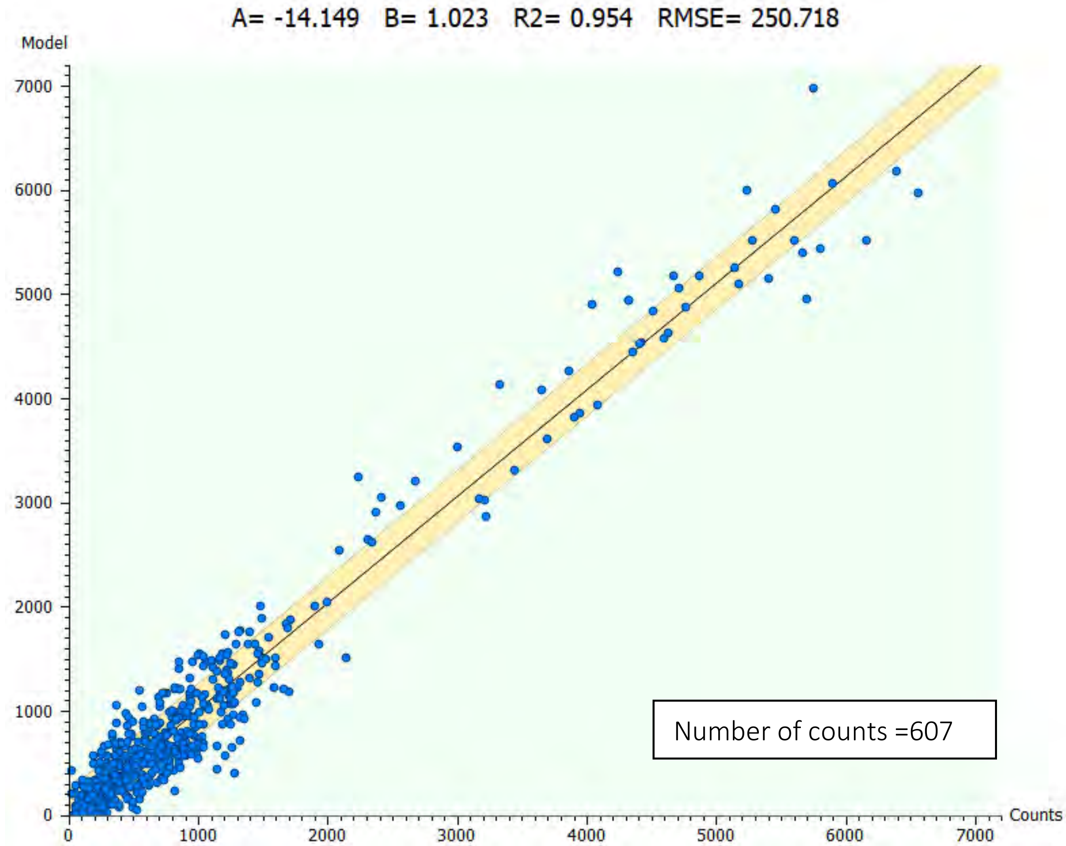


FIGURE 3B: R squared correlation between GTLC model volumes and traffic counts – PM Model



GTLC Model Feature Extraction for the I-5 DTA

Several features were extracted from the GTLC model to begin development of the I-5 DTA. They included:

Zonal Structure: The I-5 DTA subarea model was developed to have a consistent zonal structure (transportation analysis zones) with the GTLC model to facilitate streamlined exchange of information such as trip tables between the two models.

Network: The GTLC network (nodes, centroids, and links) provided a basis for I-5 DTA network development.

Trip Tables: Trip tables were developed for a subarea cut of the GTLC model and exported to the I-5 DTA model.

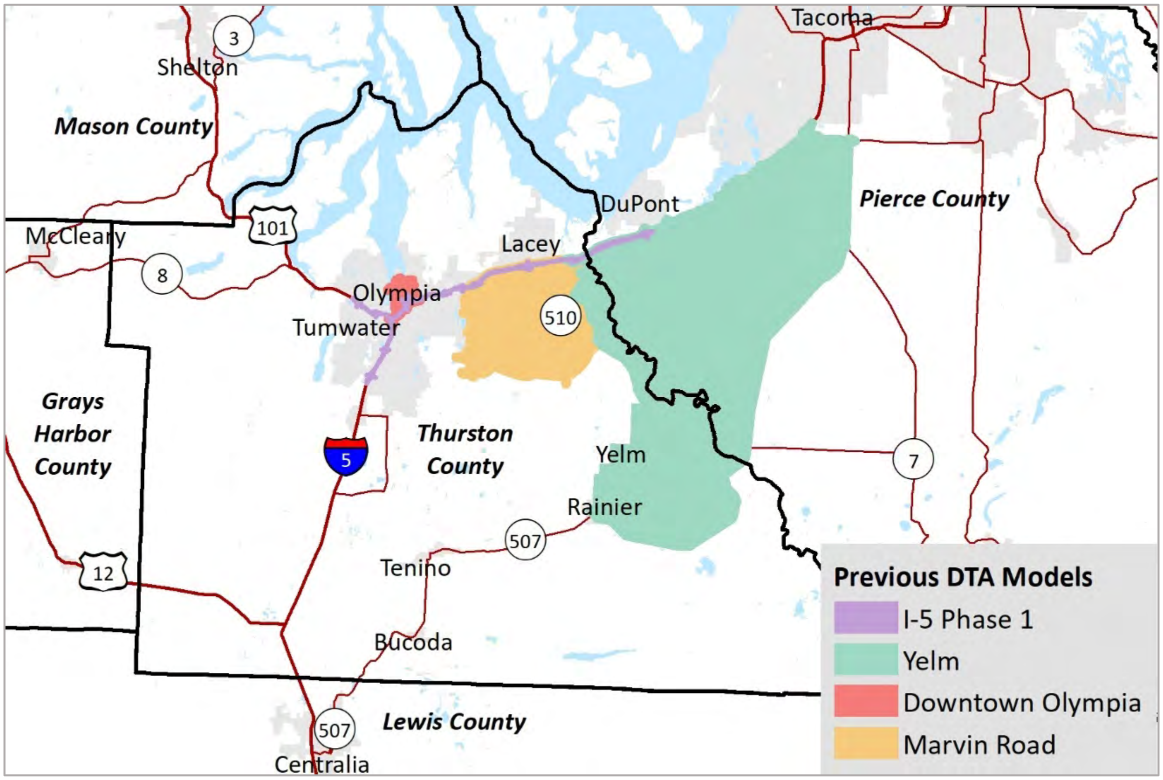
Traffic Counts: Traffic counts were input into the GTLC model and exported to the I-5 DTA model.

I-5 DTA Subarea Development

The I-5 DTA model contains a greater degree of network detail than the GTLC model. For instance, the I-5 DTA contains details such as turn lanes and intersection controls (stops signs, roundabouts, or traffic signals, including traffic signal timing) that cannot be modeled in a macro model or TDM.

Four DTA models existed within the study area, as shown in Figure 4. The detailed network geometries and signal controls from the existing DTA models were spliced into the I-5 DTA shell taken from the GTLC model.

FIGURE 4: Existing DTA models used to build the I-5 DTA model



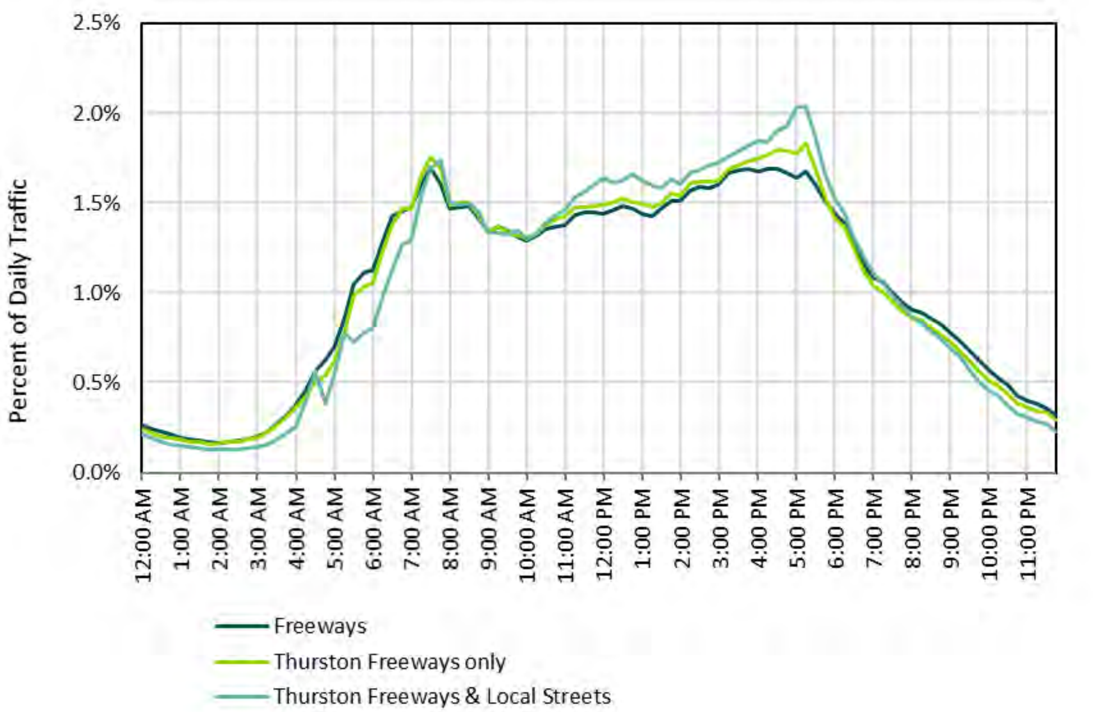
The I-5 DTA model shell was then edited to include add necessary roadways details as well as intersection controls and geometries such as turn lanes. Intersection stop lines and turn lane configurations were determined by referencing online air photo imagery integrated into the Dynameq software package. Google and Bing maps with fields observations were used for facilities with recent roadway improvements. Signal control plans along the I-5 corridor and all of Thurston County were collected from local jurisdictions and input into the I-5 DTA model. For areas within the study area where signal control plans were not available, they were simulated using Dynameq software, with input from the software vendor – INRO – who served as a project consultant.

Determining Trip Distribution

Recent traffic counts were obtained from TRPC, WSDOT, and local jurisdictions, including the cities of Lacey, Lakewood, Olympia, Tumwater, and Yelm, Thurston County, and Pierce County to determine the distribution of traffic over an average 24-hour weekday period (Figure 5).

This information was used to determine the distribution of traffic around the GTLC model peak hour periods (7-8 AM and 4-5 PM) to develop a five-hour distribution of trips for both the AM and PM periods.

FIGURE 5: Traffic patterns within the study area



Trip Table Distribution

Travel demand for the I-5 DTA model was developed by extracting trip tables from the GTLC model. The GTLC model has a 2015 base year and future year of 2040. The 2017 base year was developed by updating land use using building permits.

The one-hour peak period trip tables derived from the GTLC model were used to develop a five-hour set of trip tables for the I-5 DTA using travel distributions from observed traffic counts. Table 2 shows how the PM trip distributions were calculated.

TABLE 2. Example of using traffic count data to develop distribution of hourly trip tables

PERCENT OF DAILY TRIPS ON THURSTON FREEWAYS		
Time	15-minute Intervals	Hourly
14:00:00	1.60%	6.39%
14:15:00	1.67%	
14:30:00	1.68%	
14:45:00	1.71%	
15:00:00	1.73%	6.76%
15:15:00	1.76%	
15:30:00	1.79%	
15:45:00	1.82%	
16:00:00	1.84%	7.10%
16:15:00	1.84%	
16:30:00	1.90%	
16:45:00	1.92%	
17:00:00	2.03%	6.83%
17:15:00	2.04%	
17:30:00	1.85%	
17:45:00	1.66%	
18:00:00	1.52%	5.14%
18:15:00	1.45%	
18:30:00	1.30%	
18:45:00	1.21%	

The focus for the I-5 DTA was developing trip tables to simulate three hours of peak traffic. An additional hour was added before and after the three-hour peak to account for traffic loading on to, and off of, the network for a total analysis period of five hours.

Trip Table Classes

The vehicle classes from the GTLC has trip tables were summarized into ten modes of travel excluding transit, five modes each for both military and non-military trips. Non-military trips are restricted from traveling on Joint Base Lewis-McChord. Transit trips were added to the I-5 DTA in a separate module. Bike and walk trip are not captured in operational models such as Dynameq. The five-hour demand trip tables, by vehicle class, are summarized in Table 3.

TABLE 3: Trip table summary for the I-5 DTA, five-hour peak period

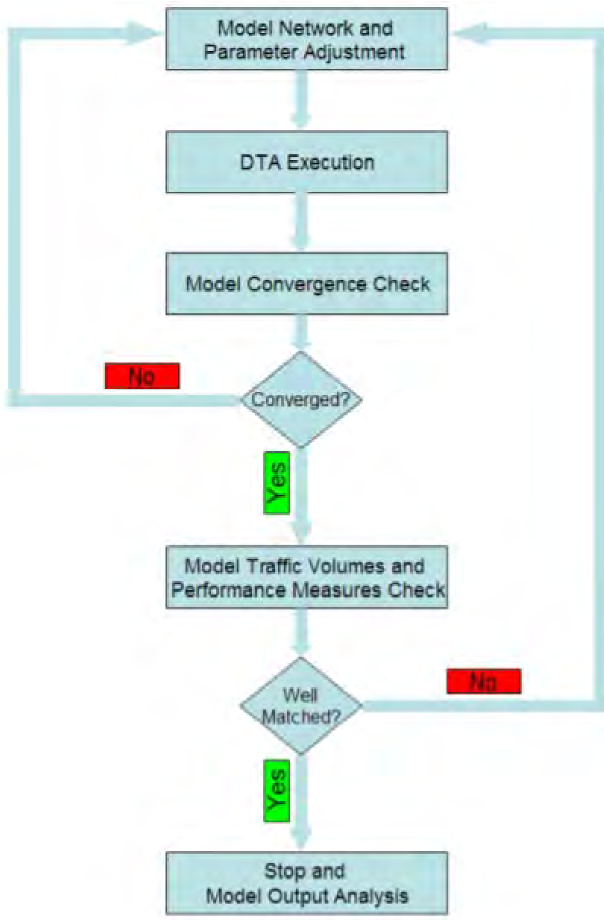
AM 2017		
	VEHICLE CLASS	**TRIPS**
NON-MILITARY		
SOV	Single Occupancy	243,324
LOV	Low Occupancy Vehicles (2 Persons)	23,302
HOV	High Occupancy Vehicles (+3 Persons)	32,986
VAN	Van Occupants (+3.5 Persons)	870
TRK	Middle & Heavy Trucks	15,716
MILITARY		
MSOV	Single Occupancy	34,280
MLOV	Low Occupancy Vehicles (2 Persons)	4,742
MHOV	High Occupancy Vehicles (+3 Persons)	1,903
VAN	Van Occupants (5 Persons)	50
MTRK	Middle & Heavy Trucks	252
TOTAL		**357,425**

PM 2017		
	VEHICLE CLASS	**TRIPS**
NON-MILITARY		
SOV	Single Occupancy	389,211
LOV	Low Occupancy Vehicles (2 Persons)	81,844
HOV	High Occupancy Vehicles (+3 Persons)	38,835
VAN	Van Occupants (+3.5 Persons)	503
TRK	Middle & Heavy Trucks	15,363
MILITARY		
MSOV	Single Occupancy	31,253
MLOV	Low Occupancy Vehicles (2 Persons)	5,023
MHOV	High Occupancy Vehicles (+3 Persons)	2,406
VAN	Van Occupants (+3.5 Persons)	69
MTRK	Middle & Heavy Trucks	763
TOTAL		**565,270**

I-5 DTA MODEL CALIBRATION AND VALIDATION

Calibration / validation of a DTA model is an iterative process of troubleshooting. Once a preliminary model is developed, it is "executed" or built. The model is then run through a convergence check. If the model does not converge, changes are made to the model network or other inputs such as trip tables, and the model is run again. Once the model reaches convergence, the outputs are checked against real data such as traffic counts and corridor travel time/speeds. Adjustments are made to the network or other inputs until the model outputs are reasonably similar to observed conditions. At that point the model is ready to be used. This process shown in Figure 6.

FIGURE 6: Model calibration / validation process



From: Application of Dynamic Traffic Assignment (DTA) Model to Evaluate Network Traffic Impact during Bridge Closure - A Case Study in Edmonton, Alberta. Zin, P., Bhowmick, Arun, and Juran, I. Paper Prepared for presentation at the Session "Best Practices in Urban Transportation Planning" Of the 2014 Conference of the Transportation Association of Canada Montreal, Quebec.

Model Convergence

DTA models use an iterative traffic assignment process that will yield different model outputs until the model is run through enough iterations that the various network assignments achieve convergence around the equilibrium condition for various modes of travel. Convergence is measured by relative gap in travel times between origin-destination pairs, and is most easily seen in Figure 7. When all the various lines begin to "converge" the model has reached equilibrium, meaning the model will yield similar results each time it is run. Table 4 lists convergence results by vehicle class.

FIGURE 7: Model convergence graphs for the single occupancy vehicle class in the AM model

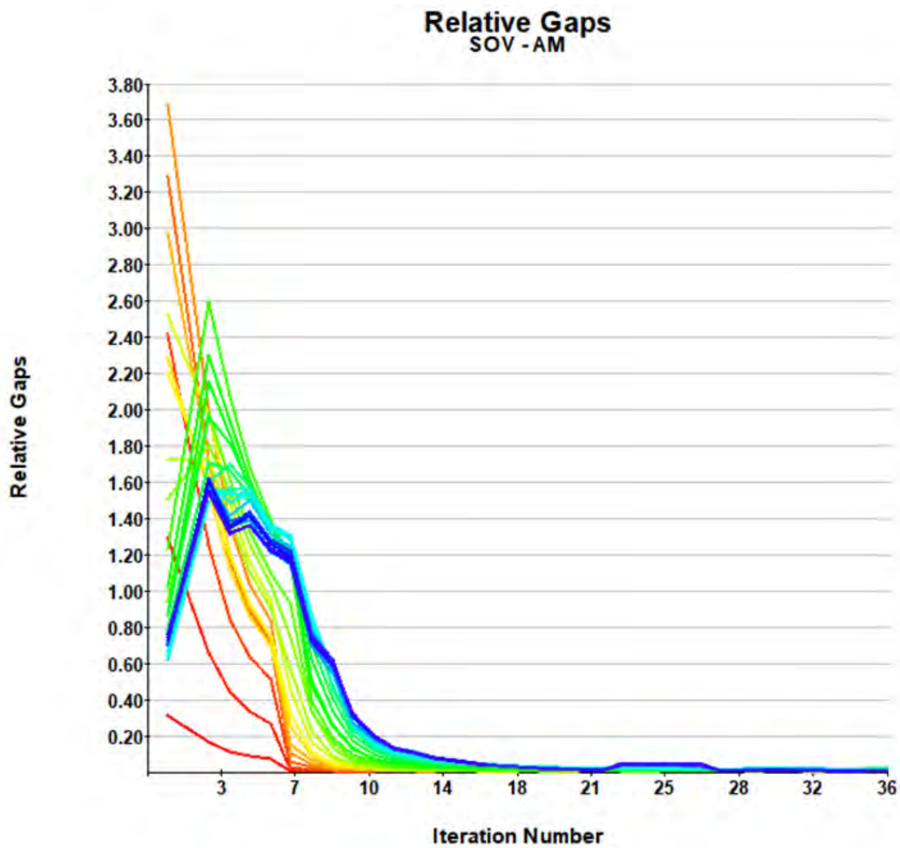


TABLE 4: Convergence results by vehicle class (relative gap)

	AM		PM	
	MINIMUM CONVERGENCE AT 36 ITERATIONS		MINIMUM CONVERGENCE AT 36 ITERATIONS	
VEHICLE CLASS	NON-MILITARY	MILITARY	NON-MILITARY	MILITARY
SOV	0.0029	0.0128	0.0023	0.0029
HOV	0.0061	0.0176	0.0035	0.0088
LOV	0.0075	0.0149	0.0037	0.0075
VAN	0.0091	0.0059	0.0187	0.0053
TRK	0.0036	0.0162	0.0022	0.0136

Traffic Volume Validation

Travel models are expected to replicate observed conditions within reason before being used for analysis. A standard part of the model validation process is to compare modeled traffic volumes with traffic counts measured on the road network. Traffic counts were assembled for morning (AM) and afternoon (PM) traffic in 2017/2018 for use in validating the I-5 DTA model.

One model validation check is to measure hourly model link volumes to hourly traffic counts to determine how the predicted values (model volumes) fit with real data (traffic counts). The following traffic counts were used in validating the model:

- AM Period - 387 counts total
- PM Period - 627 counts total

The I-5 DTA model volumes compared to traffic counts produced an R squared of 0.9444 for the AM peak hour, and an R squared of 0.9855 for the PM peak hour (Figure 8). The R squared was slightly higher for both peak periods when looking at freeway and freeway ramp volumes compared to counts.

FIGURE 8A: R squared correlation between I-5 DTA subarea model volumes and traffic counts – all facilities - AM

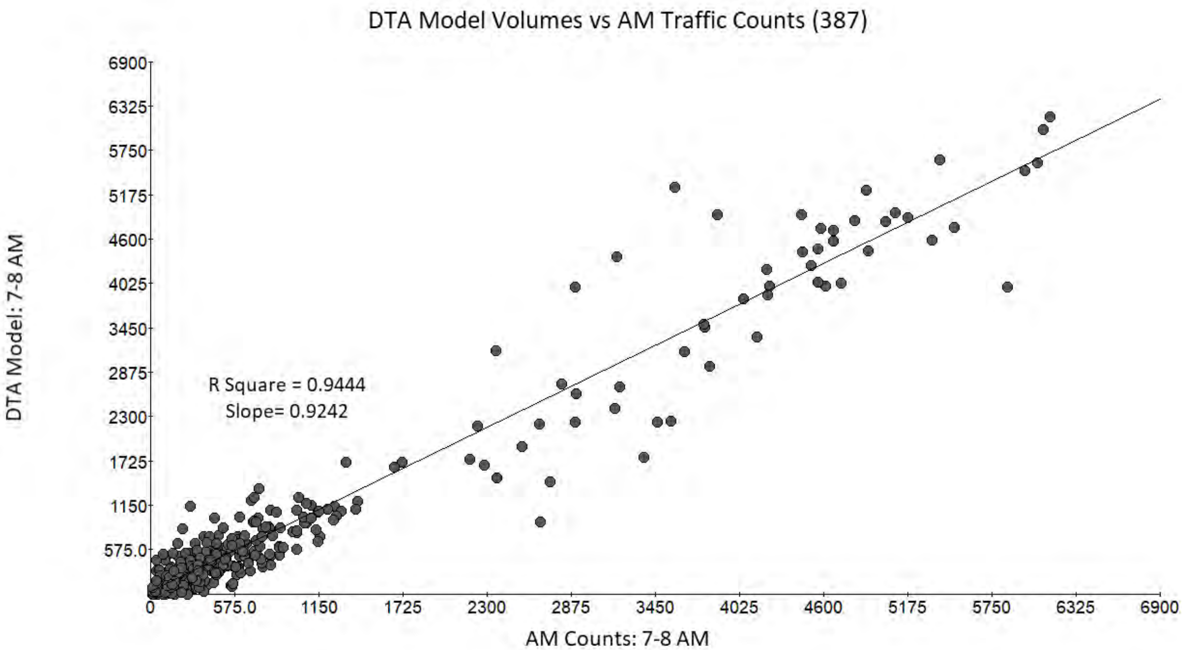


FIGURE 8B: R squared correlation between I-5 DTA subarea model volumes and traffic counts – freeway and ramps - AM

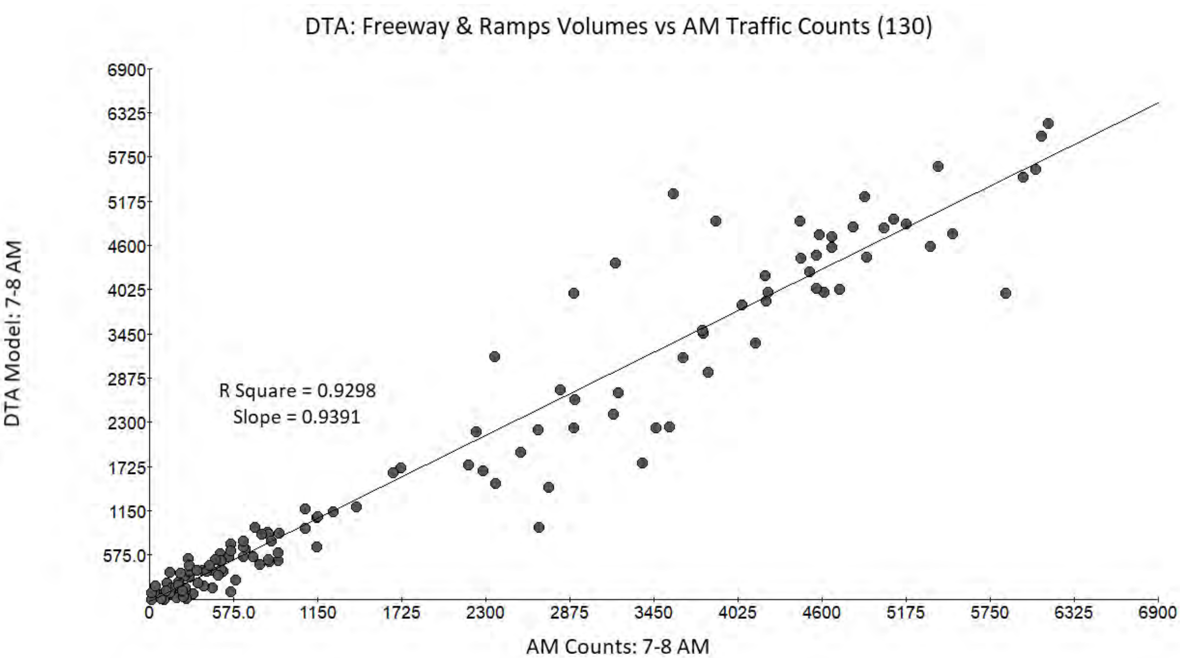


FIGURE 8C: R squared correlation between DTA subarea model volumes and traffic counts – all facilities - PM

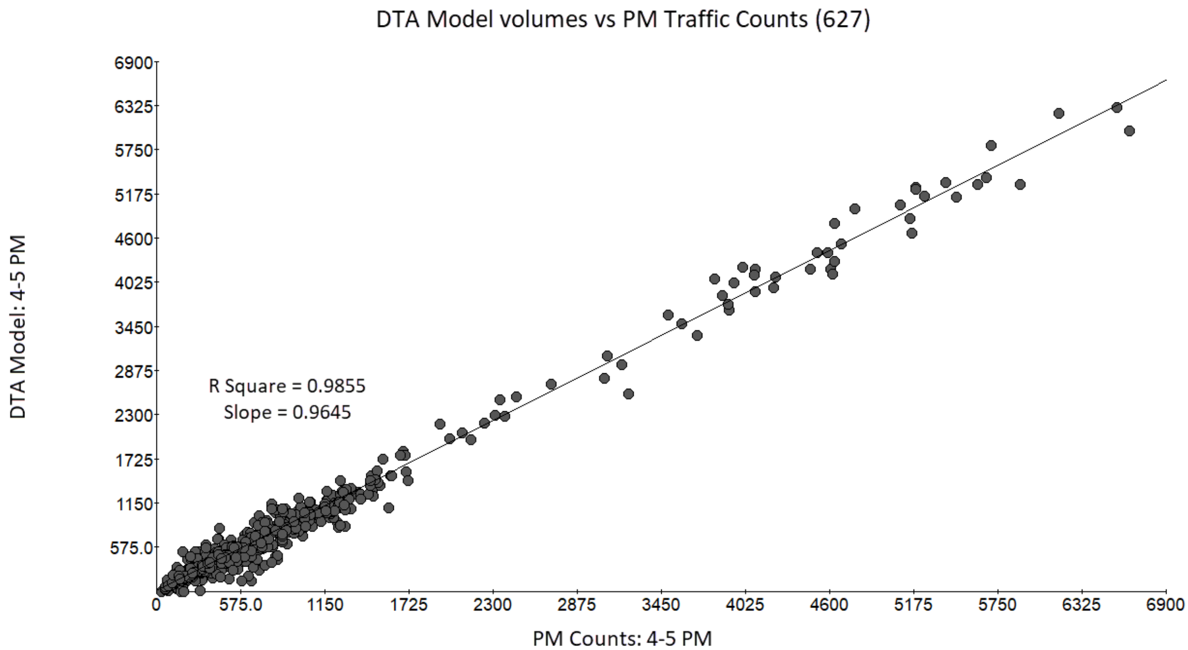
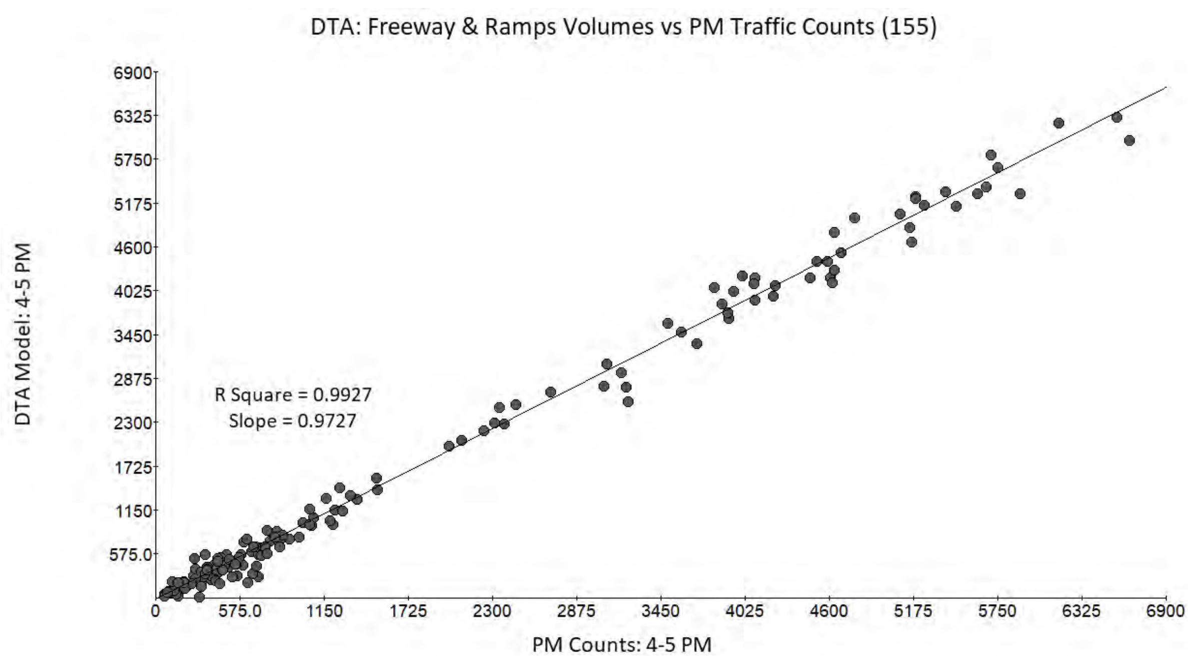


FIGURE 8D: R squared correlation between I-5 DTA subarea model volumes and traffic counts – freeway and ramps - PM



Screenline Validation

Another I-5 DTA model validation check is to measure hourly directional modeled link volumes along screenlines to see how they compare to traffic counts. A screenline is an imaginary line on a map that intersects with the road/street network to capture traffic in one direction of flow. The screen line sums points along the line to see how traffic flow is captured overall, rather than at discrete points on the network. Screenlines were developed for both the freeway (Interstate 5 and US 101) and for the general model area (areawide). In general, model developers aim to have modeled volumes within 10 percent of counts.

FIGURE 9: Screenline locations

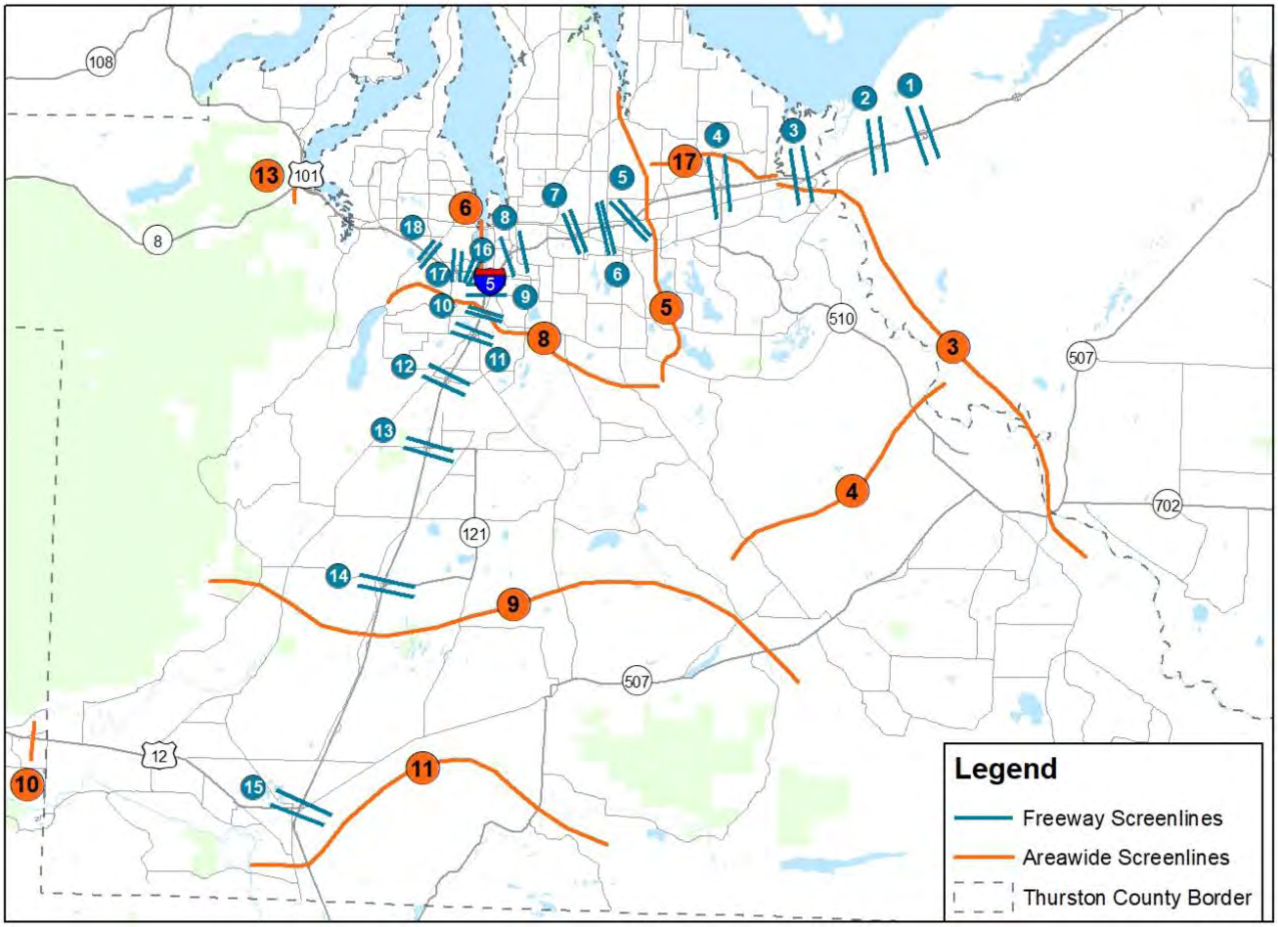


TABLE 5A: Freeway I-5 DTA screenlines – counts versus model volumes – AM peak hour (7 – 8 AM)

NUMBER	NAME	OBSERVED COUNTS	2017 AM MODEL	ABSOLUTE DIFFERENCE	% DIFF.
1	I-5 - Center Dr	10,960	9,024	(1,794)	-19.6%
2	I-5 - Mounts Rd	9,479	8,903	(782)	-9.0%
3	I-5 - Nisqually Cut-Off Rd SE	9,116	8,216	(1,049)	-13.0%
4	I-5 - Marvin Rd SE	11,017	9,552	(1,007)	-10.1%
5	I-5 - Martin Way E	11,934	10,445	(1,654)	-16.1%
6	I-5 - Sleater Kinney Rd SE	11,465	10,006	(1,530)	-15.4%
7	I-5 - Pacific Ave SE	14,840	11,182	(2,604)	-21.3%
8	I-5 - Plum St / 14th	11,187	9,984	(1,281)	-7.6%
9	I-5 - US101	8,929	11,010	(446)	-4.0%
10	I-5 - E Street SW	8,778	8,943	(61)	-0.7%
11	I-5 - Trosper Rd SE	9,502	9,699	52	0.5%
12	I-5 - Tumwater Blvd	9,336	8,513	(1,106)	-13.4%
13	I-5 - 93rd Ave SW	8,245	6,991	(1,374)	-20.0%
14	I-5 - Maytown Rd	5,877	6,995	941	13.8%
15	I-5 - Old Hwy-99	6,819	5,821	(1,113)	-19.5%
16	US101	8,886	9,448	562	5.9%
17	US101 - Crosby Blvd SW	9,796	10,686	890	8.3%
18	US101 - Black Lake Blvd SW	8,979	9,492	513	5.4%
TOTALS		**184,654**	**177,947**	**-12,843**	**-7.5%**

TABLE 5B: Freeway I-5 DTA screenlines – counts versus model volumes – PM (4 – 5 PM)

NUMBER	NAME	OBSERVED COUNTS	2017 PM MODEL	ABSOLUTE DIFFERENCE	% DIFF.
1	I-5 - Center Dr	11,291	10,477	(1,536)	-15.7%
2	I-5 - Mounts Rd	10,185	9,489	(464)	-4.8%
3	I-5 - Nisqually Cut-Off Rd SE	9,850	8,406	(689)	-7.5%
4	I-5 - Marvin Rd SE	13,661	11,719	(1,349)	-11.0%
5	I-5 - Martin Way E	12,765	12,911	(561)	-4.6%
6	I-5 - Sleater Kinney Rd SE	12,645	13,755	(562)	-4.7%
7	I-5 - Pacific Ave SE	14,840	15,287	(1,084)	-7.9%
8	I-5 - Plum St / 14th	13,380	14,269	(1,468)	-12.3%
9	I-5 - US101	13,165	12,279	(1,699)	-14.8%
10	I-5 - E Street SW	8,778	8,341	(840)	-10.1%
11	I-5 - Trosper Rd SE	10,967	9,918	(520)	-5.0%
12	I-5 - Tumwater Blvd	9,698	8,113	(1,066)	-12.3%
13	I-5 - 93rd Ave SW	7,714	6,257	(945)	-14.0%
14	I-5 - Maytown Rd	6,711	5,784	(718)	-12.0%
15	I-5 - Old Hwy-99	8,329	6,166	(1,152)	-16.1%
16	US101	8,886	9,448	562	5.9%
17	US101 - Crosby Blvd SW	9,796	10,686	890	8.3%
18	US101 - Black Lake Blvd SW	8,979	9,492	513	5.4%
TOTALS	**TOTALS**	**191,640**	**182,797**	**-9,215**	**-5.0%**

TABLE 5C: Areawide I-5 DTA screenlines – counts versus model volumes – AM (7 – 8 AM)

	OBSERVED COUNTS		2017 AM MODEL		% DIFFERENCE	
SCREENLINE	**NB-EB**	**SB-WB**	**NB-EB**	**SB-WB**	**NB-EB**	**SB-WB**
3	2,144	1,104	2,331	1,101	9%	0%
4	412	1,378	426	890	3%	-35%
5	5,906	7,890	5,584	7,196	-5%	-9%
6	5,873	3,212	5,410	4,141	-8%	29%
8	6,733	6,059	2,178	2,288	21%	5%
9	3,764	2,497	6,914	5,774	3%	-5%
10	276	316	5,536	2,590	47%	4%
11	2,584	2,503	211	310	-24%	-2%
13	1,806	2,183	2,687	2,304	4%	-8%
17	917	1,819	891	1,616	-3%	-11%
Total	**30,415**	**28,961**	32,168	28,210	6%	-3%

TABLE 5D: Areawide I-5 DTA screenlines – counts versus model volumes – PM (4 – 5 PM)

	OBSERVED COUNTS		2017 PM MODEL		% DIFFERENCE	
SCREENLINE	**NB-EB**	**SB-WB**	**NB-EB**	**SB-WB**	**NB-EB**	**SB-WB**
3	1,416	2,884	1,319	3,029	-7%	5%
4	1,047	957	1,449	819	38%	-14%
5	8,394	7,819	7,988	7,714	-5%	-1%
6	6,166	6,589	5,742	6,126	-7%	-7%
8	6,875	6,932	7,456	7,218	8%	4%
9	2,933	4,106	3,245	4,301	11%	5%
10	276	316	502	618	82%	96%
11	2,946	3,178	3,246	3,590	10%	13%
13	2,091	2,157	2,276	2,498	9%	16%
17	1,685	1,413	1,848	1,491	10%	6%
Total	**33,829**	**36,351**	35,071	37,404	4%	3%

Note: NB = northbound; EB = eastbound; SB = southbound; WB = westbound

Travel Time and Speed Comparison

Other I-5 DTA model validation data sets are corridor travel time and average speed. Travel time and speed data were downloaded from the National Performance Management Research Data Set (NPMRDS) procured and sponsored by Federal Highway Administration (FHWA), and provided to Washington State Department of Transportation (WSDOT) and Metropolitan Planning Organizations such as TRPC. NPMRDS data from February of 2017 onward is provided by a team led by the University of Maryland Center for Advanced Transportation Technology Laboratory (CATT Lab) and is based on data collected by INRIX.

The following data were downloaded for the corridors shown in Figure 10.

- Month: Entire month of March 2018
- Days: All weekdays
- Time of day: 6-9 am and 3-6 pm
- Passenger vehicles and trucks

Data were compared to the I-5 DTA model data to validate the model for both the I-5 and US-101 corridors and other major arterials within the study area. The reliability of the NPMRDS data declines for lower volume corridors.

FIGURE 10: Corridor segments for speed and travel time validation

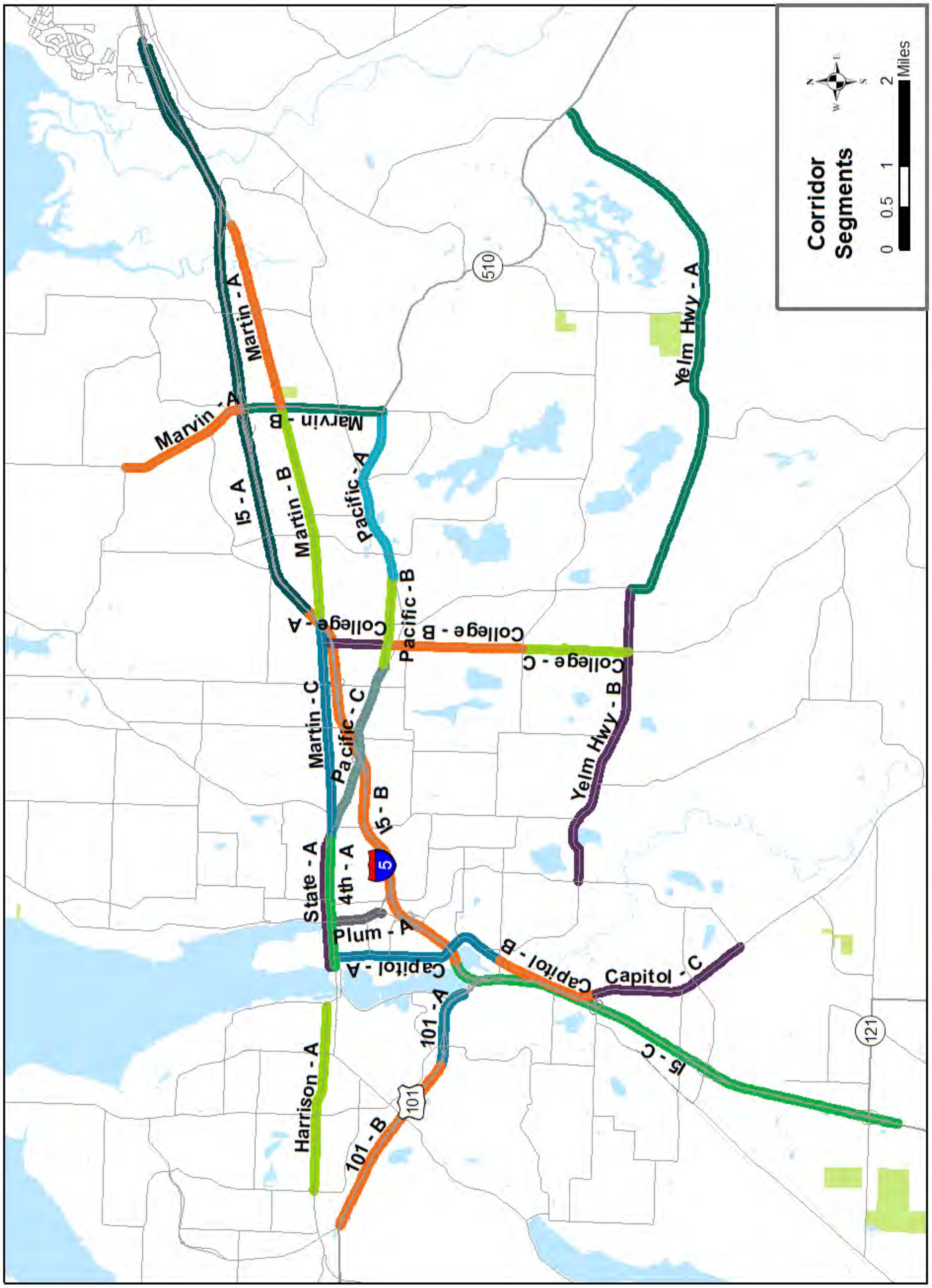


TABLE 6A: AM I-5 DTA speed comparison (miles per hour)

	NPMRDS - Corridor AM Average Congested Speed						2018 DTA - Corridor AM Congested Speed						DTA minus NPMRDS Speed					
	North Bound			South Bound			North Bound / EB			South Bound /WB			North Bound / EB			South Bound /WB		
	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9
I-5 Seg A	51	52	58	61	61	60	58	58	58	60	59	59	-7	-6	0	1	1	0
I-5 Seg B	57	57	58	59	58	51	59	58	57	59	58	58	-2	-1	1	0	1	-7
I-5 Seg C	61	60	61	61	61	61	62	57	55	63	62	63	-1	2	6	-2	-1	-2
Martin Wy Seg A	30	30	28	33	28	29	26	22	25	28	27	28	4	8	3	4	0	1
Martin Wy Seg B	28	26	26	25	21	21	23	22	22	22	19	19	5	4	4	4	3	2
Martin Wy Seg C	20	18	17	22	18	18	19	18	19	21	21	20	1	0	-2	1	-3	-2
Capitol Blvd Seg A	18	19	19	26	20	17	20	21	20	22	21	21	-1	-2	-1	5	-1	-4
Capitol Blvd Seg B	19	17	17	22	24	23	27	24	25	22	22	22	-9	-7	-8	0	2	1
Capitol Blvd Seg C	22	14	19	22	19	21	21	18	19	23	22	22	1	-4	0	-2	-4	-1
Plum Seg A	19	17	14	22	15	15	13	14	13	18	17	18	6	3	1	4	-3	-3
College Seg A	23	18	19	19	19	20	22	19	20	24	22	21	1	-1	-1	-5	-3	0
College Seg B	27	26	22	24	16	20	31	29	30	32	31	32	-4	-3	-8	-8	-15	-12
College Seg C	28	24	27	29	23	26	29	28	28	25	24	23	-1	-4	-1	4	-1	2
Marvin Seg A	25	25	26	19	18	18	32	31	32	29	27	28	-7	-6	-6	-10	-9	-10
Marvin Seg B	21	16	19	27	21	22	19	17	18	20	19	20	3	-1	1	7	2	2
4th/State Seg A	24	22	22	20	20	19	21	21	21	21	20	20	3	1	1	-1	0	-1
Harrison Seg A	21	20	22	25	25	21	25	25	24	22	21	20	-3	-4	-3	3	3	1
Pacific/Lacey Seg A	20	22	22	27	26	21	29	28	28	27	26	26	-9	-6	-6	1	0	-5
Pacific/Lacey Seg B				24	17	21	24	22	22	23	22	22				0	-5	0
Pacific/Lacey Seg C	20	17	20	21	19	18	17	17	17	17	16	16	2	0	4	4	3	2
US 101 Seg A	52	52	51	48	46	48	50	49	49	56	55	55	2	3	2	-8	-8	-7
US 101 Seg B	59	59	59	58	54	52	60	59	60	60	60	60	-1	0	-1	-2	-6	-8
Yelm Hwy Seg A	44	44	36	40	33	26	46	46	46	46	46	46	-3	-2	-10	-6	-12	-20
Yelm Hwy Seg B	30	25	24	29	22	25	27	26	26	27	24	25	3	-1	-3	2	-2	-1

TABLE 6B: PM I-5 DTA speed comparison (miles per hour)

	NPMRDS - Corridor PM Average Congested Speed						2018 DTA - Corridor PM Congested Speed						DTA minus NPMRDS Speed					
	North Bound			South Bound			North Bound / EB			South Bound /WB			North Bound / EB			South Bound /WB		
	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6
I-5 Seg A	61	61	60	58	57	58	58	58	58	59	58	58	3	3	2	-1	-2	0
I-5 Seg B	59	59	59	48	41	39	59	51	50	56	43	40	0	8	9	-8	-3	-1
I-5 Seg C	62	61	61	60	60	60	63	60	61	63	61	62	-1	1	0	-3	0	-2
Martin Wy Seg A	25	25	24	27	25	24	27	28	28	28	27	23	-2	-3	-5	0	-2	1
Martin Wy Seg B	20	21	20	18	17	19	22	21	20	21	18	18	-2	0	0	-4	-1	0
Martin Wy Seg C	16	15	16	16	15	16	19	17	15	19	18	19	-3	-2	1	-4	-2	-2
Capitol Blvd Seg A	18	18	17	17	15	14	20	20	20	21	18	19	-2	-2	-3	-3	-3	-4
Capitol Blvd Seg B	20	16	14	24	21	19	25	23	24	22	21	20	-6	-7	-10	2	0	-2
Capitol Blvd Seg C	14	13	12	18	19	15	21	20	20	21	21	19	-7	-7	-9	-3	-2	-4
Plum Seg A	16	14	15	18	15	12	16	13	13	17	16	17	0	1	2	0	-1	-5
College Seg A	17	16	15	15	15	12	21	18	18	20	15	16	-4	-2	-4	-4	0	-4
College Seg B	14	14	16	17	20	19	30	27	27	31	30	31	-16	-13	-11	-14	-10	-12
College Seg C	21	18	19	23	27	21	28	28	29	25	19	19	-8	-10	-10	-2	8	1
Marvin Seg A	23	26	25	17	19	20	33	30	31	29	28	28	-11	-4	-7	-12	-9	-8
Marvin Seg B	15	15	15	17	15	15	18	17	17	16	14	10	-3	-2	-3	0	1	5
4th/State Seg A	17	17	16	18	18	18	21	20	20	19	17	17	-3	-2	-4	-1	2	1
Harrison Seg A	16	19	19	19	18	20	24	23	24	21	19	20	-8	-4	-5	-3	-1	0
Pacific/Lacey Seg A	24	21	22	27	23	25	24	22	19	27	26	26	0	-1	3	0	-3	-1
Pacific/Lacey Seg B				16	15	16	21	18	19	23	22	21				-8	-7	-5
Pacific/Lacey Seg C	17	16	15	17	17	17	17	14	16	16	15	16	0	2	-1	1	2	1
US 101 Seg A	51	52	52	49	49	48	50	48	49	54	52	50	1	4	3	-5	-3	-2
US 101 Seg B	60	60	60	58	58	59	60	59	59	59	59	58	0	0	1	-1	-1	1
Yelm Hwy Seg A	34	40	39	39	43	35	46	45	44	45	45	45	-11	-5	-5	-6	-2	-10
Yelm Hwy Seg B	24	22	20	27	24	22	26	25	24	27	26	26	-1	-2	-4	0	-1	-4

TABLE 7A: AM I-5 DTA travel time comparison (seconds)

	NPMRDS - Corridor AM Congested Travel Time - Seconds						2018 DTA - Corridor AM Travel Time						DTA minus NPMRDS Travel Time					
	North Bound			South Bound			North Bound			South Bound			North Bound			South Bound		
	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9	6 to 7	7 to 8	8 to 9
I-5 Seg A	494	485	430	425	426	433	433	434	434	436	438	438	-60	-51	5	11	12	5
I-5 Seg B	304	305	297	287	291	333	297	305	310	293	301	298	-7	0	13	6	9	-35
I-5 Seg C	335	341	337	332	328	332	327	353	370	327	331	330	-8	12	33	-5	3	-2
Martin Wy Seg A	267	267	286	246	288	279	319	371	331	285	295	289	52	103	45	39	7	11
Martin Wy Seg B	323	348	350	356	424	436	434	451	458	453	528	518	110	103	108	97	104	81
Martin Wy Seg C	465	503	526	427	512	500	432	453	432	390	394	398	-34	-49	-94	-38	-117	-102
Capitol Blvd Seg A	410	399	390	286	370	452	382	360	369	349	358	360	-28	-39	-22	64	-12	-92
Capitol Blvd Seg B	243	261	266	203	188	198	166	187	182	206	203	207	-76	-74	-85	4	15	9
Capitol Blvd Seg C	307	474	360	312	362	324	321	370	360	292	306	315	14	-104	1	-20	-56	-9
Plum Seg A	115	135	157	100	151	146	161	153	160	141	144	138	46	19	3	42	-7	-8
College Seg A	129	161	156	153	151	144	150	170	163	136	143	156	21	9	7	-18	-8	12
College Seg B	217	222	265	239	350	285	174	187	180	167	172	168	-42	-35	-84	-72	-178	-117
College Seg C	162	188	166	158	195	176	157	164	161	186	187	196	-5	-24	-5	29	-7	20
Marvin Seg A	235	241	232	310	331	339	198	204	200	217	231	226	-37	-38	-32	-92	-101	-114
Marvin Seg B	271	351	309	209	271	262	310	340	318	284	295	288	39	-11	9	75	24	26
4th/State Seg A	234	255	261	283	288	301	267	268	268	270	286	282	32	13	7	-13	-2	-19
Harrison Seg A	376	393	369	324	325	380	322	324	326	366	377	391	-54	-69	-43	42	52	11
Pacific/Lacey Seg A	380	342	342	271	286	355	265	273	272	285	292	296	-115	-69	-70	14	6	-60
Pacific/Lacey Seg B				156	218	173	178	189	190	168	180	181				12	-38	8
Pacific/Lacey Seg C	388	446	378	362	400	418	418	432	432	443	465	463	31	-14	54	81	64	45
US 101 Seg A	69	69	71	71	73	71	68	70	69	66	68	67	-1	1	-1	-5	-5	-3
US 101 Seg B	135	134	134	140	149	155	117	118	117	114	115	115	-18	-17	-17	-25	-34	-40
Yelm Hwy Seg A	549	550	667	603	723	939	533	535	533	529	533	533	-16	-15	-135	-74	-190	-406
Yelm Hwy Seg B	442	538	558	450	609	538	493	509	501	483	550	525	50	-28	-57	33	-59	-13

TABLE 7B: PM I-5 DTA travel time comparison (seconds)

	NPMRDS - Corridor PM Congested Travel Time - Seconds						2018 DTA - Corridor PM Travel Time						DTA minus NPMRDS Travel Time					
	North Bound			South Bound			North Bound			South Bound			North Bound			South Bound		
	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6	3 to 4	4 to 5	5 to 6
I-5 Seg A	413	411	419	445	457	444	434	436	436	439	447	450	21	25	16	-6	-10	5
I-5 Seg B	293	295	295	356	419	431	300	348	353	310	398	430	7	54	58	-46	-21	-1
I-5 Seg C	330	335	335	333	335	336	325	339	335	325	340	332	-5	4	0	-8	6	-4
Martin Wy Seg A	320	314	339	295	323	328	300	287	290	295	304	354	-19	-27	-49	0	-18	25
Martin Wy Seg B	461	435	443	510	520	487	449	473	487	463	535	539	-12	38	44	-47	15	52
Martin Wy Seg C	582	626	584	593	604	559	444	502	558	425	456	430	-138	-124	-26	-169	-147	-128
Capitol Blvd Seg A	425	420	458	436	496	528	373	378	380	364	417	404	-52	-42	-78	-72	-80	-124
Capitol Blvd Seg B	229	274	313	189	218	237	180	197	190	205	215	221	-49	-77	-123	16	-3	-16
Capitol Blvd Seg C	467	537	568	368	352	461	325	350	335	323	328	369	-141	-187	-233	-45	-24	-92
Plum Seg A	138	157	151	124	143	183	136	165	168	144	154	145	-2	8	17	20	11	-37
College Seg A	170	186	196	189	188	243	155	179	175	163	213	202	-15	-7	-21	-27	26	-42
College Seg B	397	424	365	330	290	307	176	198	198	171	177	175	-221	-226	-167	-159	-113	-131
College Seg C	220	252	242	198	165	217	161	162	160	181	239	236	-59	-90	-82	-17	73	19
Marvin Seg A	264	230	242	358	315	300	191	213	202	220	227	224	-73	-17	-40	-138	-88	-76
Marvin Seg B	364	389	398	347	374	369	314	346	331	353	397	554	-50	-43	-67	6	23	185
4th/State Seg A	329	329	356	319	312	328	273	288	287	309	345	340	-56	-41	-69	-10	33	12
Harrison Seg A	488	426	428	432	452	404	332	344	337	377	422	403	-156	-82	-91	-55	-29	-2
Pacific/Lacey Seg A	322	354	341	281	325	303	320	343	392	286	295	294	-2	-11	51	6	-29	-9
Pacific/Lacey Seg B				237	241	226	201	229	222	169	180	186				-69	-61	-41
Pacific/Lacey Seg C	457	491	507	440	432	445	428	538	463	462	492	470	-29	46	-43	21	59	25
US 101 Seg A	70	69	69	69	70	70	68	72	70	68	71	74	-2	2	1	-1	1	4
US 101 Seg B	132	133	132	139	139	137	117	118	118	116	116	118	-15	-15	-14	-23	-22	-19
Yelm Hwy Seg A	699	603	618	613	567	688	543	554	562	537	543	543	-156	-48	-56	-76	-24	-145
Yelm Hwy Seg B	543	594	663	491	541	603	518	535	547	491	514	515	-24	-59	-117	0	-27	-88

SUMMARY

This report documents the development and validation/calibration of the I-5 Models in Thurston County. Transportation models are used to make objective, judicious and informed decisions on transportation investments. In addition, models provide a platform to assess future transportation issues, to identify potential solutions, and to evaluate the efficiency of such solutions.

All efforts have been made to validate the 2017 model to actual data. For the base year, the models give a reasonable estimation of regional travel behavior.

All future year models are based on land use forecasts and current travel behaviors. A forecast is only as accurate as the assumptions that underlie it. They give us important information about our general direction, given what is known today. It is recognized that many other factors, beyond the forecast, may impact future travel patterns.

It should be noted that the models are statistical estimations of regional travel behavior. As such, they should only be used for generalized planning purposes. For specific investment decisions more detailed modeling, such as operational modeling, is generally used.

Appendix E – TRPC 2040 Land Use Forecast

The TRPC 2040 Land Use Forecast was developed under guidance of the Forecast Advisory Group over the course of several years, with the final phase adopted by TRPC on February 1, 2013. It is used by TRPC and Thurston County jurisdictions in the planning efforts. A new land use forecast is currently under development, with the county-wide forecast completed in early 2018. In comparison with the 2013 forecast, growth appears to have been delayed approximately five years due to the continuing effects of the recession recovery. In other works, the 2040 Future Year developed in the 2013 Forecast, is likely to be similar to the 2045 Future Year being developed for the 2018/2019 Forecast. Some key features and assumptions at the time of the 2013 forecast development included:

- There was approximately 10 to 12 years' worth of single-family subdivision projects that were permitted, vested or planned in Thurston County. Many of these were planned for the suburban areas of the cities and unincorporated growth area in what is currently greenfield or partially vacant lands.
- There was also an approximate 10 to 12 years of supply of permitted, vested, or planned multifamily projects. Most of the multifamily activity that was permitted or planned was occurring outside of central city cores and in the form of garden style apartments.
- Demand for walkable urban residential housing choices (housing of all pricing ranges) was higher than existing supply. This was expected to continue in the future.
- Central areas (including south county cities and towns) will continue to struggle to retain essential goods and services, (keep storefronts full) and compete successfully against big box stores and internet shopping.
- Redevelopment along urban transit corridors was expected to continue in a suburban, auto-oriented form.
- Very few accessory dwelling units were permitted in infill areas in the last ten years prior to the forecast. This was not expected to increase much in the future unless financing, concerns over design, and education on how to build these types of homes are addressed.
- Neighborhood centers (small hubs of retail/services) within neighborhoods will continue to be difficult to create – due to 1) not enough customers – rooftops – within walking distance to support the business or 2) community opposition for new businesses/community clubs in existing neighborhoods, 3) community concerns about new mixed-use neighborhoods adjacent to their neighborhoods.
- There was a sharp decrease in the percent of new homes going into the rural areas, likely due to the rural rezone in 2007 as well as the attractiveness of some master planned communities in the cities. The forecast assumed that around 13 percent of new growth will go into rural areas.
- Home based employment will continue to be at the levels of today.

The number of county-to-county (and city to city) commuters will continue to grow at the same rate as the last few decades.

Appendix F – Master list of ideas considered

The table in this appendix lists all ideas that were considered through the I-5 Tumwater to Mounts Road planning study process organized by strategy category. The table also provides the general strategy that more specific ideas fit under and the source of the idea (either from the study advisory group/previous studies or public input). Not all of these ideas were modeled. Ideas that were eliminated from consideration due to not serving study goals or conflicts with current law are called out in the notes column.

Key	Strategy Category	General Strategy	Specific idea	Source	Notes
1	Operational	Implement transit signal priority	Martin Way	TAG/Previous Studies	
2	Operational	Implement transit signal priority	Capitol Way/Capitol Boulevard	TAG/Previous Studies	
3	Operational	Centralize traffic management	Signal operations throughout the county	TAG/Previous Studies	
4	Operational	Centralize traffic management	Incident response	TAG/Previous Studies	
5	Operational	Selectively close access points along corridor to simplify operations	Deschutes Way SW to I-5 NB	TAG/Previous Studies	
6	Operational	Selectively close access points along corridor to simplify operations	Martin Way Interchange at exit 114 (Nisqually Ramps) except in cases of emergency	Public input	
7	Operational	Active Traffic Management/Intelligent Transportation Systems	Variable message signs with travel time information	TAG/Previous Studies	
8	Operational	Active Traffic Management/Intelligent Transportation Systems	Variable speed limits	TAG/Previous Studies	
9	Operational	Implement hard shoulder running	Pacific Ave to Plum St	TAG/Previous Studies	
10	Operational	Implement hard shoulder running	Sleater-Kinney to US 101	TAG/Previous Studies	
11	Operational	Improve interchange operations	I-5 Exit 104 NB - Extend merge zone between Deschutes Way and Exit 104	TAG/Previous Studies	
12	Operational	Improve interchange operations	I-5 Exit 104 NB - Add high-friction surfacing	TAG/Previous Studies	
13	Operational	Improve signing to help distribute traffic	I-5 SB at Henderson to guide through traffic away from weaving	TAG/Previous Studies	
14	Operational	Improve signing to help distribute traffic	US 101 between Crosby and I-5	TAG/Previous Studies	
15	Operational	Add HOV/Transit queue jumps at interchange ramps		Public input	
16	Operational	Stripe/Add a motorcycle lane		Public input	
17	Operational	Improve lighting at ramps		Public input	Screened out, WSDOT has existing policy on lighting

18	Operational	Add speed limit signs at I-5 exit 104 NB entrance to US 101		Public input	
19	Operational	Reduce vertical and horizontal curves of I-5		Public input	
20	Operational	Improve intersection operations at Mounts Road interchange ramp terminals		Public input	
21	Operational	Make right-only lane from Martin at Nisqually Cut-Off a right or straight during peak periods		Public input	
22	Operational	Get rid of on-ramp metering		Public input	Screened out, did not serve study goals
23	Operational	Close the truck weigh station north of Mounts Road during peak periods		Public input	
24	Operational	Open additional access gates to JBLM		Public input	
25	Operational	Keep the Mounts Road access gate to JBLM open longer		Public input	
26	Operational	Install emergency call boxes connecting to Incident Response Teams/Washington State Patrol		Public input	
27	Demand Management	Enhance park-and-rides to increase use	Existing park-and-rides - Improve illumination, safety features, etc…	TAG/Previous Studies	
28	Demand Management	Enhance park-and-rides to increase use	Existing park-and-rides - Provide bike facilities	TAG/Previous Studies	
29	Demand Management	Enhance park-and-rides to increase use	Existing park-and-rides - Evaluate existing park-and-rides for expansion	TAG/Previous Studies	
30	Demand Management	Enhance park-and-rides to increase use	Existing park-and-rides - Direct access to I-5 NB from Martin Way park-and-ride	TAG/Previous Studies	
31	Demand Management	Enhance park-and-rides to increase use	Evaluate locations for new park-and-rides and transit centers such as Tumwater Town Center	TAG/Previous Studies	
32	Demand Management	Increase transit use and alternative commutes to/from major job sites to reduce demand	Implement/expand transit pass programs	TAG/Previous Studies	
33	Demand Management	Increase transit use and alternative commutes to/from major job sites to reduce demand	Improve transit/alternative commute incentives	TAG/Previous Studies	
34	Demand Management	Increase transit use and alternative commutes to/from major job sites to reduce demand	Manage parking at key employment sites	TAG/Previous Studies	
35	Demand Management	Increase transit use and alternative commutes to/from major job sites to reduce demand	Expand use of telework/compressed work weeks	TAG/Previous Studies	
36	Demand Management	Increase transit use and alternative commutes to/from major job sites to reduce demand	Require telework and staggered start times at Capitol Campus	Public input	

37	Demand Management	Increase transit use and alternative commutes to/from major job sites to reduce demand	Mandate vanpooling for JBLM	Public input	
38	Demand Management	Increase low-income ridership		TAG/Previous Studies	
39	Demand Management	Expand transit services	Expand passenger rail into Thurston County - DuPont to Centenial Station	TAG/Previous Studies	
40	Demand Management	Expand transit services	Expand passenger rail into Thurston County - DuPont to downtown Olympia via existing rail ines	TAG/Previous Studies	
41	Demand Management	Expand transit services	Expand passenger rail into Thurston County - New line down median of I-5	TAG/Previous Studies	
42	Demand Management	Expand transit services	Expand vanpooling using peer-to-peer marketing	TAG/Previous Studies	
43	Demand Management	Expand transit services	Implement "Go Transit" initiative at JBLM	TAG/Previous Studies	
44	Demand Management	Expand transit services	Restore express transit between regional centers	TAG/Previous Studies	
45	Demand Management	Expand transit services	Light rail transit - Between Hawks Prairie and DuPont Station	TAG/Previous Studies	
46	Demand Management	Expand transit services	Light rail transit - Between Olympia and Tacoma	TAG/Previous Studies	
47	Demand Management	Expand transit services	Bus Rapid Transit - Between Hawks Prairie and DuPont Station	TAG/Previous Studies	Combined with 48 and 49
48	Demand Management	Expand transit services	Bus Rapid Transit - Capitol Way and Harison-Martin corridors	TAG/Previous Studies	Combined with 47 and 49
49	Demand Management	Expand transit services	Bus Rapid Transit - to JBLM	TAG/Previous Studies	Combined with 47 and 48
50	Demand Management	Expand transit services	Create direct shuttles/micro transit in rural areas to high-demand sites	Public input	
51	Demand Management	Expand transit services	Monorail	Public input	
52	Demand Management	Expand transit services	Subway/BART-type system	Public input	
53	Demand Management	Expand transit services	Express bus connection to Amtrak Centennial Station	Public input	

54	Demand Management	Expand transit services	Expand transit to south Thurston County/Improve Rural Transit	Public input	
55	Demand Management	Expand transit services	Rapid transit systems - statewide	Public input	
56	Demand Management	Expand transit services	Rapid transit systems - Portland to Bellingham	Public input	
57	Demand Management	Expand transit services	Rapid transit systems - Portland to Vancouver B.C.	Public input	
58	Demand Management	Expand transit services	Make transit free	Public input	
59	Demand Management	Expand transit services	Employee shuttle or bus system for capitol campus like Google bus	Public input	
60	Demand Management	Expand transit services	Ultra-high-speed transportation (Hyperloop)	Public input	
61	Demand Management	Expand transit services	Create ferry service	Public input	
62	Demand Management	Offer childcare and/or schools at major employment sites		Public input	
63	Demand Management	Implement tolling or congestion pricing on all of I-5 through study area		Public input	
64	Demand Management	Air taxi service to Tacoma, Seattle, and Everett		Public input	
65	Demand Management	Improve transit operations	Improve first/last mile connections	TAG/Previous Studies	
66	Demand Management	Improve transit operations	Transit-only hard shoulder running/Bus shoulder use	TAG/Previous Studies	
67	Demand Management	Improve transit operations	Implement transit signal priority generally on local system	TAG/Previous Studies	
68	Demand Management	Improve transit operations	Relocate Amtrak station to Olympia	Public input	
69	Demand Management	Establish active transportation routes between major destinations		TAG/Previous Studies	
70	Demand Management	Improve local network bike infrastructure		TAG/Previous Studies	
71	Demand Management	Adjust pickup/drop off hours to off peak times at Ports		TAG/Previous Studies	
72	Demand Management	Adjust employee parking requirements based on density and transit service availability		TAG/Previous Studies	
73	Demand Management	Expand ORCA card program to include Intercity Transit		TAG/Previous Studies	
74	Demand Management	Convert existing lanes to managed lanes	Repurpose left lanes as HOV/Express lanes between US101 and Mounts Road	Public input	Combined with 75

75	Demand Management	Convert existing lanes to managed lanes	Convert a lane in each direction to HOV between Marvin/SR 510 and SR 512 (near-term)	Public input	Combined with 74
76	Local Network	Update signal timing and channelization on local network		TAG/Previous Studies	
77	Local Network	Improve local network operations	Pacific Avenue east of I-5	TAG/Previous Studies	
78	Local Network	Improve local network operations	College Street and Martin Way	TAG/Previous Studies	
79	Local Network	Improve local network operations	Pacific Avenue and Martin Way	TAG/Previous Studies	
80	Local Network	Improve local network operations	Improve local system circulation at interchanges to reduce mainline queuing	TAG/Previous Studies	
81	Local Network	Improve local network operations	Improve Local system flow at Nisqually Rd SW, Mounts Rd, & Nisqually Cut-off	TAG/Previous Studies	
82	Local Network	Improve local network operations	Address traffic flow at Capitol Boulevard/North Street/Yelm Highway (Tumwater)	TAG/Previous Studies	
83	Local Network	Improve local network operations	Improve 2nd Avenue/Custer Way intersections - Double left turn from SB North 2nd Ave SW to Custer Way SW	TAG/Previous Studies	
84	Local Network	Improve local network operations	Improve 2nd Avenue/Custer Way intersections - Roundabouts at N 2nd Ave SW & Custer and Custer & Boston	Public input	
85	Local Network	Improve local network operations	Move Thurston County's Waste and Recovery Center south to rail access station	TAG/Previous Studies	
86	Local Network	Improve local network connectivity	Connect Bob's Hollow Ln through to Mounts Rd	TAG/Previous Studies	
87	Local Network	Improve local network connectivity	Extend College St NE to 15th Ave NE	TAG/Previous Studies	
88	Local Network	Improve local network connectivity	Build Log Cabin Rd	TAG/Previous Studies	
89	Local Network	Improve local network connectivity	Reconfigure 4th Avenue roundabout in Olympia to allow direct access to Deschutes Parkway	TAG/Previous Studies	

90	Local Network	Improve local network connectivity	Connect E Street to Yelm Hwy (Tumwater)	Public input	
91	Local Network	Improve local network connectivity	Extend 93rd Ave SE to connect Rich and Rainier Roads	Public input	
92	Local Network	Add capacity to local roads	Expand Waddell Creek Road	Public input	
93	Local Network	Add capacity to local roads	Henderson Blvd - Yelm Hwy to I-5	Public input	
94	Local Network	Add capacity to local roads	Steilacoom Rd SE between Pacific Ave and Nisqually Cuttoff Rd SE	Public input	Edited to specify Steilacoom Rd
95	Local Network	Add capacity to local roads	Martin Way and Mounts Road/Nisqually Road	Public input	
96	Policy Change	Work with local agencies and developers to reduce trips through development policy		TAG/Previous Studies	
97	Policy Change	Halt development		Public input	Screened out, did not serve study goals
98	Policy Change	Make downton Olympia/Capitol Campus a no private cars zone		Public input	Screened out, did not serve study goals
99	Policy Change	Camera-based speeding enforcement		Public input	
100	Policy Change	Increase driver testing requirements (mandatory tests every 5 years, higher standards, etc...)		Public input	
101	Policy Change	Require concurrency through GMA on local development for I-5		Public input	
102	Policy Change	Change the speed limit	Increase to 70mph throughout corridor	Public input	
103	Policy Change	Change the speed limit	Extend 60mph zone to south of Tumwater Blvd	Public input	
104	Policy Change	Change the speed limit	Reduce to 55, 50, or 45	Public input	
105	Policy Change	Change the speed limit	Change US 101 EB speed limit to 50mph between Crosby and I-5	Public input	
106	Policy Change	Charge JBLM mitigation fees for community impacts		Public input	Screened out, not feasible
107	Policy Change	Increase gas tax to discourage driving		Public input	
108	Policy Change	Require trucks to only use the right lane.		Public input	
109	Further study	Evaluate alternate routes for and local traffic impacts from non-recurring congestion		TAG/Previous Studies	
110	Further study	Conduct lane configuration audit		TAG/Previous Studies	
111	Further study	Study freight needs and traffic origins/destinations		TAG/Previous Studies	
112	Further study	Complete refined origin/destination study to evaluate local system improvements		TAG/Previous Studies	

113	Roadway capacity expansion	Widen I-5	US 101 to Mounts Road	TAG/Previous Studies	
114	Roadway capacity expansion	Widen I-5	Express lanes	Public input	
115	Roadway capacity expansion	Widen I-5	Reversible Express lanes	Public input	
116	Roadway capacity expansion	Add freight climbing/passing lanes	Meridain Rd NE to Mounts Road	TAG/Previous Studies	
117	Roadway capacity expansion	Add managed lanes	HOV 2+	TAG/Previous Studies	
118	Roadway capacity expansion	Add managed lanes	HOV 3+	TAG/Previous Studies	
119	Roadway capacity expansion	Add managed lanes	HOT	TAG/Previous Studies	
120	Roadway capacity expansion	Add managed lanes	Update Martin Ave bridge to accommodate HOV lanes	TAG/Previous Studies	
121	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	I-5 SB auxiliary lane	TAG/Previous Studies	
122	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	US 101 WB auxiliary climbing lane	TAG/Previous Studies	
123	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	I-5 Pacific Ave NB Off-ramp double left turn	TAG/Previous Studies	Combined with 135
124	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	I-5 Martin Way SB off ramp double right turn	TAG/Previous Studies	Combined with 128 and 135
125	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	US 101 Cooper Point to I-5 auxiliary lanes	TAG/Previous Studies	
126	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	I-5 Pacific to Martin collector/distributor lanes or extend auxiliary lanes,	TAG/Previous Studies	
127	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	I-5 Martin Way NB off ramp deceleration lane	TAG/Previous Studies	Combined with 125 and 135
128	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Add collector-distributor system near I-5/US101 to move US 101 traffic to outside lane	TAG/Previous Studies	Combined with 129 and 130

129	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Braided ramp to I-5 SB from City Center	TAG/Previous Studies	Combined with 128 and 130
130	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	I-5 to US 101 WB ramp realignment	TAG/Previous Studies	Combined with 128 and 129
131	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Add a lane to I-5 exit 104 NB to US 101	TAG/Previous Studies	
132	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Improve Trosper road interchange terminal flows	TAG/Previous Studies	Funded for construction by 2025, Tumwater lead agency
133	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Improve Sleater-Kinney interchange terminals	TAG/Previous Studies	
134	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Improve Martin Way interchange terminals	TAG/Previous Studies	Combined with 125 and 128
135	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Improve Pacific Ave interchange terminals	TAG/Previous Studies	Combined with 123
136	Roadway capacity expansion	Add capacity to I-5 near interchanges to improve flow	Add HOV direct access ramps	Public input	
137	Roadway capacity expansion	Improve parallel/alternate corridors to provide redundancy in emergencies	SR 507 - Centralia to Parkland	Public input	
138	Roadway capacity expansion	Improve parallel/alternate corridors to provide redundancy in emergencies	SR 510 - Yelm to SR 702	Public input	
139	Roadway capacity expansion	Improve parallel/alternate corridors to provide redundancy in emergencies	Cross base highway	Public input	
140	Roadway capacity expansion	Improve parallel/alternate corridors to provide redundancy in emergencies	Connection between Roy and Olympia (East Gate Rd?)	Public input	
141	Roadway capacity expansion	Improve parallel/alternate corridors to provide redundancy in emergencies	Old 99/SR 507 - Grand Mound to Spanaway	Public input	
142	Roadway capacity expansion	Improve parallel/alternate corridors to provide redundancy in emergencies	Tunnel to bypass I-5/US 101	Public input	
143	Roadway capacity expansion	Move I-5 out of Nisqually Delta		Public input	
144	Roadway capacity expansion	Add Highway Access	Carpenter Rd	Public input	
145	Roadway capacity expansion	Add Highway Access	Add NB on-ramp from Sleater-Kinney	Public input	

146	Roadway capacity expansion	Add Highway Access	Add SB on-ramp from Custer Way	Public input	Screened out, conflicts with FHWA policy
147	Roadway capacity expansion	Add Highway Access	Meridian Rd NE	Public input	Screened out, conflicts with FHWA policy

Appendix G –Scenario and Performance Measure Report

Scenario and Performance Measure Report

for the I-5 Tumwater to Mounts Road Study

Washington State Department of Transportation
&
Thurston Regional Planning Council
2019

In 2018, the Washington State Department of Transportation (WSDOT) Headquarters and Olympic Region and Thurston Regional Planning Council (TRPC) entered in partnership to develop a transportation modeling framework for the Thurston Region and adjacent areas, with emphasis on the I-5 corridor between 93rd Avenue in Tumwater to Mounts Road and SR-101 from I-5 to Black Lake Boulevard. The modeling framework includes integrated Travel Demand Model (TDM) and Dynamic Traffic Assignment (DTA) model platforms. The I-5 Tumwater to Mounts Road Study used this modeling framework to compare performance measures for a variety of future scenarios, including land use, travel demand management, operational improvements, transit improvements, and infrastructure improvements.

This report documents the scenario and performance measure details.

Scenarios

The following process was used to refine ideas into strategies and group them into scenarios:

1. The Project Team combined similar ideas into strategies.
2. Working with the Technical Advisory Group, the Project Team conducted a first screening on strategies to ensure they met the project's purpose and need.
3. Working with the Technical Advisory Group, the Project Team conducted a second screening using a high-level qualitative scoring.
4. The Project Team separated strategies into two categories:
    a. Strategies that could be modeled.
    b. Strategies that could not be modeled.
5. Working with the Technical Advisory Group, the Project Team placed the "Strategies that could be modeled" into modeling buckets, or scenarios.
6. Working with the Technical Advisory Group, the Project Team determined scenario order. The group agreed to take a Practical Solutions approach to the order of scenario modeling, starting with lower cost, easier to implement items. The final scenario order was the following:
    a. Funded Base
    b. Operations
    c. Sustainable Thurston Land Use
    d. Travel Demand Management
    e. Transit
    f. Hard Shoulder Running
    g. Local Network
    h. Interchange Improvements
    i. High Occupancy Vehicle (HOV) Lane Conversion
    j. Capacity Expansion - I-5 –Add General Purpose (GP) Retain HOV Lane
    k. Capacity Expansion - I-5- Add GP Remove HOV Lane

7. Working with the Technical Advisory Group, the Project Team grouped the scenario into scenario buckets, recognizing that some scenarios built upon other ones, while others were mutually exclusive as they would occupy the same physical space (for example Part Time Shoulder Use and the two Capacity Expansion scenarios). The scenario bucket relationship to scenarios is shown in Table 1.

Table 1: Model scenarios and inclusion in improvement scenarios

	Improvement Scenarios Included in Modeling										
		1	2	3	4	5	6	10	7	9	11
2040 Improvement Scenarios	Funded Base	Operations	Land Use	Travel Demand Management	Transit	Part Time Shoulder Use	HOV Conversion	Local Network	Interchange Improvements	Widen I-5 – Add GP Retain HOV Lane	Widen I-5 – Add GP Convert HOV Lane
A. Funded Base	X	X	X	X	X	X	X	X	X	X	X
B. Operations		X	X	X	X	X	X	X	X	X	X
C. Sustainable Thurston Land Use			X	X	X	X	X	X	X	X	X
D. Travel Demand Management				X	X	X	X	X	X	X	X
E. Transit					X	X	X	X	X	X	X
F. Hard Shoulder Running						X	X	X	X		
G. HOV Conversion							X	X	X	X	X
H. Local Network								X	X	X	X
I. Interchange Improvements									X	X	X
J. Capacity Expansion I-5 –Add GP Retain HOV Lane										X	
K. Capacity Expansion I-5- Add GP Convert HOV Lane											X

Scenario Modeling

In 2018, the Washington State Department of Transportation's (WSDOT) Headquarters and Olympic Region Mutlimodal Planning Offices and Thurston Regional Planning Council (TRPC) entered in partnership to develop a transportation modeling framework for the Thurston Region and adjacent areas, with emphasis on the I-5 corridor between 93rd Avenue in Tumwater to Mounts Road and SR-101 from I-5 to Black Lake Boulevard. The modeling framework includes integrated Travel Demand Model (TDM) and Dynamic Traffic Assignment (DTA) model platforms. The models were used to evaluate the various scenarios identified in the study. It should be noted that the models are statistical estimations of regional travel behavior. As such, they should only be used for generalized planning purposes. For specific investment decisions more detailed modeling, such as operational modeling, is generally used.

All model scenarios are built for a future year of 2040. Land use forecasts used in the modeling framework were developed by TRPC as part of their regional work program. A forecast is only as accurate as the assumptions that underlie it. They give us important information about our general direction, given what is known today. It is recognized that many other factors, beyond the forecast, may impact future travel patterns.

Funded Base

The funded base scenario contains the following elements:

- TRPC 2040 Land Use forecast. This is the 'business as usual' land use forecast developed in 2012. (https://www.trpc.org/236/Population-Employment-Forecasting).
- Changes to intersection traffic signal timing to facilitate a model-optimized traffic flow through the study area.
- Funded operations, travel demand, transit and capacity projects.

Other projects, identified through the WSDOT I-5 Short Term Strategies study, were considered in the project but not explicitly included in the modeling. They included:

- Implementation of Transit Signal Prioritization and Signal Coordination along the Martin Way Corridor. This project is underway, however there is not sufficient data available to inform modeling.
- Vanpool outreach. Based on discussions with Intercity Transit, similar outreach resulted in 11 new vanpools – which shifted 60 trips in the am and 60 in the pm periods. This shift is below the rounding threshold of mode split results.
- Hard Shoulder Running feasibility study. This action was a study into the feasibility of hard shoulder running in the I-5 corridor. The study has been completed. The implementation of the study is contained in a scenario.

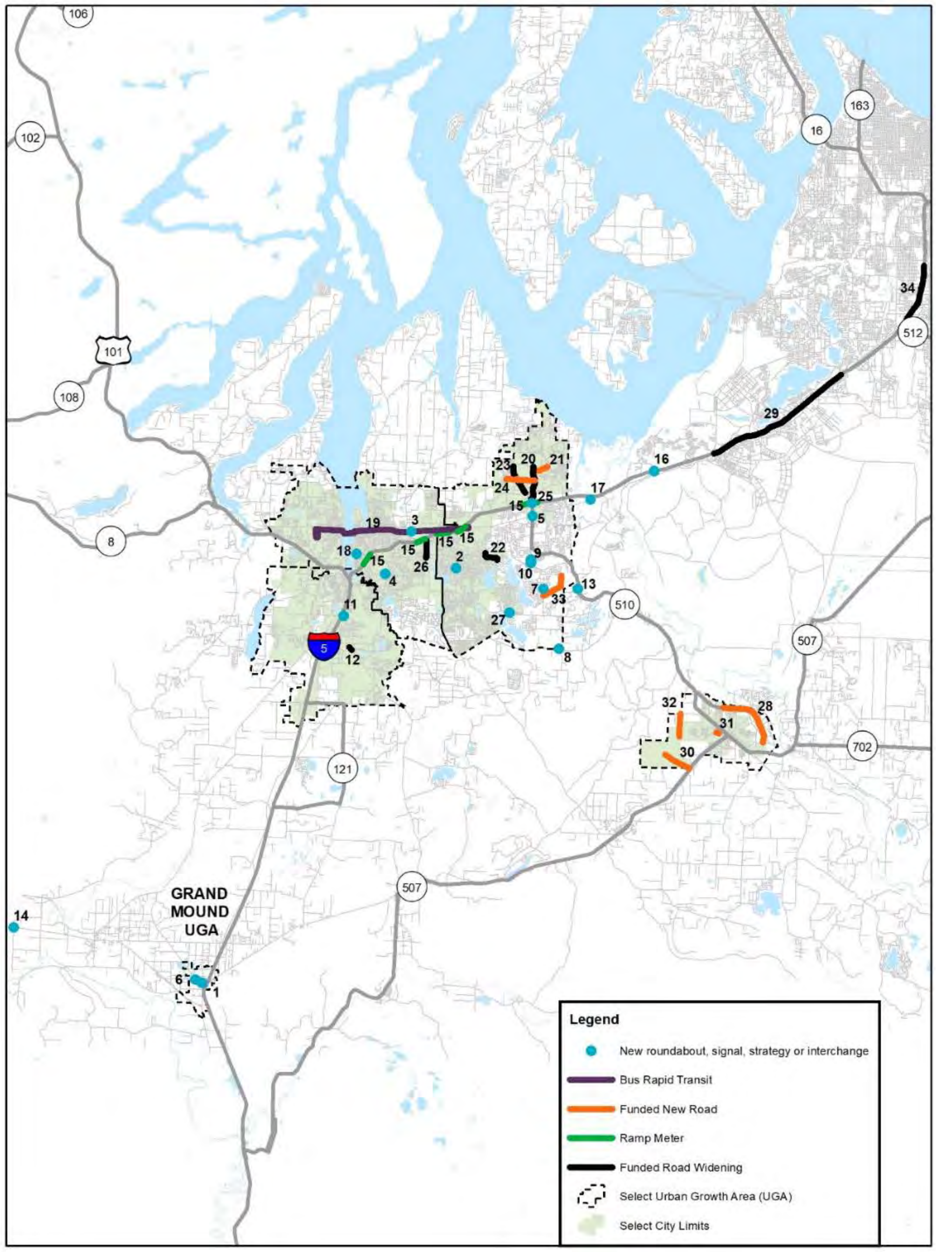


Figure 1: Funded projects

Table 2: Projects included in Funded Base scenario

Number	Area/ Jurisdiction	Location	Extent/Limits	Improvement
Operational Improvements				
1	Chehalis Tribe	Old Hwy 99 at 198th Ave SW	Old Hwy 99 at 198th Ave SW	New roundabout
2	Lacey	College St and 22nd Ave SE	College St and 22nd Ave SE	New roundabout
3	Olympia	Martin Way and Pattison St	New signal	New signal
4	Olympia	Eskridge and Henderson	New roundabout	New roundabout
5	Private Developer	Mullen Road at Marvin Road	Mullen Road at Marvin Road	New roundabout
6	Thurston Co	Sargent Road SW at SR 12	Sargent Road SW at SR 12	New roundabout to connect Sargent Road with SR 12
7	Thurston Co	Marvin Road at Evergreen Forest Drive	South of Evergreen Elementary at new road connection to/from Oak Tree Preserve	New roundabout
8	Thurston Co	Yelm Hwy and Meridian Rd	Yelm Hwy at Meridian Rd	New roundabout
9	Thurston Co	15th Ave and Marvin Rd	15th Ave and Marvin Rd	New compact roundabout
10	Thurston Co/ Private Developer	Marvin Road at Union Mills Road/19th Ave	Union Mills Road/19th Ave	New roundabout and access management
11	Tumwater	Trosper Boulevard and Capitol Way	Construct 3 adjacent roundabouts	Construct 3 adjacent roundabouts
12	Tumwater	Capitol Boulevard	Tumwater Boulevard to 73rd Ave	Add a second south bound through lane at the Tumwater Boulevard interchange, and a turn pocket at 73rd Ave SE
13	WSDOT	SR 510 and Meridian Road	SR 510 and Meridian Road	New roundabout
14	WSDOT	US12 at Anderson Road	New roundabout	New roundabout
15	WSDOT	I5 Southbound ramp meters	Henderson/14th Ave, Pacific Ave, Sleater-Kinney Rd, Martin Way and Marvin Rd	Add ramp meters
16	WSDOT	Mounts Road Interchange	Mounts Road Interchange	Revise southbound off-ramp from to be all-way stop
17	WSDOT	Near Nisqually Interchange	Martin Way at Nisqually Cut Off Rd SE	Two through lanes on north side of Martin Way through the intersection.
Travel Demand Management				
18	TRPC/ Olympia	Capitol Campus Telework and Flexible Hours	Capitol Campus	Assumption that 25% of state workers on Capital Campus will telework one day a week - spread evenly over work days.
19	Intercity Transit	Capital Mall to Martin Way Park-and-ride	Express (bus rapid transit light)	Add express (bus rapid transit light) route

Number	Area/ Jurisdiction	Location	Extent/Limits	Improvement
Capacity Projects				
20	Lacey	Hogum Bay Truck Route	Marvin Road NE to between 31st Ave and Hawks Prairie Road	Widen to 2/3 lanes with roundabout at Willamette Drive
21	Lacey	Campus Glen Drive NE Extension	Campus Glen Drive NE from Salish Middle School to Hogum Bay Road	New street connection
22	Lacey	Carpenter Road Improvements	Pacific Ave to Shady Lane	Widening: 4/5 lane section, 3/4 lane section with 2 lane NB /1 lane SB, & 2/3 lane section
23	Lacey	Marvin Road Widening	Britton Parkway NE to Columbia Way NE	Widen to 4 lanes with median treatment. Roundabout at Hawks Prairie and Marvin. Three lane section north of the roundabout.
24	Lacey	31st Ave NE Extension	Hogum Bay Road to Gateway	Street Extension
25	Lacey	Marvin Road I-5 Interchange Improvements	Marvin Road at I-5	Reconstruct Freeway Interchange to diverging diamond design
26	Olympia	Fones Road Widening	Pacific Ave to 18th Ave	Widen 3/4 lanes
27	Thurston Co	Mullen Road	Lacey City Limits to Carpenter	Channelization for Mullen Rd, and roundabout at Carpenter and Mullen
28	WSDOT	510 Yelm Loop North Section Y3 - SR510 Spur Yelm Loop	Cullens Rd. SE to SR-507 at Walmart Boulevard Intersection	New 2/3 lane limited access road
29	WSDOT	I-5 Corridor Improvements	Steilacoom-Dupont Road to Thorne Lane Interchange	Add one lane in each direction; Auxiliary lanes NB between Berkeley St to Gravelly Lake Dr, SB between Gravelly Lake Dr to Thorne Lane, and from Berkeley St to JBLM Main Gate.
30	Yelm	Tahoma Boulevard Extension - South	Dotson St to SR 507	New street connection
31	Yelm	Mosman Ave Phase 2	Railroad St to Longmire St	New street connection
32	Yelm	Tahoma Boulevard Extension - North	93rd Ave SE to Tahoma Boulevard	New street connection
33	Private Developer	19th Ave SE Extension & roundabout at 19th and Marvin	Lochton Court SE to Lake Forest Drive	New street extension
34	WSDOT	I-5 - SR 512	SR 512 On/Off Ramps north to model extent	Add HOV Lane

Operations

The Operations scenario contains a variety of intersection improvements identified by project partners to address congestion issues in the 2040 Funded Base scenario. They are listed in below Table 1.

Table 1: Operations projects

Number	Area/Jurisdiction	Location	Extent/Limits	Improvement
1	Olympia	Martin Way and Sleater- Kinney	Martin Way and Sleater-Kinney	Double left turn
2	Rainier	SR 507 & Centre St	SR 507 and Centre St	New roundabout
3	Tenino	Sussex Ave E/SR 507 & Old Hwy 99	Sussex Ave E/SR 507 & Old Hwy 99	New roundabout
4	Thurston County	Johnson Point Rd	Johnson Point Road and Hawks Prairie Road	New roundabout
5	Thurston County	Steilacoom Road	Steilacoom Road and SR 510	New roundabout
6	WSDOT	Near Nisqually Interchange	Martin Way at Nisqually Cut Off Road SE	Extra lane approaching ramp meter for northbound ramp
7	WSDOT	Deschutes Parkway	Deschutes Parkway onramp	Extend taper on on-ramp
8	WSDOT	Sleater-Kinney Interchange	Sleater-Kinney	New traffic signal
9	WSDOT	SR 507 in Yelm	SR 507 and SR 702	New roundabout
10	WSDOT	SR 507 in Yelm	SR 507 at Vail Road	New roundabout
11	WSDOT	Rochester	US 12 and 183rd Ave	New roundabout

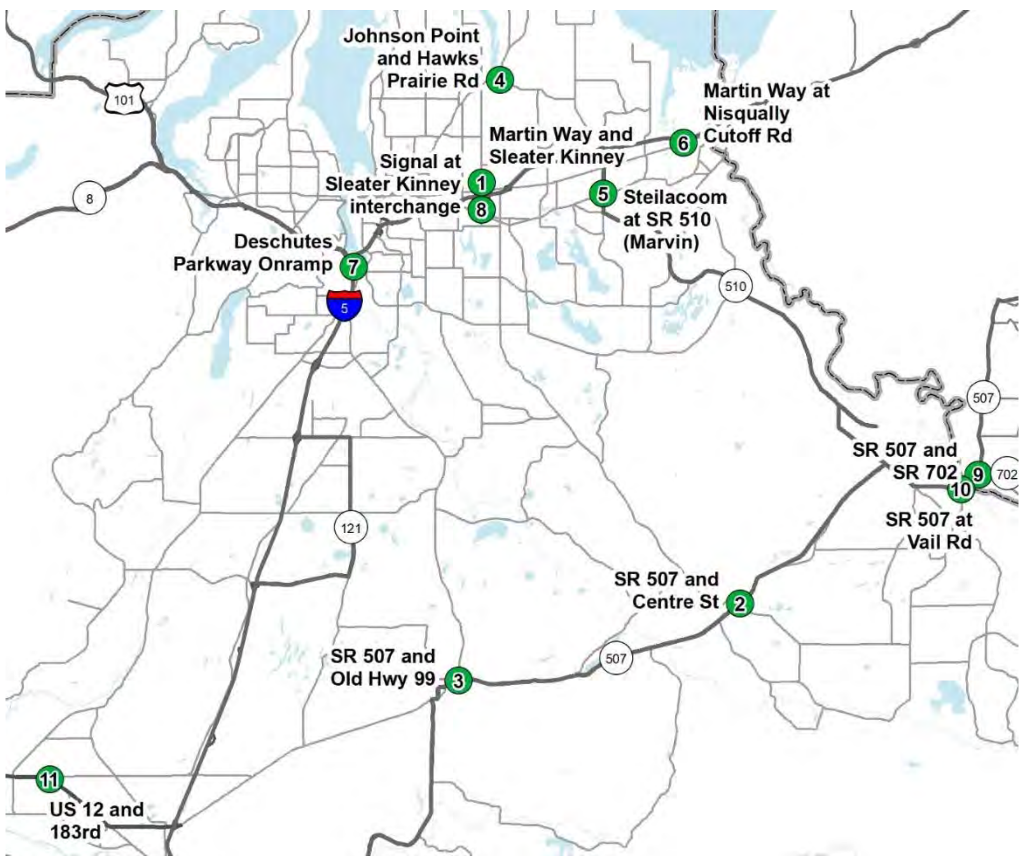


Figure 1: Operations projects map

Sustainable Thurston Land Use

The Sustainable Thurston Land Use scenario uses a 2040 land use forecast based on visionary goals from the Sustainable Thurston Plan rather than the TRPC 2040 Land Use Forecast. Similar to the adopted forecast, it was last updated in 2013. It was built with two primary targets in mind:

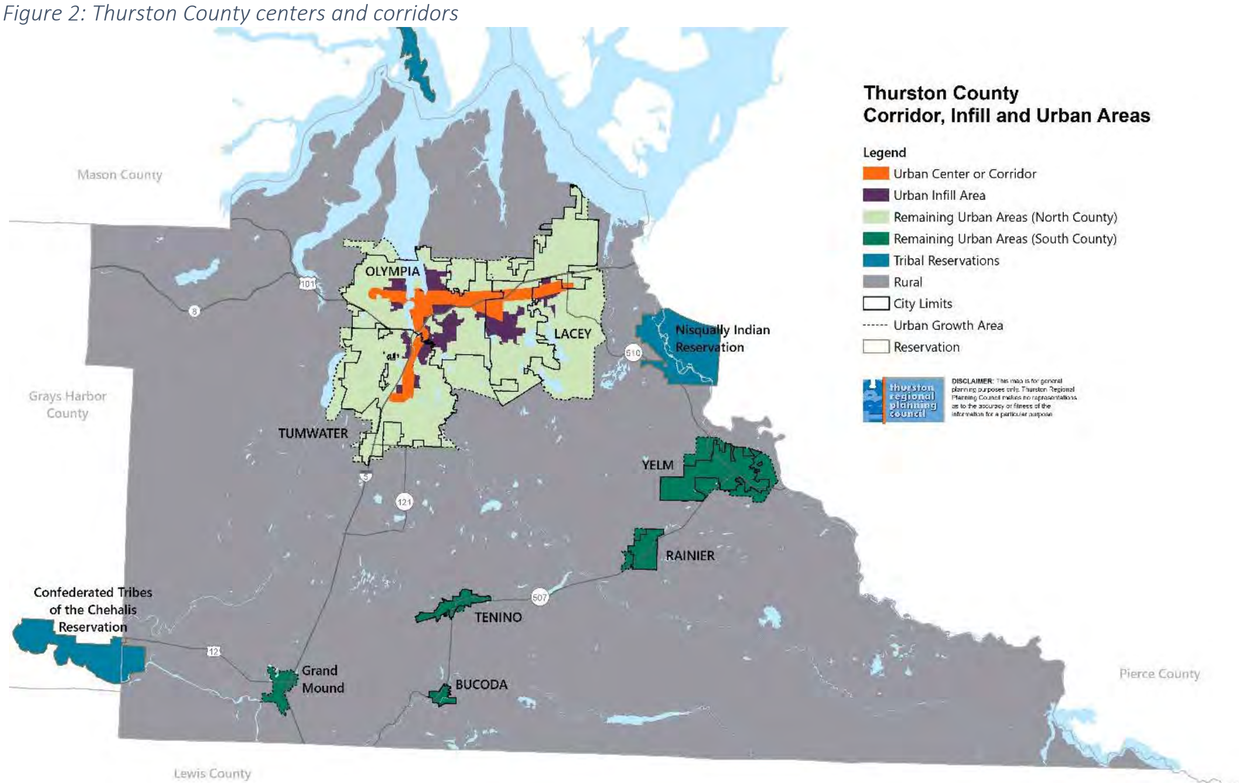
- By 2035, 72 percent of all (new and existing) households in Thurston County's cities, towns, and unincorporated growth areas will be within a half mile (comparable to a 20-minute walk) of an urban center, corridor, or neighborhood center with access to goods and services to meet some of their daily needs.
- Between 2010 and 2035, 5 percent of new housing will locate in the rural areas. Rural areas are defined as outside of the cities, towns, unincorporated urban growth areas and tribal reservations.

Some of the major elements of the Sustainable Thurston Land Use scenario include:

- Focus on creating or enhancing walkable urban city and town centers in Bucoda, Grand Mound, Lacey, Olympia, Rainier, Tenino, Tumwater and Yelm. These sorts of places create the hearts of our community, foster economic development and an innovative culture, and offer places to live, work, shop, and play.
- Transition auto-oriented corridors into a more walkable urban form and seek opportunities for housing and a mix of services and amenities. The "nodes" along the corridor can be the city centers or smaller clusters of activity at fairly regular intervals.
- Increase sustainable economic development activities. Increase commercial infill and redevelopment in city and town centers and along major transit corridors. Look for opportunities for neighborhood commercial centers where appropriate.
- Increase the range and choice of housing, especially in areas with access to goods and services such as transit. Focus on "moderate density" and accessible housing choices for neighborhoods to meet the needs of our changing demographics.
- Rethink low density residential-only zoning districts in the urban areas. These zoning districts encourage development to occur at densities too low to be serviced by transit, creating large neighborhoods that have very few transportation options, and often are far away from jobs, goods, and services.
- Use remaining urban land supply more efficiently.
    - Take a comprehensive look at the vacant land supply, especially in the unincorporated area, and remove any areas that are not suitable for urban development for environmental reasons such as high groundwater, large amounts of wetlands, or steep slopes.
    - Assess the cost of extending infrastructure to the remainder of the urban growth areas and consider the full costs of maintenance when determining appropriate areas for urban growth. Place areas of the unincorporated growth area that do not currently have urban infrastructure (sewer or water lines) or where there are no specific plans to extend infrastructure, into longer-term holding zones or lower density development.
- Increase opportunities for urban agriculture while accommodating growth.

- Take into account property rights, vesting, and reasonable use of property. With around a 10-to 12-year supply of residential lots and multifamily projects either permitted, vested, or proposed, work with property owners to ensure new development supports the preferred land-use vision when possible.
- Inventory and assess farmlands, forest lands, prairies, and other rural lands, and take steps such as re-examining rural zoning, transferring or purchasing development rights, or providing economic incentives to protect the rural character of Thurston County.

Figure 2: Thurston County centers and corridors



Travel Demand Management

The Travel Demand Management scenario consists of three elements:

- Expanded telework/compressed work week and other commute trip reduction techniques. The assumption is that this will resulting in 25 percent of employees in Government non-education and Professional Service sectors reducing travel one day a week.
- Managed parking at key employment sites, including raising the parking rate where parking is currently managed.
- New multimodal trails.

The managed parking alterative is shown in Figure 3. A list of multimodal trail projects is found in Table 2.

Figure 3: Managed parking alternative

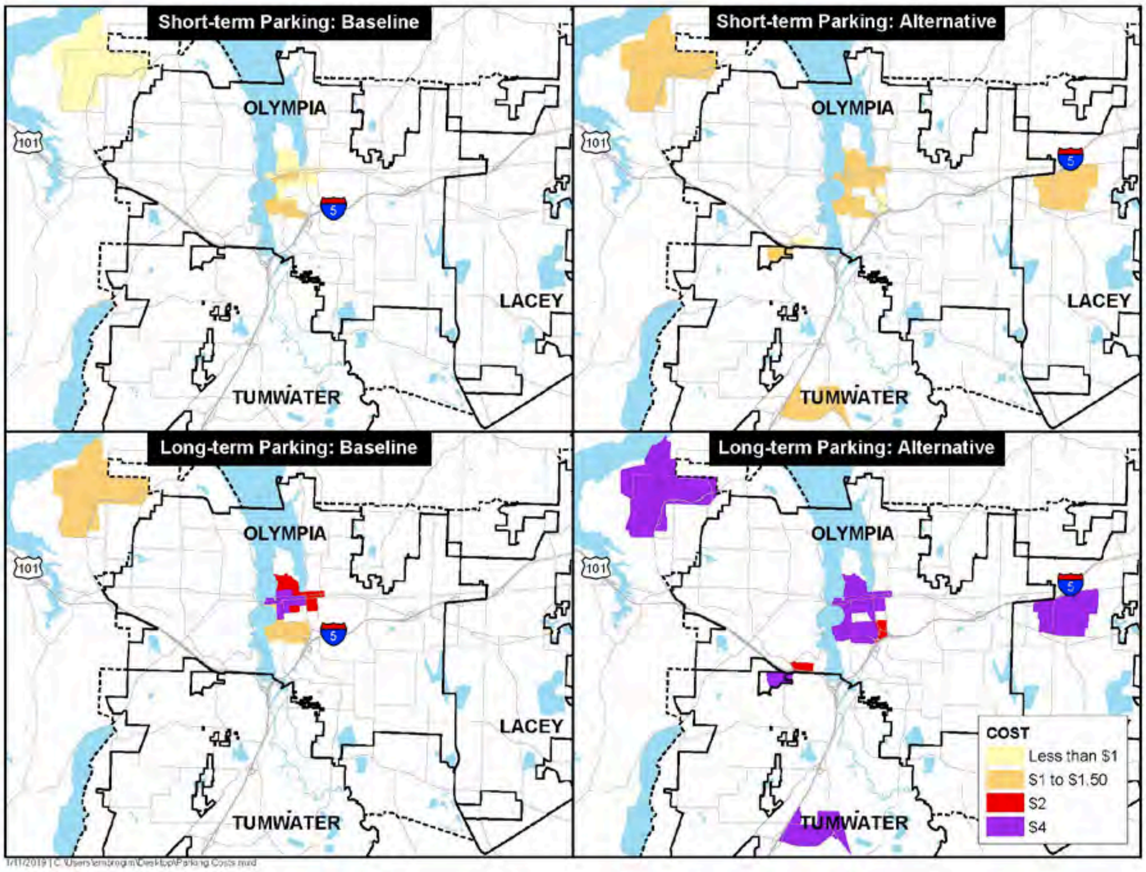


Table 2: Multimodal trail projects

Number	Area/Jurisdiction	Location	Extent/Limits	Improvement
1	Lacey and Thurston County	Karen Fraser Woodland Trail Extension	Eastern termini of trail to Marvin Road SE and McAllister Community Park (Future City of Lacey Park)	Build a shared-use Class I trail
2	Olympia	Karen Fraser Woodland Trail Phases 3 and 4	Olympia Woodland Trail, from Eastside Street to Tumwater Historical Park	Build a shared-use Class I trail
3	Thurston County	Gate-Belmore Trail	Gate-Belmore Trail, Confederated Tribes of the Chehalis Reservation/Gate to 66th Ave SW	Build a shared-use Class I trail
4	Thurston County	Yelm-Tenino Trail Extension	Extend shared-use Class I trail from Tenino to Bucoda and Tenino to West Tenino.	Extend a shared-use Class I trail
5	Thurston County	Rochester-Grand Mound Trail	Class 1 trail from Rochester to Grand Mound	Build a shared-use Class I trail
6	Tumwater	Deschutes Valley Trail	Deschutes Valley Trail, from Pioneer Park (vicinity of Henderson Boulevard) to Tumwater Historical Park (Deschutes Parkway)	Build a shared-use Class I trail
7	Yelm	Yelm Prairie Line Trail	Yelm Prairie Line Trail from Canal Road to Roy (vicinity 288th Street S)	Build a shared-use Class I trail

Transit

The Transit scenario consists of four elements:

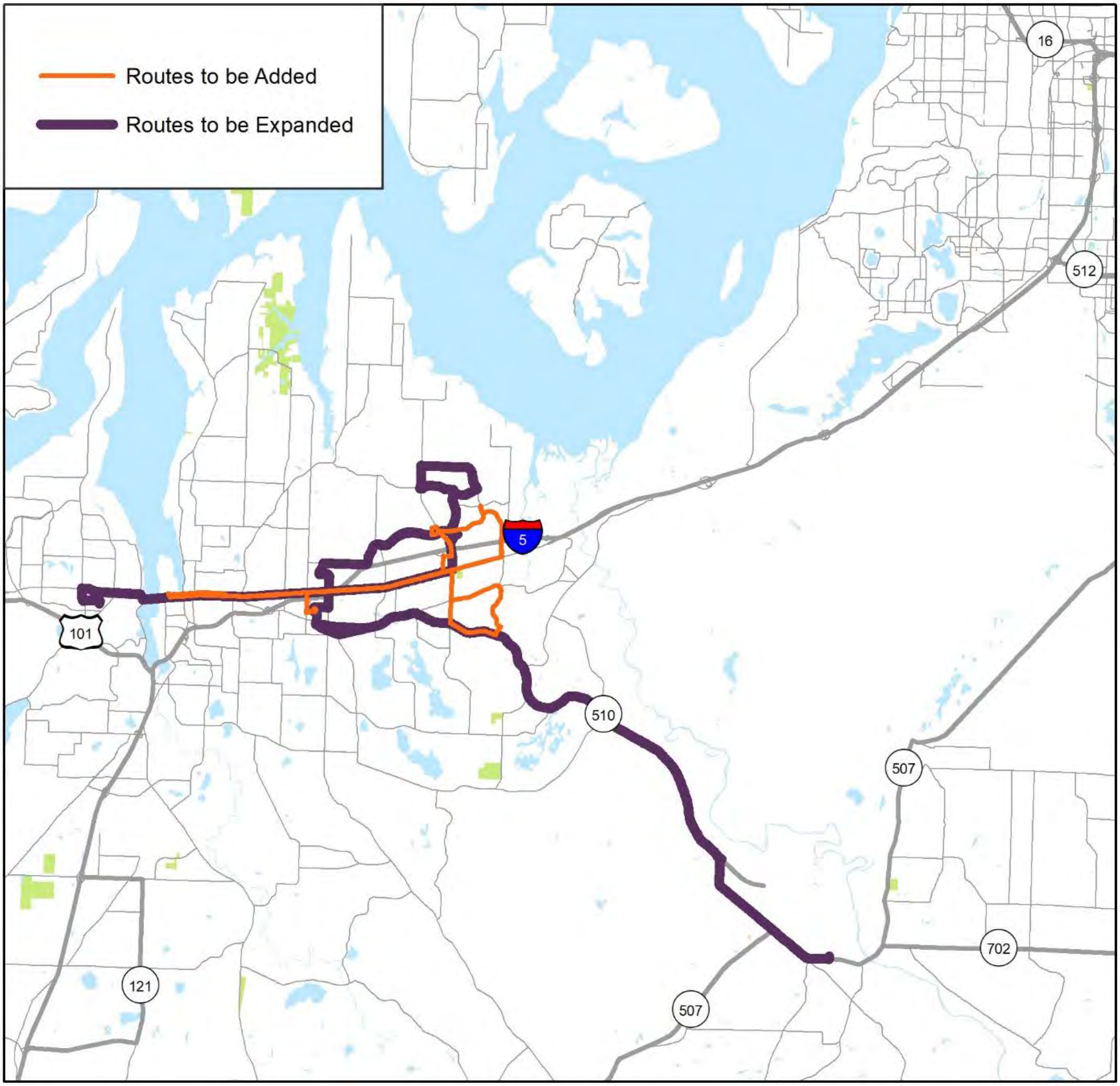
- Increased transit services per Intercity Transit's Long Range Plan.
- New transit routes (expanded service) (Figure x).
- A transit queue jump in downtown Olympia near the Olympia Transit Center.
- A projected 30% increase in transit ridership based on implementation of a variety of measures to increase transit ridership, including a Zero-Fare transit system.

A list of the elements in the Transit scenario are found in table 3.

Table 3: Transit projects

Number	Area/Jurisdiction	Improvement
1	Various	Increased transit service as per Intercity Transit's Long Range Plan: 62B Martin Way / The Meadows - A 62B Martin Way / The Meadows - B 62A Martin Way / NE Lacey - A
2	Various	New routes: NE Lacey Yelm Express Note: New Bus Rapid Transit light line (62X concept) was included in the Funded Base scenario
3	Olympia	Queue jump - remove on-street parking on the north side of State Ave between Franklin and Washington (south side of the Olympia Transit Center). Convert the lane to a "Bus Only" zone which will allow the new Bus Rapid Transit light route to service the transit center without the need to enter the site. Install queue jump on the westbound direction of the State Ave and Washington Street signal. Signals will be adjusted to detect a bus leaving the "bus only" zone and provide an exclusive westbound green light for the bus to exit the zone without needing to merge back into traffic.
4	Countywide	Implement a variety of measures to increase transit ridership, including a Zero-Fare transit system. A Transit Cooperative Research Program Study, Implementation and Outcomes of Zero-Fare Transit Systems (2012) estimates that such programs will result in approximately a 30 percent increase in transit ridership.

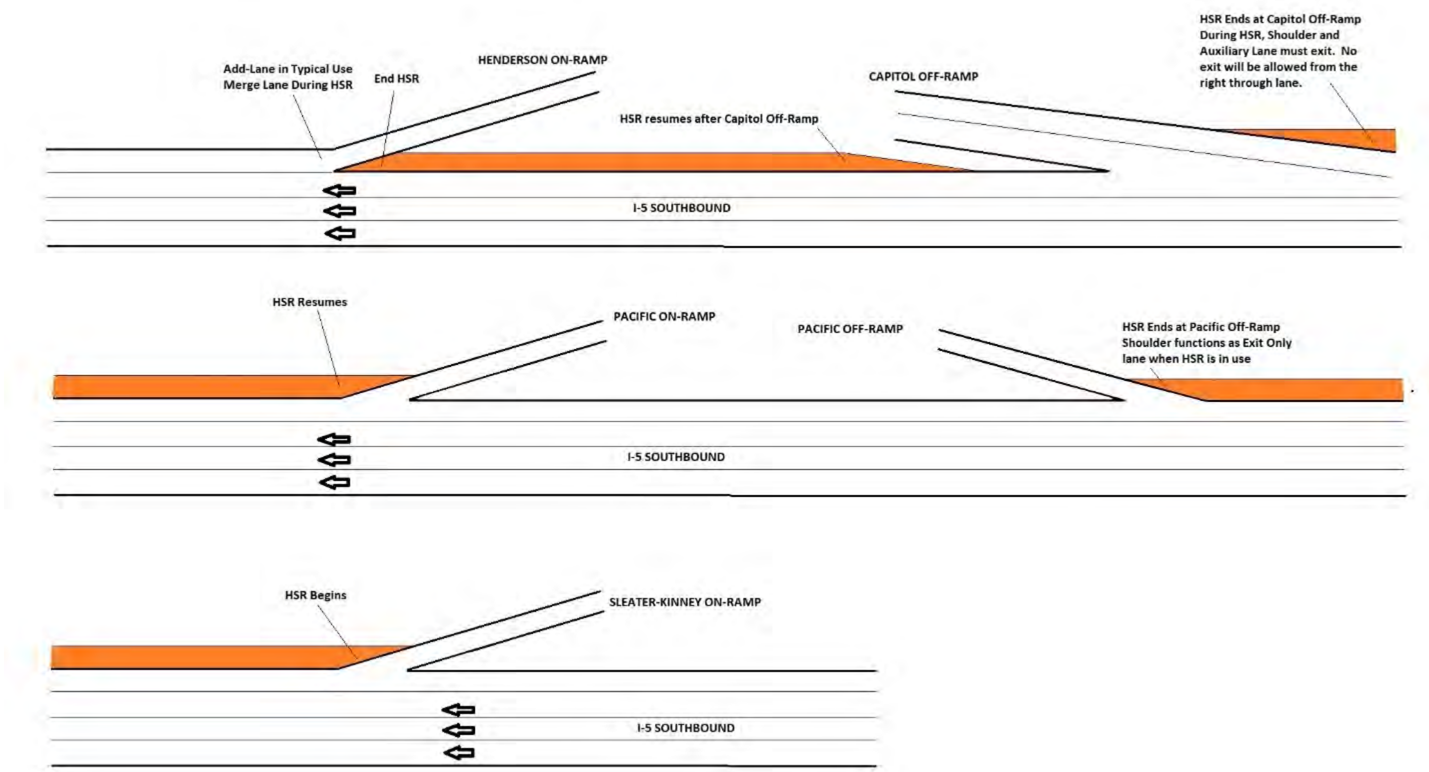
Figure 4: Expanded transit service concept



Part Time Shoulder Use

The Part Time Shoulder Use scenario consists of allowing travel on the existing shoulder in the south-bound direction of I-5, between the Sleater-Kinney on-ramp and the Henderson on-ramp (Figure 5.)

Figure 5: Hard shoulder running concept



High Occupancy Vehicle Lane Conversion

The High Occupancy Vehicle (HOV) Lane Conversion scenario consists of four major elements:

- Converting an existing general capacity lane to HOV.
- Adding HOV queue jumps at select on-ramps with ramp meters.
- Increasing express transit service frequency.
- Adding new park-and-ride lots or expanding capacity in existing park-and-ride lots.

Specific improvements are outlined in Table 4.

Table 4: HOV Conversion scenario elements

Number	Area/Jurisdiction	Improvement
1	I-5	Convert inside lane in both northbound and southbound directions starting at milepost 104.2 and through Pierce County to the new HOV lanes

2	I-5 Intersections	Add HOV queue jumps at Martin Way northbound and Plum Street northbound. A Trosper interchange queue jump will be added in the Interchange scenario.
3	I-5	Increase express service to 15-minute frequency (between the various lines)
4	Various	Add new park-and-ride lots and increase capacity at existing park-and-ride lots. New park-and-ride lots: West Olympia (near the transit station at Capital Mall) South Tumwater (near Town Center) Tillicum (near the new Sound Transit stop)

Local Network

The Local Network scenario consists of unfunded non-interstate local and state road and street projects included in the 2040 Regional Transportation Plan, and at the time of the modeling anticipated to be included in for the 2045 Regional Transportation Plan (RTP), as well as several projects on the local network identified by the Technical Advisory Group members. Projects consist of:

- Street and road capacity projects (new lanes, center turn lanes, medians and roundabouts).
- Street and road extensions.
- Additional operational improvements.

Specific improvements are outlined in Table 5. Further details on most of the projects can be found in the RTP, available on TRPC's website.

Table 5: Local Network scenario elements

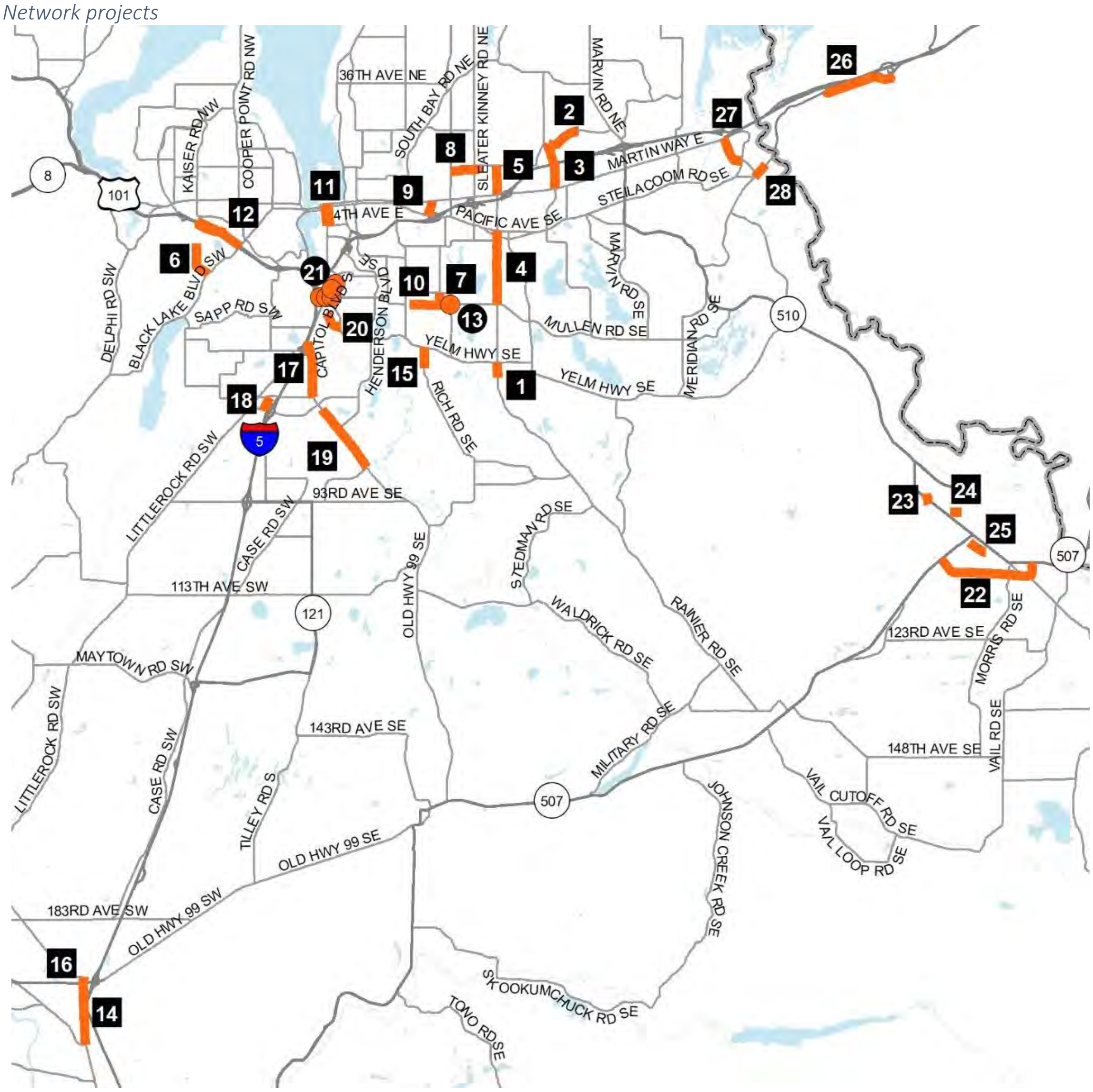
Number	Area/ Jurisdiction	Location	Extent/Limits	Improvement
1	Lacey	Rainier Road	Rainier Road, from Yelm Highway to around 62nd Ave SE	Widen Rainier Road to 4/5 lane arterial from Yelm Highway to the old south city limits near 62nd Ave SE. Bike lanes and sidewalks.
2	Lacey	Britton Parkway	Britton Parkway, Gateway Boulevard to Carpenter Road	Add one general purpose lane in each direction.
3	Lacey	Carpenter Road	Carpenter Road, Martin Way to Britton Parkway	Widen Carpenter Road to 4/5 lanes with medians, bicycle lanes, planter strips and sidewalks.
4	Lacey	College Street Corridor	College Street, Lacey Boulevard to 37th Ave/Mullen Road	Construct 2 new roundabouts at 16th Ave and 29th Ave. Roundabout at College and 22nd was in the funded base. Widen to 4 lanes with center medians between roundabouts. Add sidewalks and other urban amenities.

Number	Area/ Jurisdiction	Location	Extent/Limits	Improvement
5	Lacey	College Street NE Extension from Martin Way to 15th Ave NE	College Street NE, from Martin Way to 15th Ave NE	Extend College Street north from 6th Ave NE to 15th Ave NE, with significant re-channelization from Martin Way to 6th Ave. The improvements will include bicycle lanes and sidewalks.
6	Olympia	Kaiser Road	Kaiser Road, from 16th Ave SW to Black Lake Boulevard	Extend Kaiser Road south and east to Black Lake Boulevard. Bike lanes and sidewalks.
7	Olympia	Hoffman Road	Hoffman Road, from Morse-Merryman Road to the Log Cabin Road Extension.	Extend Hoffman Road from Morse-Merryman Road to the Log Cabin Road Extension with a 2/3 lane major collector. Bike lanes and sidewalks.
8	Olympia	12th/15th Ave	12th/15th Ave NW, from Lilly Road to Sleater Kinney Road	Extend 12th Ave from Lilly Road to Sleater Kinney Road with a 2/3 lane major collector. Bike lanes and sidewalks.
9	Olympia	Ensign Road	Ensign Road, from Martin Way to Pacific Ave SE	Construct new 2/3 lane major collector connection between Martin Way (at Ensign) and Pacific Ave (west of I-5 southbound off-ramps). Bike lanes and sidewalks.
10	Olympia	Log Cabin Road	Log Cabin Road, from Boulevard Road to Wiggins Road, connecting at 37th Ave/Herman Road	Extend Log Cabin Road from Boulevard Road to Wiggins Road with a 2 lane major collector boulevard. Construct a roundabout at Wiggins Road and 37th Ave. Bicycle and pedestrian facilities on a shared-use path. Add a 4th leg to the existing roundabout at Log Cabin Road.
11	Olympia	Capitol Way and Washington Ave	Union Ave to State Street	Capitol Way to a three lane section Washington one-way
12	Olympia	US 101/West Olympia Access	US 101 and Kaiser Road; Yauger Way, between Kaiser Road and Yauger Way in the vicinity of US 101	Add a westbound off-ramp and eastbound on-ramp from US 101 to Kaiser Road. Widen the Kaiser Road bridge to accommodate a 3 lane section. Add westbound ramp to Yauger Way from Black Lake Boulevard Interchange.
13	Olympia (Not an RTP Project)	Herman Ave and Wiggens Road	Intersection	Roundabout.
14	Thurston County	Old Highway 99 SW	Old Highway 99, from US 12 to 210th Ave SW	Widen Road to 4/5 lanes, urban improvements, access management, and intersection improvements.

Number	Area/ Jurisdiction	Location	Extent/Limits	Improvement
15	Thurston County	Rich Road Capacity Project	Rich Road SE, Yelm Highway SE to 60th Ave SE	Widen Road to 3/5 lanes, urban improvements, access management, and intersection improvements.
16	Thurston County	Elderberry Road	Elderberry Road, SR 12 to 196th Ave	Widen Elderberry Road to 4/5 lanes, urban improvements, access management, intersection improvements at 196th and SR12, and improved transitions to adjoining roadways.
17	Tumwater	Capitol Boulevard – M Street to Israel Road	Capitol Boulevard, Trosper Road to Israel Road	Roundabouts on Capitol Boulevard at Trosper Road, T Street, X Street, and Dennis Street; replace the center turn lane with a median. Add bike lanes.
18	Tumwater	Tyee Drive	Tyee Drive, Israel Road to Tumwater Boulevard	Extend Tyee Drive from Israel Road to Tumwater Boulevard. One lane in each direction. Bike lanes and sidewalks.
19	Tumwater	Old Highway 99	Old Highway 99 SE, from 73rd Ave to 88th Ave	Widen Old Highway 99 to 4/5 lanes. Bicycle lanes and sidewalks.
20	Tumwater	E Street Extension	Cleveland Ave and Capitol Boulevard	Construct a new multiple lane roadway with bicycle lanes.
21	Tumwater	Brewery District Transportation Project	Capitol Boulevard, Custer Way, and Cleveland Ave, Capitol/Custer to Custer/Cleveland to Cleveland/Capitol	Build 5 roundabouts: Custer at Boston, Custer at Capitol, Custer at Cleveland, Capitol at Carlyon, and Capitol at Cleveland. Reconfigure the roadway sections between the roundabouts. Add bike lanes and sidewalks.
22	WSDOT	510/507 Loop – South Section (Y2)	SR 507 Spur-Yelm Loop from vicinity of 105th Ave SE-Palisades Street (Milepost 27.39) to Walmart Boulevard SE (Milepost 29.72)	Construct a new 2/3 lane, limited access route in the southeast portion of Yelm providing an alternate route for through traffic. Assume bicycle lanes and sidewalks.
23	WSDOT and Yelm	Burnett/93rd Intersection - Realignment & Traffic Signal	Realignment of both Burnett Road and 93rd Ave to align with each other at SR510	Add a traffic signal; realign both Burnett Road and 93rd Ave to align with each other at SR510.
24	Yelm	Coates Ave	Coates Ave SW, from Cullen Road NW to Killion Road SE	New commercial collector connection with 2 lanes and a left turn lane at the Coates/Killion intersection. Bike lanes and sidewalks.
25	Yelm	Mosman Ave SE (Phase 3)	Mosman Ave SE, from 2nd Street SE to Clark Road SE	Reconstruct 2 lane Mosman Ave SE from 2nd Street SE to 4th Street SE, and extend Mosman from 4th Street SE to Clark Road SE. Add bike lanes and sidewalks.

Number	Area/ Jurisdiction	Location	Extent/Limits	Improvement
26	WSDOT/JBLM (Not an RTP Project)	Perimeter Road	Mounts Road to Center Drive	Remove gate at Mounts Road and Perimeter Road to open to general traffic; add gate at Perimeter Drive and Center Drive; add a southbound lane to Center Drive connecting over the weigh station ramp.
27	Thurston County (Not an RTP Project)	Kulman Road	Nisqually cut off road to Nisqually Interchange	Extend Kulman Road from Nisqually cutoff to Martin Way Interchange at Nisqually. Dead end Nisqually-cut off road. Roundabout at interchange. 2-way stop on Nisqually cut-off road.
28	Thurston County (Not an RTP Project)	Old Pacific Highway SE	7th Ave to 6th Ave	Turn lanes and a green tee, and maybe a two way left turn lane.

Figure 6: Local Network projects



Interchange Improvements

The Interchange Improvement scenario consists of interchange projects that aren't included in previous scenarios.

Specific improvements are outlined in Table 6.

Table 6: Interchange scenario elements

Number	Area/Jurisdiction	Location	Improvement
1	WSDOT	Mounts Road Interchange	Roundabouts on both the northbound and southbound ramps. Move ramp meter slightly on southbound on-ramp.
2	Lacey	Martin Way Interchange	Partial cloverleaf interchange.
3	Olympia	Pacific Ave Interchange	Lane to northbound off ramp.
4	WSDOT	US 101 Interchange	Exit at Plum Street to access braided ramp southbound.
5	WSDOT	US 101 and I-5	Add a hard shoulder running lane between the Deschutes Way off ramp and the US 101 off ramp.
6	Tumwater	Trosper northbound on-ramp	Add HOV lane ramp segment in cloverleaf northbound. Add ramp meter.
7	Tumwater	Tumwater Boulevard Interchange	Realign and rebuild ramps, and extend Tumwater Boulevard to match points beyond ramps. Increase travel lanes from 3 to 4 lanes on Tumwater Boulevard and bridge over I-5, install 2 roundabouts at the ramp connections and modify and improve ramps to freeway.

Figure 7: Interchange projects

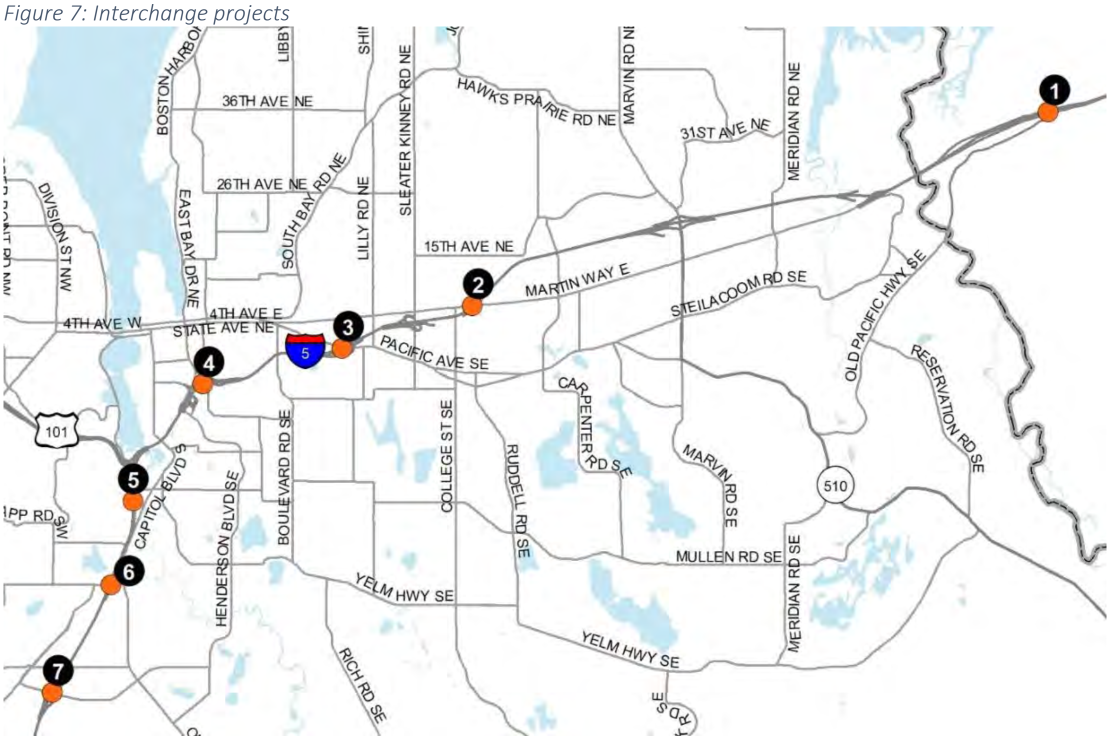
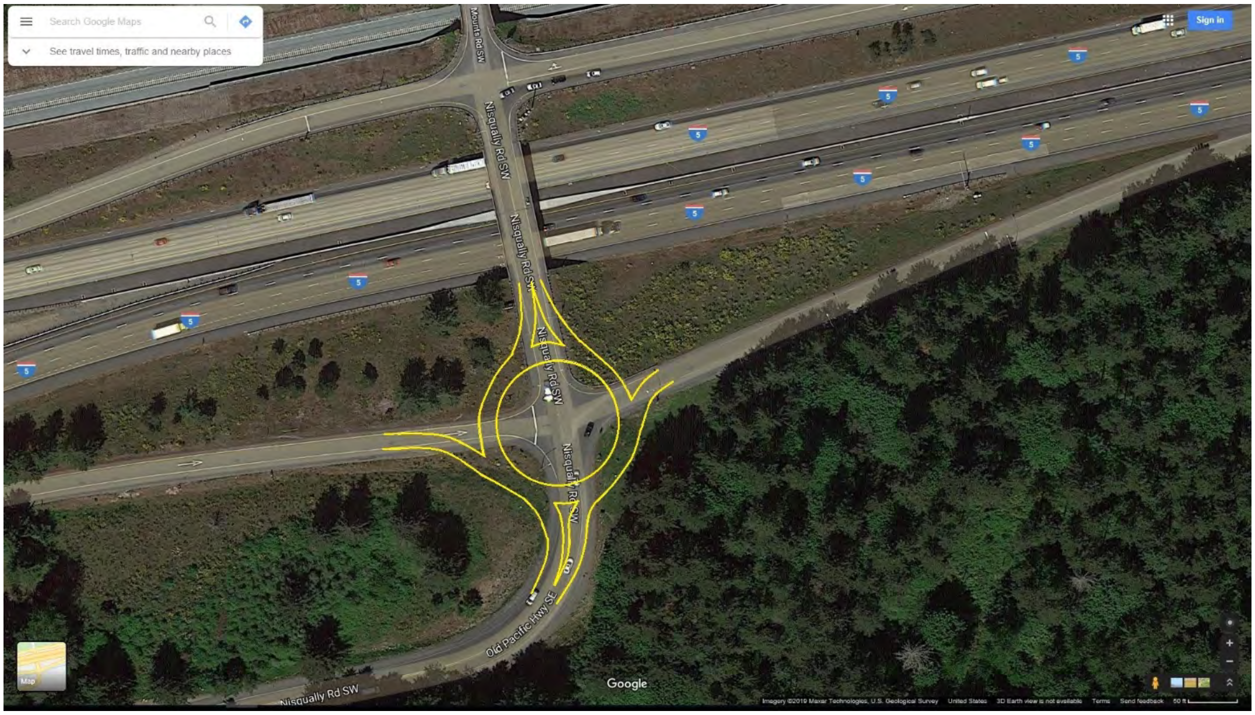


Figure 8: Interchange Improvements Project One - Mounts Road Interchange

Northbound Ramps



Southbound Ramps

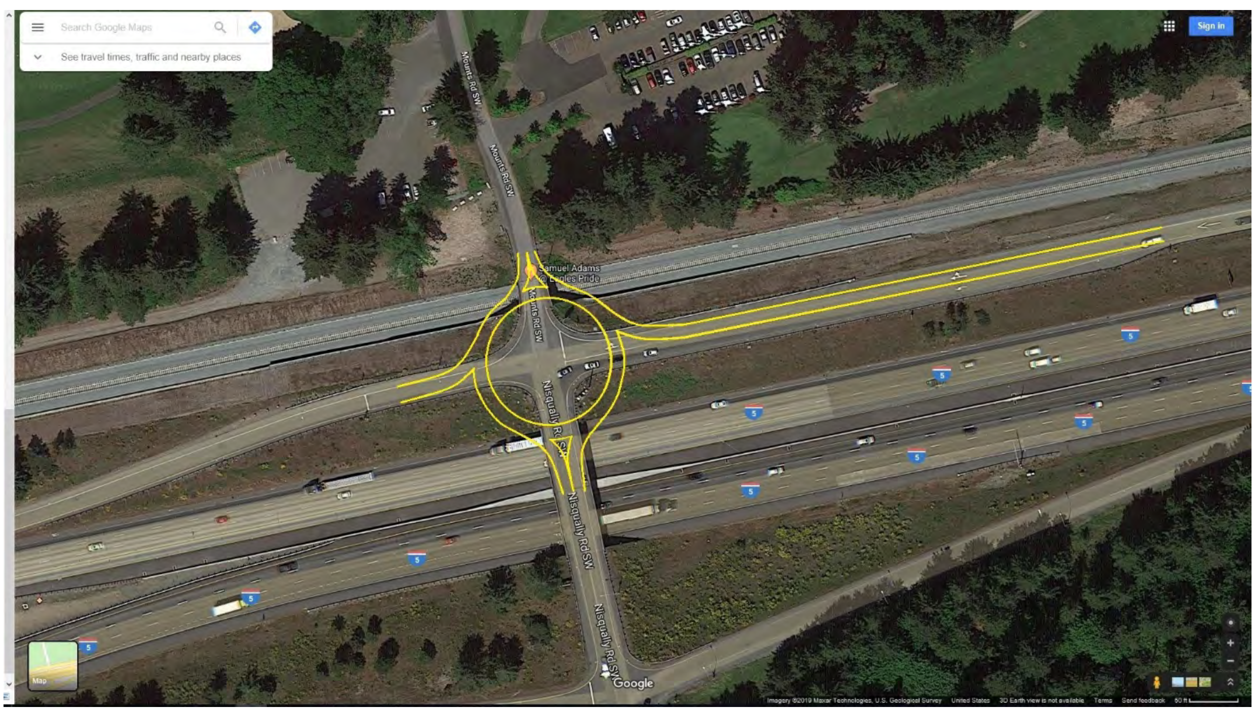


Figure 9: Interchange Improvements Project Two - Pacific Avenue Interchange

Figure 10: US 101 Braided Ramp


Legend
New Roadways
Retaining Wall
Pedestrian Path
New Bridge
New Ramp from SB I-5 to US 101
New bridge over existing on-ramp to I-5 and Henderson Blvd
New bridge over railroad


Legend
New Roadways
Retaining Wall
Pedestrian Path
New Bridge
New bridge over railroad
New Ramp from SB I-5 to US 101

Figure 11: US 101 Northbound Hard Shoulder Running

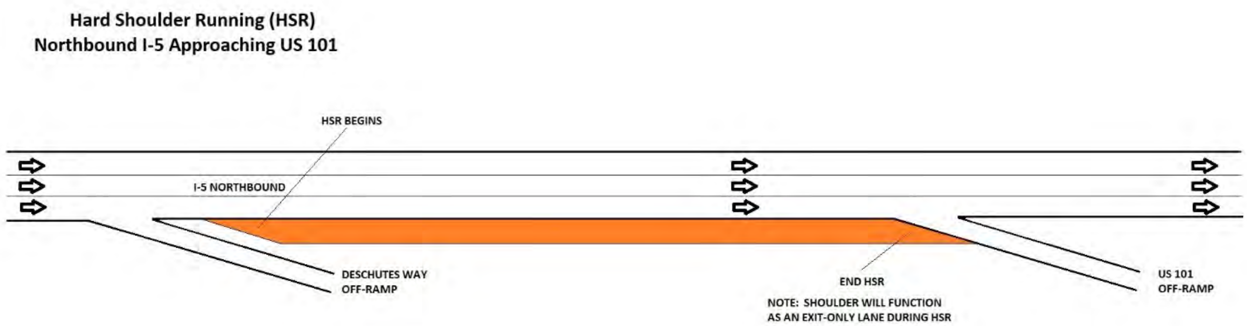


Figure 12: Trosper Road Interchange

Capacity Expansion I-5 –Add General Purpose Retain HOV Lane

The Capacity Expansion – I-5 Managed Lanes scenario consists of adding one additional vehicle travel lane (while retaining the HOV lane) to I-5 in two sections:

- Between 38th Street and Thorne Lane (Pierce County), including a reconstruction of the SR 512/I-5 Interchange.
- Between Mounts Road and US 101. This scenario retains the I-5/US 101 Braided Ramp interchange option in lieu of a fourth lane on the main line in the southbound direction.
- Add auxiliary lanes.
- Add a flyover exit ramp from I-5 northbound to US 101.

Table 7: Capacity Expansion I-5 – Add General Purpose Retain HOV Lane scenario elements

Number	Area/Jurisdiction	Location	Improvement
1	WSDOT	Thorne Ave to 38th Ave	Add a general use lane, and retain the HOV lane as the inside lane.
2	WSDOT	SR 512 Interchange	Convert this interchange to a diverging diamond configuration.
3	WSDOT	Mounts Rd to Thorne Ave	As in the HOV conversion, use existing inside lane as HOV lane
4	WSDOT	Deschutes on-ramp to Mounts Road	Add an HOV lane (add a lane, but retain the HOV lane as the inside lane). Replace the hard shoulder where it exists.
5	WSDOT	I-5 Southbound - Pacific Ave to Plum St off-ramp	Add an auxiliary lane between Pacific Avenue and Capitol Way.
6	WSDOT	I-5 Northbound US 101 on-ramp to Pacific Ave off-ramp	Add an auxiliary lane from US 101 on-ramp to 14th Avenue off-ramp, and from Plum Street on-ramp to Pacific Avenue off-ramp.
7	WSDOT	I-5 Northbound at US 101 - flyover ramp	Add a flyover off ramp linking NB I-5 to WB US 101, and merging in on the outside lane of US 101. Retain the Deschutes Parkway on-ramp to provide access from the local network to US 101.

Figure 13: Existing and future I-5 lane configuration from 38th Street to Thorne Lane

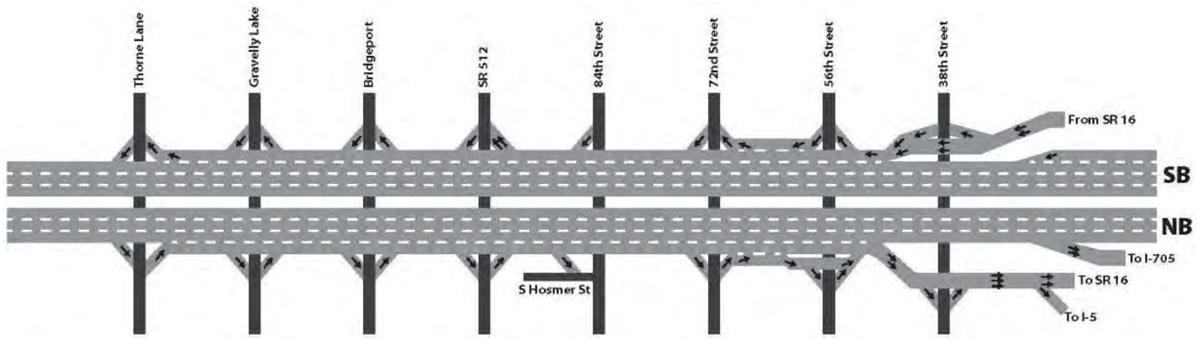


Figure 2: Existing I-5 Lane Configuration

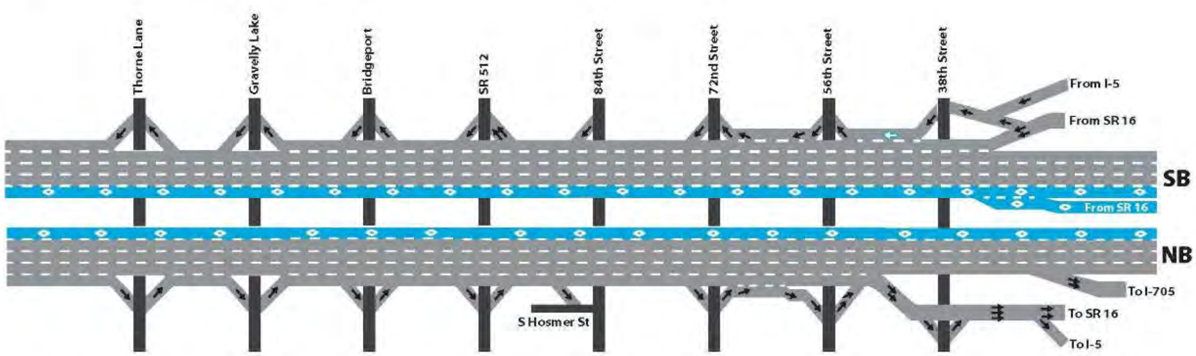


Figure 3: Future Baseline I-5 Lane Configuration

Figure 14: Diverging diamond interchange at SR 512 and I-5

Figure 15: Future I-5 lane configurations from Mounts Road to US 101 Interchange - southbound

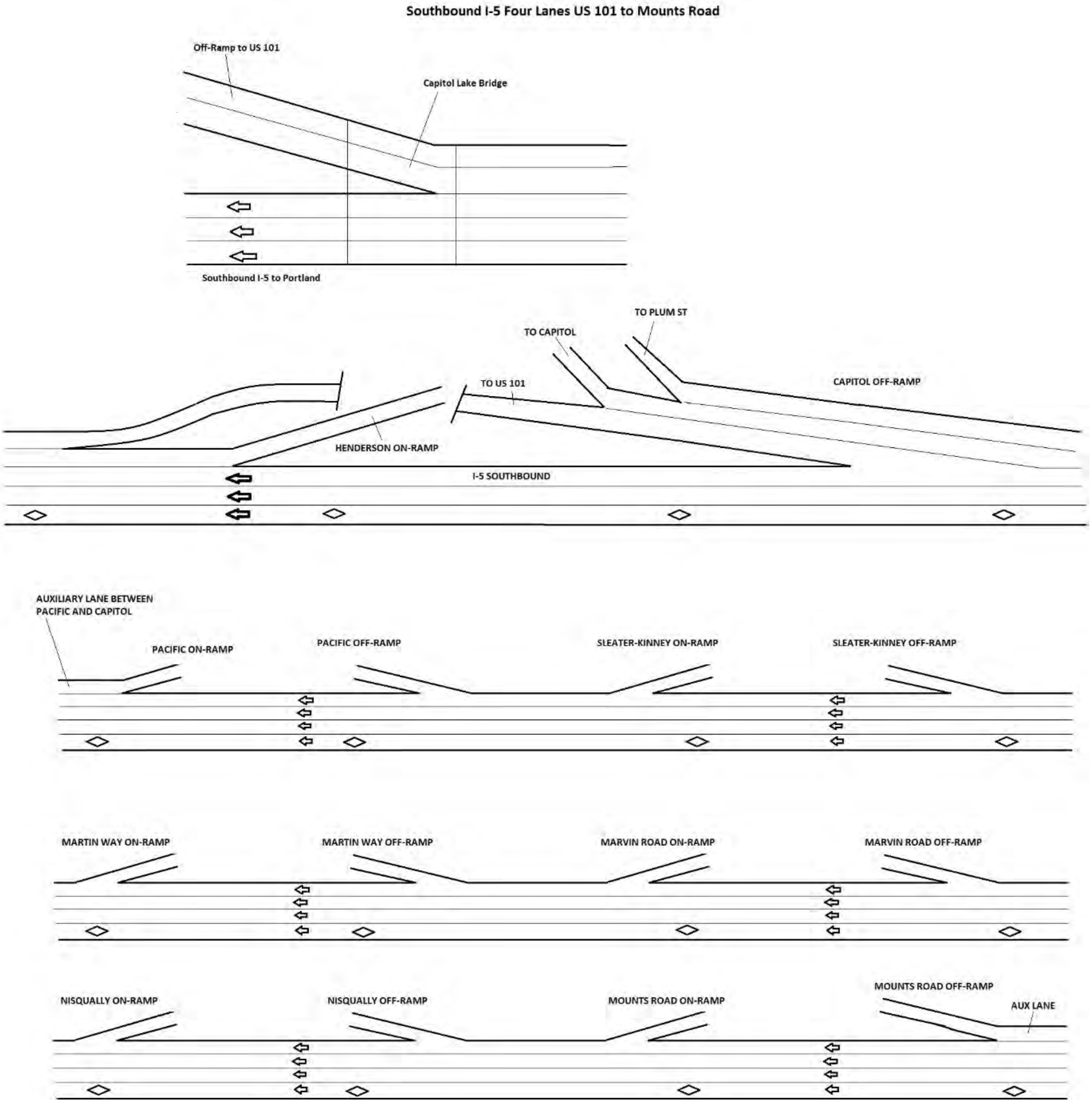


Figure 16: Future I-5 lane configurations from Mounts Road to US 101 Interchange – northbound

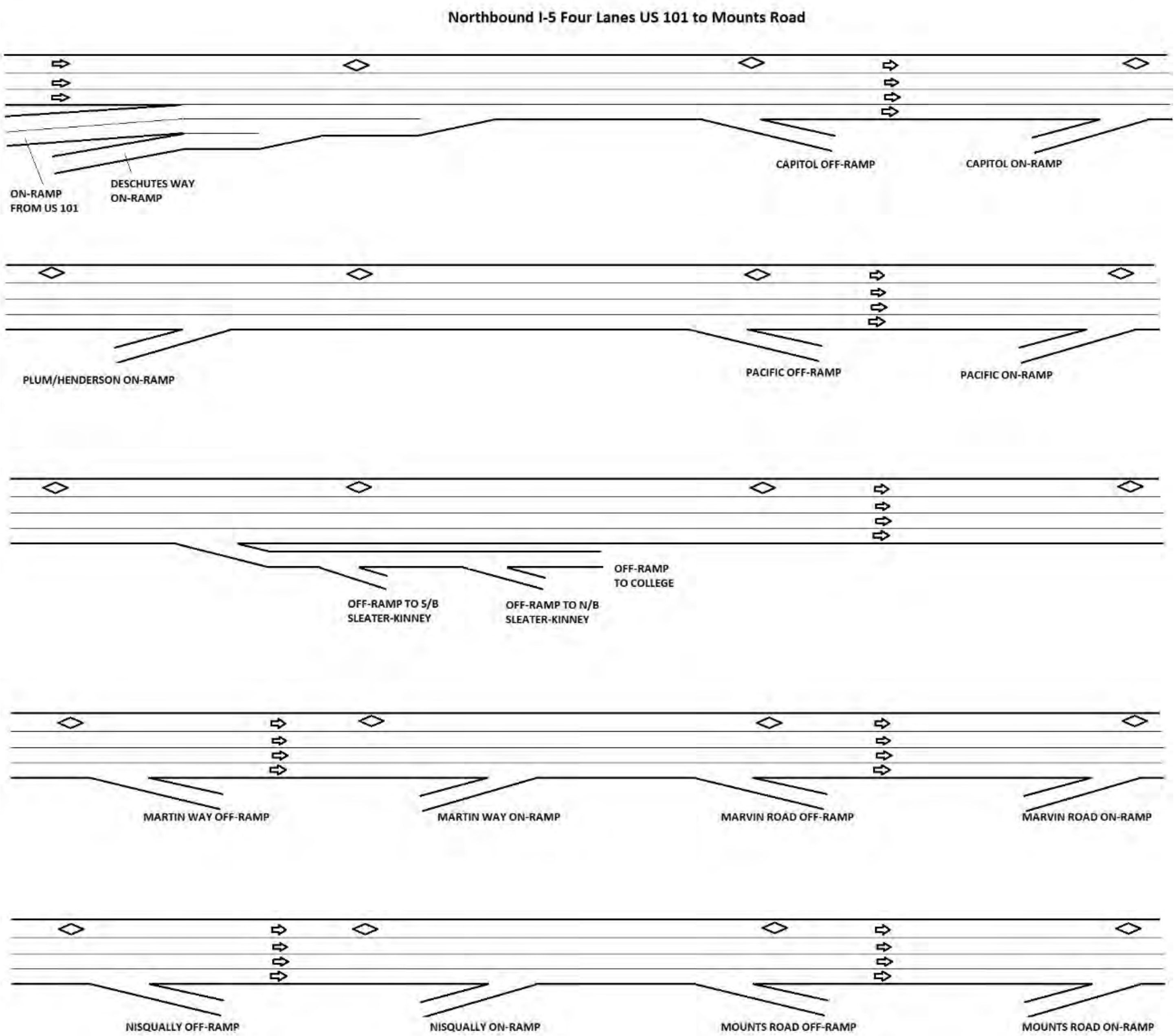


Figure 17: Northbound I-5 auxiliary lane between US 101 on-ramp and 14th Avenue off-ramp

Figure 18: Northbound I-5 auxiliary lane between Plum Street on-ramp and Pacific Avenue off-ramp

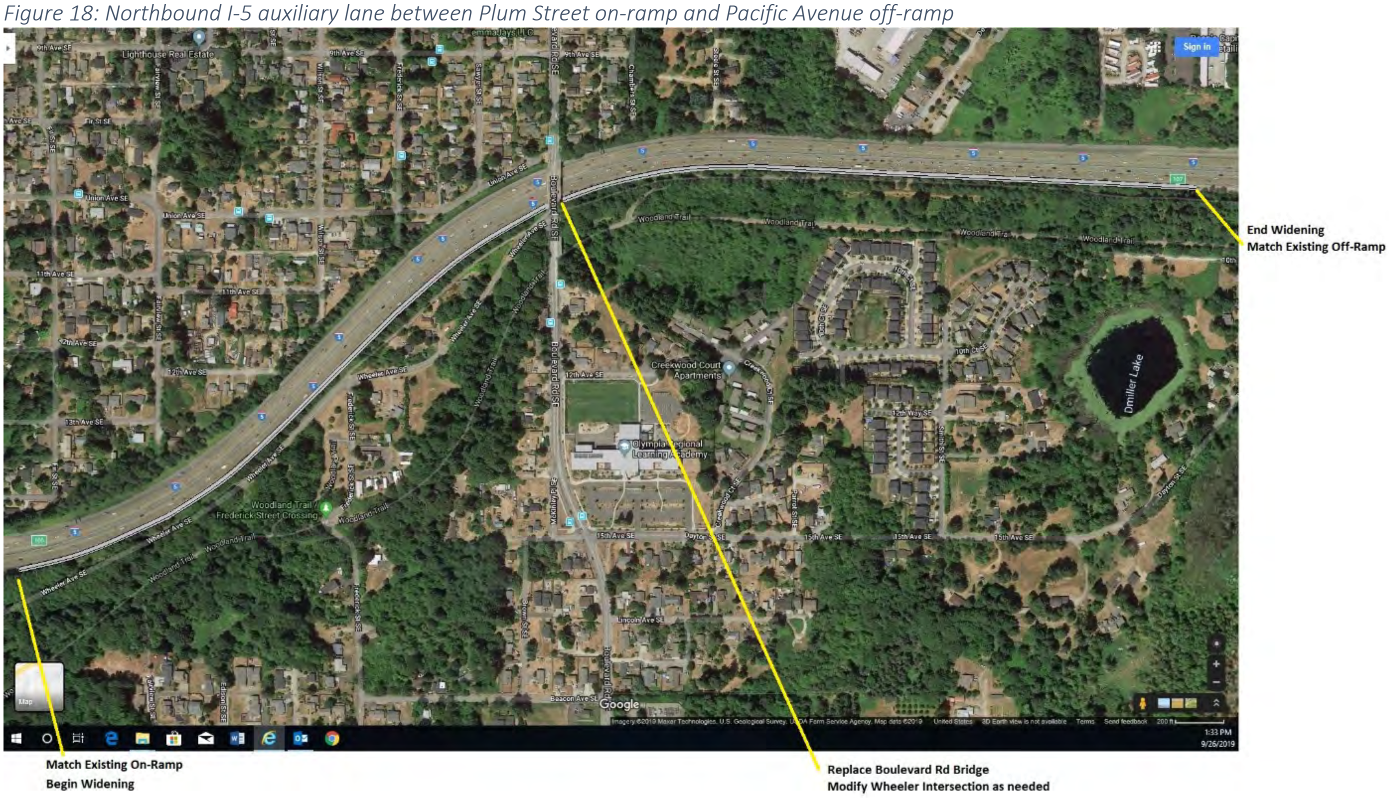
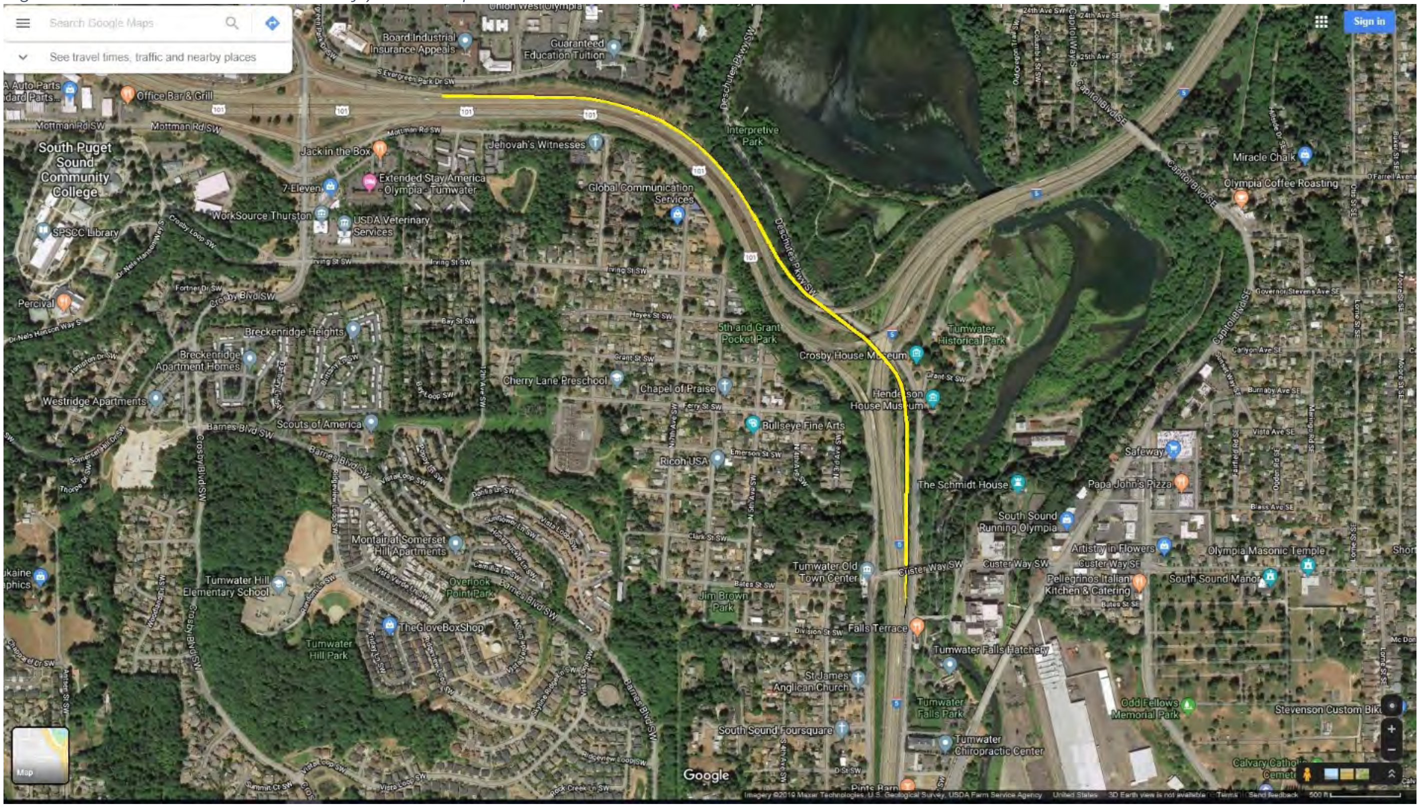


Figure 19: I-5 northbound at US 101 flyover ramp



Capacity Expansion - I-5- Add General Purpose Remove HOV Lane

The Capacity Expansion – I-5 General Purpose Lanes scenario consists of the same elements as the previous scenario, with the HOV lane on I-5 converted to a general purpose lane.

Performance Measures Overview

The table below lists all of the performance measures used in the I-5 Tumwater to Mounts Road Planning Study organized by goal area. Subsequent pages will provide additional detail about each performance measure.

Study goal area	Performance measures	Desired outcome
Improve travel times on I-5 and make them more predictable	• Travel times along I-5 between SR 121 (exit 99) and Main Gate (exit 120)	Reduce travel times
	• Maximum throughput travel time index (MT^3I) for I-5 in the study area for all traffic and HOV	Achieve an MT^3I of 1, this means the corridor is operating at peak efficiency for moving vehicles
Increase the transportation system's ability to efficiently and equitably move all people and goods	• Number of people moved during peak periods on I-5 for all traffic and HOV	Increase person throughput
	• Travel mode split in Thurston County between driving alone, carpooling, vanpooling, transit, walking, and biking.	Decrease percent of trips made by driving alone
	• Total vehicle miles traveled in Thurston County	Decrease total vehicle miles traveled
	• Percent of traffic on I-5 traveling through the corridor rather than entering or exiting the highway	Increase the "through traffic" percentage on I-5
	• Access to jobs and commercial services for Environmental Justice[1] populations by driving alone, HOV, and transit.	Increase access to jobs and commercial services for Environmental Justice populations
Improve access to job sites, commercial services, and industrial areas	• Access to jobs and commercial services by driving alone, HOV, and transit	Increase access to jobs and commercial services
	• Travel times on local roads that connect I-5 to industrial areas (freight access routes)	Decrease travel times on freight access routes
Protect and enhance the environment including reducing the transportation-related impact on fish and wildlife habitat in the Nisqually River Delta.	• Total greenhouse gas emissions in Thurston County	Decrease greenhouse gas emissions
Improve the transportation system's ability to operate during and recover from disruption.	• Advisory group evaluation comparing which strategies "improve the availability and/or capacity of alternate routes to I-5.	Increase availability or capacity of alternate routes to I-5
	• Travel times on alternate routes to I-5 through the study area.	Decrease travel times on alternate routes to I-5

1 WSDOT's Environmental Manual Chapter 458.02 – Environmental Justice; https://www.wsdot.wa.gov/publications/manuals/fulltext/M31-11/458.pdf#page=3
WSDOT's Community Engagement Plan – "Environmental Justice at WSDOT"; https://www.wsdot.wa.gov/sites/default/files/2017/02/28/FinalCEP2016.pdf#page=15
The study team analyzed access to jobs and services for minority populations, households experiencing poverty, households with disabled individuals, and households with no vehicle.

Corridor Travel Time

Corridor travel time measures the average time it takes to travel through selected routes in the study area in the peak direction, including Interstate 5 and two parallel routes, during the three hour peak periods in the morning and evening.

Unit of measure: Minutes

What it means: This performance measure shows the change in travel time compared to the prior scenario in the modeling order. The desired outcome for this measure is a decrease in travel time on Interstate 5 and parallel routes.

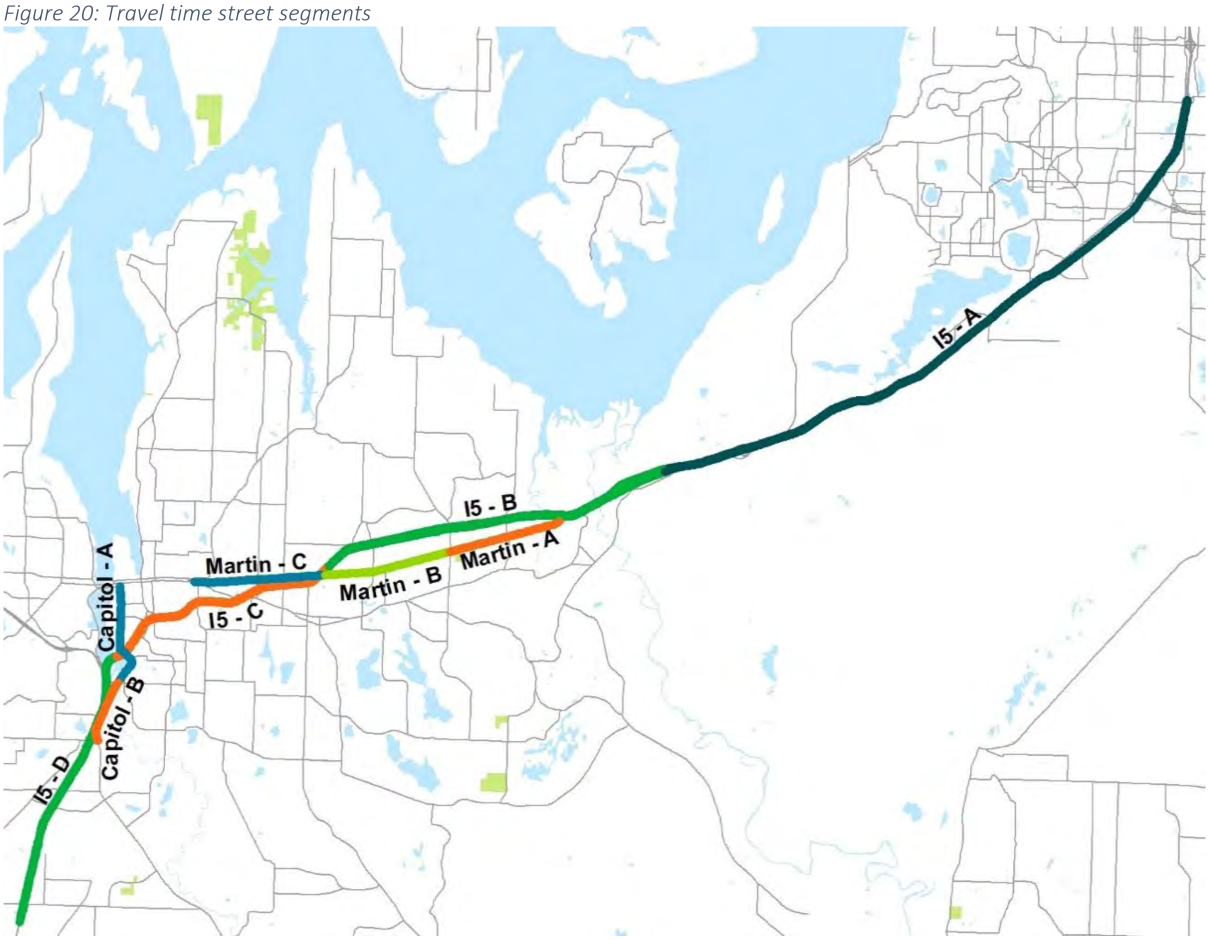
Time period: Peak period – either 6 am to 9 am or 4 pm to 7 pm

Geographic extent:

The study team used travel times for the corridors listed below. In addition, those corridors were broken down into segments so the study team and partners could analyze where strategies were making improvements. See the map below for the extent of these segments:

- Interstate 5 between 93rd Ave/SR 121 and the Main Gate Interchange south of Tumwater and near Lakewood.
- Martin Way between Nisqually Cutoff Road east of Lacey and Pacific Avenue in Olympia.
- Capitol Way/Boulevard between 4th Avenue East in Olympia and Trosper Road in Tumwater.

Figure 20: Travel time street segments



Source of Data: Regional Dynameq Model.

Additional Information:

Maximum Throughput Travel Time Index

The maximum throughput travel time index (MT^{3}I) measures travel times on a roadway compared to its most efficient operating speed. WSDOT uses maximum throughput speed (the speed at which the largest number of vehicles can pass through a roadway segment) as the baseline speed for congestion and capacity performance measurement on highways. Maximum throughput is achieved on highways when vehicles travel at 70% to 85% of the posted speed limit (42 to 51 mph for a 60 mph speed limit). As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity.

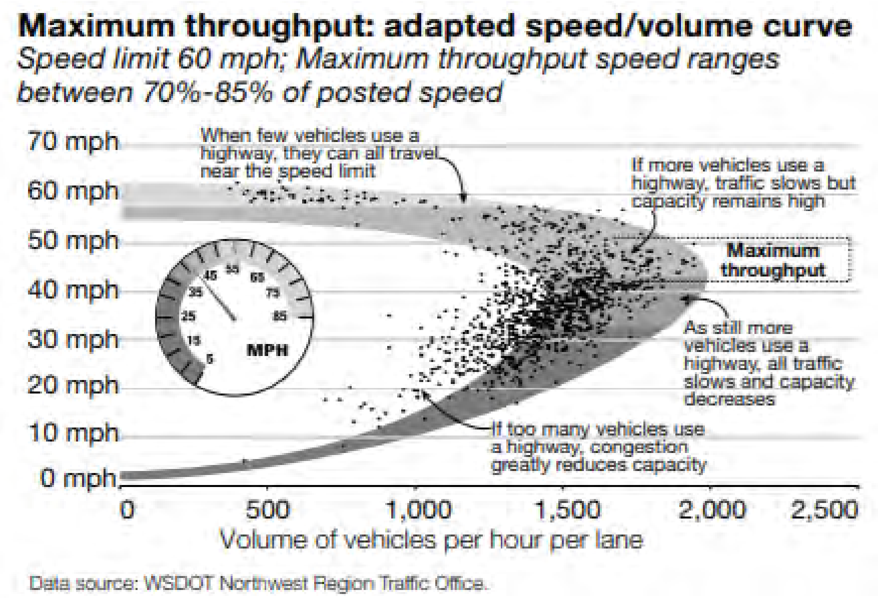


Figure 21: Maximum throughput diagram

MT^{3}I is calculated by dividing the average corridor travel time by the travel time at maximum throughput speed.

Unit of measure: An index score which is essentially a percent, comparing model travel times to maximum throughput travel times.

What it means: The output used to calculate scenario scores is the change in MT^{3}I if it's above 1 compared to the prior scenario in the modeling order. A score of 1 means that the travel times experienced during the period measured are equal to maximum throughput speeds (51mph for this study). A score below 1 means average travel times are faster. A score above one means average travel times are slower. For example, a score of 2.0 could be interpreted as average travel times on a segment are two times longer than at maximum throughput speeds.

Time Period: Peak period – either 6 am to 9 am or 4 pm to 7 pm

Geographic Extent: Interstate 5 between 93rd Avenue/SR 121 south of Tumwater and Main Gate Interchange near Lakewood. Similar to the travel time measure, the study team also looked at performance in the segments shown on Figure 21 on the previous page.

Source of Data: Regional Dynamic Model; Washington State Department of Transportation for Optimum Travel Time.

Additional Information: Additional detail on maximum throughput and MT^{3}I is available in WSDOT's Handbook for Corridor Capacity Evaluation[2].

2 "Travel Time Trends Corridor Capacity Analysis Methodology" from WSDOT's Handbook for Corridor Capacity Evaluation; https://www.wsdot.wa.gov/publications/fulltext/graynotebook/CCR14_methodology.pdf#page=21 (PDF)

Person Throughput

Person throughput is the number of people that pass through a specific point or segment of road within a defined timeframe (people per hour per lane). This metric is an efficiency measure that helps us better understand how many people are being moved through the transportation network.

Unit of measure: Average number of People per hour during peak periods.

What it means: The figure used to score the scenarios was the change in person throughput compared to the prior scenario in the modeling order. The more people moved on the corridor within the peak periods, the more efficiently the segment is being utilized assuming the segment is at or near capacity for vehicles (otherwise known as congested).

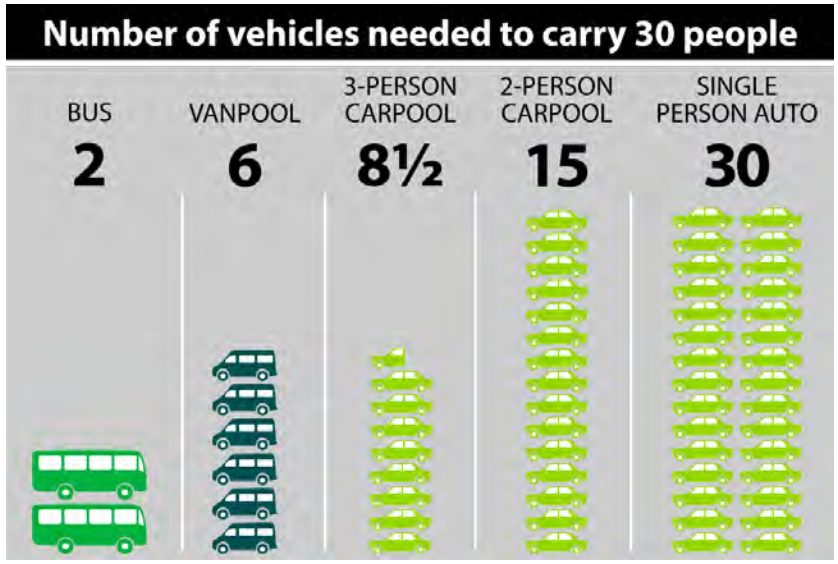


Figure 22: Number of vehicles needed to carry 30 people base on utilization rates used in the modeling process

Time Period: Peak period – either 6 am to 9 am or 4 pm to 7 pm

Geographic Extent: The study measured performance on I-5 between 93rd Ave/SR121 south of Tumwater and Main Gate Interchange near Lakewood.

Source of Data: Regional Dynamic Model; Intercity Transit for transit and vanpool ridership; Regional Travel Demand Model (based on household travel survey) for persons per vehicle for other modes.

Additional Information: Additional detail on person throughput is available in WSDOT's Handbook for Corridor Capacity Evaluation[3].

Table 8: Vehicle occupancy rates per mode

Mode	People per vehicle	
	Funded Base to Travel Demand Management scenarios	Transit scenario to Capacity Expansion scenarios
Express Bus	15	20
Vanpool	5	5
3 plus person carpool	3.5	3.5
2-person carpool	2	2
Single occupancy automobile	1	1

3 "Miles Traveled Methodology" from WSDOT's Handbook for Corridor Capacity Evaluation; https://www.wsdot.wa.gov/publications/fulltext/graynotebook/CCR14_methodology.pdf#page=11 (PDF)

Vehicle Miles Traveled

Vehicle Miles Traveled (VMT) is a measure of the total of number of travel by vehicle over a year on all roads within a defined area, Thurston County in the case of this study. VMT is often used as a system performance indicator[4]. TRPC has developed some goals for VMT in their regional plans (see table 11 below).

Table 9: Regional goals for vehicle miles traveled reduction

Year	Population	Annual Vehicle Miles Traveled	Annual per Capita VMT	Goal
2017	276,900	2,497,841,900	9,021	
2020 Target	294,300	3,171,082,500	10,775	1990 per capita VMT levels by 2020
2035 Target	354,400	2,672,884,800	7,542	based on 30% reduction of 1990 per capita VMT by 2035
2040	370,700	2,529,533,200	6,824	Mid-period interpolation
2050 Target			5,387	based on 50% reduction of per capita VMT by 2050

Unit of measure: Miles; Average annual; normalized to the Highway Performance Monitoring System (HPMS) for 2017.

What it means: This performance measure will look at the annual vehicle miles traveled in 2040 for each modeling scenario compared to the scenario prior. This measure will tell us if different strategies are resulting in increased or decreased total vehicle travel in the study area. The desired outcome is a decrease in vehicle miles traveled.

Time Period: Annual

Geographic Extent: Thurston County

Source of Data: Regional Dynamic Model calibrated to Highway Performance Monitoring System (HPMS) data.

Mode split

Mode split, also referred to as mode choice, is the average daily percentage of total trips taken in a defined area by various modes of travel. This study included single occupancy vehicles (SOV), high occupancy vehicles (HOV), walking, bicycling, transit, school buses, and vanpools as modes of travel. Mode split is generally used as a measure of system efficiency. Increasing the use of alternative modes of transportation (not single occupancy vehicles) helps maximize capacity on the entire transportation system and reduces greenhouse gas emissions.

Unit of measure: Percent of trips traveled by SOV.

What it means: The measure for this study compares the percent of trips taken by single occupancy vehicles in each modeled scenario to the prior scenario in the modeling order. The desired outcome is a reduction in the percentage of trips taken by SOV.

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4 WSDOT's Corridor Capacity Report 2018; https://www.wsdot.wa.gov/publications/fulltext/graynotebook/corridor-capacity-report-18.pdf#page=4

Time Period: Daily

Geographic Extent: Thurston County

Source of Data: Regional Travel Demand Model

Traffic Balance on Interstate 5

This performance measure looks at the percentage of vehicles using I-5 based on their origin and destination. The measure breaks traffic up into three groups; local, regional, and through traffic. Local traffic are vehicles that start and end their trip within the study area. Regional traffic either are vehicles starting their trip in the study area and ending outside or vice versa. Finally, through traffic are vehicles using I-5 in the study area but starting and ending their trip outside of the study area.

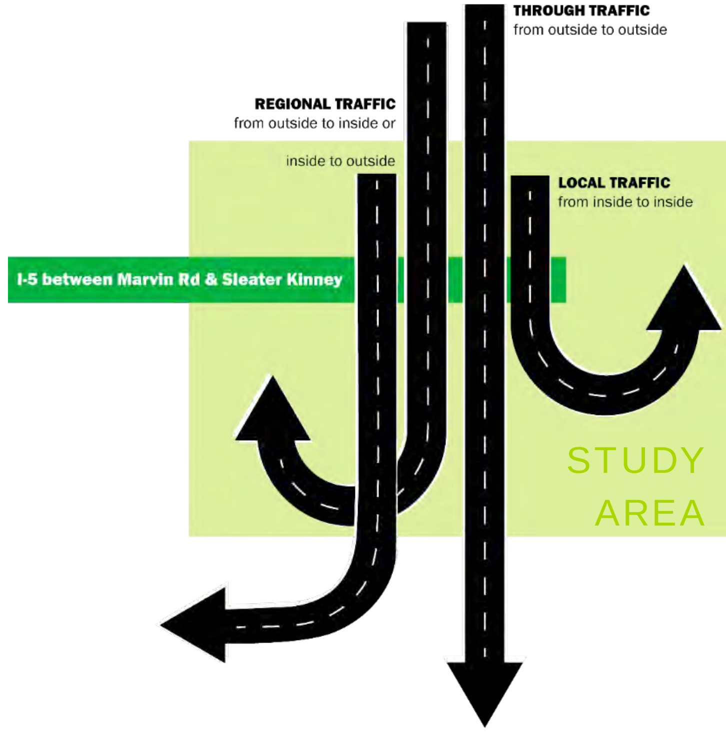


Figure 23: Through, regional, and local traffic on I-5

Unit of measure: Through traffic as percent of vehicle trips

What it means: This measure will give an indication of the effect each scenario will have on traffic circulation patterns in the North Thurston County urban area. The general outcome the study team and stakeholders agreed to was an increase in the proportion of through traffic using I-5 compared to the prior scenario. This result would most likely mean that local traffic is more able to use the local network the reach their destination and/or that regional travel demand was reduced.

Time Period: Three-hour peak period - southbound - 4 pm to 7 pm

Geographic Extent: On Interstate 5 between Sleater-Kinney Avenue and Martin Way.

Source of Data: Regional Dynamic Model

Additional Information:

Access to jobs and commercial services

This measure looks at the ease of reaching valued destinations. There are multiple ways to quantify access to destinations in terms of to what, for whom, and the relative value of destinations. This study looked at access to jobs and commercial services via SOV, HOV, and Transit for the general population in the study area and some groups of people identified in WSDOT's Environmental Manual chapter on Environmental Justice[5]. Populations included in the analysis for this study included:

- All population
- Minority (Black/African American, Hispanic regardless of race, Asian and Pacific Islander, American Indian or Alaskan Native, Two or more Races, and Other)

5 WSDOT Environmental Manual, 458.02 Environmental Justice, Page 458-3; https://www.wsdot.wa.gov/publications/manuals/fulltext/M31-11/458.pdf#page=3

- Population experiencing poverty
- Population with a disability
- Population without access to a vehicle

Access to destinations as a concept has been present in transportation planning literature for more than 40 years, and methods for quantifying it are becoming more sophisticated. WSDOT is incorporating access to destinations as a performance measure because it takes into account the purpose of travel: to fulfill life's daily needs.

Often access to destinations measures look at the number of destinations reachable within a certain commute time, for example 30 minutes, resulting in a straight count. This study does not apply a travel time cut off but rather applies a travel time decay equation which reduces the value of a destination the further away it is. The resulting measure is the number of job equivalents a person can reach within the analysis area. While it is more complicated to communicate, this approach to measuring access to destinations gives a more complete picture of how well the transportation system facilitates daily travel. See below for the travel decay equations. These equations came from results of the 2009 National Household Travel Survey and were for WSDOT developed by the Smart State Transportation Initiative[6].

- Home-based work, auto: 1.128 x *exp*(-0.045 x minutes)
- Home-based work, transit: 1.180 x *exp*(-0.018 x minutes)
- Home-based work, walk/bike: 1.000 × *exp*(-0.075 x minutes)
- Home-based non-work, auto: 1.120 × exp(-0.069 x minutes)
- Home-based non-work, transit: 1.150 × exp(-0.023 x minutes)
- Home-based non-work, walk/bike: 1.078 × exp(-0.071 x minutes)

The analysis for this study was conducted using the Transportation Analysis Zones or TAZs TRPC developed and used in the Dynameq modeling software. The accessibility score for each TAZ was weighted by the percent of the population being analyzed living in the TAZ. This results in score that is weighted by population, generally called person-weighted accessibility in transportation literature[7].

Unit of Measure: Job and commercial business equivalents

What it means: The higher the score, the better the transportation system and land use are facilitating access to jobs and commercial services. The actual output used was the change in change in access score averaged by mode, destination type, and then population group from the prior model scenario. This tells us if a strategy helps the populations analyzed reach jobs and services or reduces their ability to do so. The desired outcome is an increase in access scores.

Time Period: Three-hour peak period - southbound - 4 pm to 7 pm

Geographic Extent: Entire study area

Source of Data: Sugar Access program by Citilabs, Thurston Regional Planning Council regional model

Travel Times on Freight Access Routes

This measure looks at travel times on key freight corridors selected by the study team and stakeholder advisory groups in the study area. These corridors connect I-5 to industrial uses or are commonly used as local access routes by freight trucks.

6 Smart State Transportation Initiative Website; https://www.ssti.us/
7 Access to Destinations: Annual Accessibility Measure for the Twin Cities Metropolitan Region, 2010, page 8; http://www.cts.umn.edu/Research/ProjectDetail.html?id=2012025

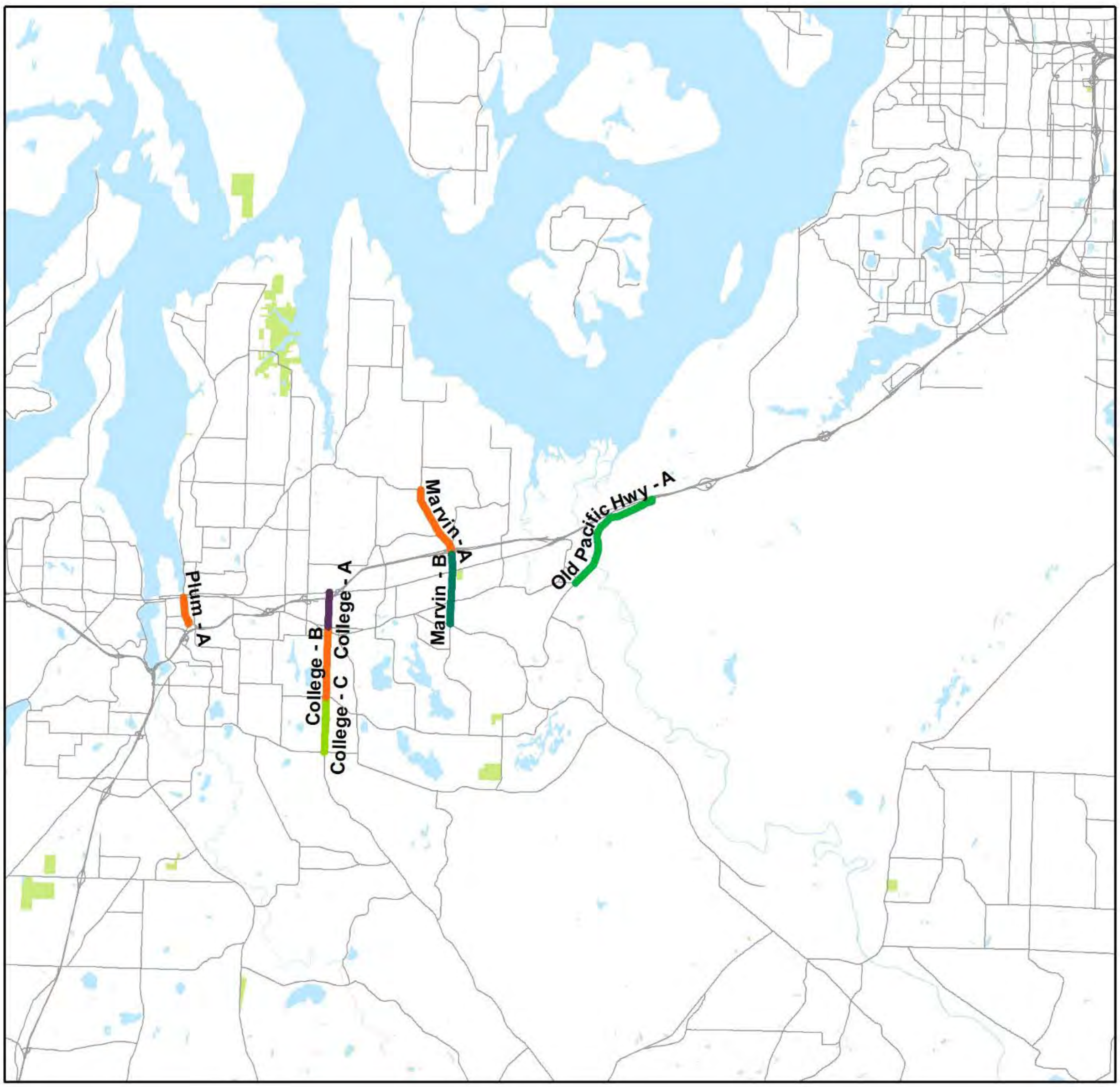
Unit of measure: Minutes

What it means: The actual output used is the change in travel times compared to the previous model scenario. The desired outcome is a decrease in travel time compared to the prior modeled scenario.

Time Period: Peak period – either 6 am to 9 am or 4 pm to 7 pm

Geographic Extent:

- College Street SE: Between Martin Way and Yelm Highway
- Marvin Rd/SR 510: Between Britton Parkway and Steilacoom Road
- Nisqually Rd/Old Pacific Hwy: Between Durgin Road and Mounts Road
- Plum Street: Between I-5 and State Avenue



Source of Data: Regional Dynamic Model

Greenhouse Gas Emissions

The Greenhouse gas emissions performance measure looks at the output of carbon dioxide (CO_2) from vehicles within Thurston County. TRPC has established regional targets for greenhouse gas emissions

- Achieve a 25 percent reduction of 1990 levels by 2020
- Achieve a 45 percent reduction of 1990 levels by 2035
- Achieve an 80 percent reduction of 1990 levels by 2050

In 2018, Lacey, Olympia, Tumwater, and Thurston County adopted new targets to reflect an updated base year. They are somewhat comparable to the targets above:

- Reduce regional greenhouse gas emissions 45 percent below 2015 levels by 2030
- Reduce regional greenhouse gas emissions 85 percent below 2015 levels by 2050

State Goal/Target:

WSDOT set statewide greenhouse gas targets during their target setting process.

- CO_2 2-year target 2019 – 3.6% below 2016 values
- CO_2 4-year target 2021 – 10.7% below 2016 values

Greenhouse gas emissions are used as in environmental indicator. Greenhouse gases act as a thermal blanket for the Earth, absorbing heat and warming the surface. Most climate scientists agree that the main cause of the current global warming trend is human expansion of the "greenhouse effect.[8]"

Thurston Climate Action Team estimates that transportation accounts for 38 percent of emissions in Thurston County.

Table 10: Sources of greenhouse gas emissions in Thurston County, 2016

Emission Source Type	Metric tons of carbon dioxide equivalents (MTCDE)	Percent
Built Environment	1,717,841	58%
On-Road Vehicles	1,129,197	38%
Solid Waste	81,109	3%
Agriculture/Livestock	37,482	1%
Wastewater Treatment	124	0%
Total	2,965,753	100%

Source: Thurston Climate Action Team

What it means: The actual output used was the percent change in greenhouse gas emissions from the prior model scenario. This will tell us if a strategy is resulting in more greenhouse gas emissions or less. The desired outcome for this measure is a decrease in overall emissions.

Measure (units): Annual Metric Tons of Carbon Dioxide Equivalent (MTCDE).

Time Period: Annual.

Geographic Extent: County-wide.

[8] For a discussion of the greenhouse effect and list of sources, please see NASA's website: https://climate.nasa.gov/causes/.

Source of Data: Regional Dynamic Model. TRPC Household Travel Survey. Puget Sound Regional Planning Council emissions calculator.

Additional Information:

Table 11: Average Emissions Factors (grams CO2e/mile)

Mode	2015	2040
SOV/LOV/HOV	443.5	246.2
Vanpool	443.5	246.2
Truck	595.8	350.7
Bus	1,089.6	991.7

Emissions Factor Assumptions

- Household travel survey does not have a vehicle type category (car/van/truck/etc.). Assume respondents driving a gas vehicle are driving a car and driving a diesel vehicle are driving a passenger truck
- PSRC emissions calculator does not include a van category. Use same assumptions as SOV/LOV/HOV
- Use age assumptions for diesel vehicles in household travel survey and light duty trucks from PSRC emissions calculator
- Current: Use 2010/2013 emissions estimates for gas/diesel transit buses. Future: Use 2022/2025 estimates for gas/diesel/hybrid-electric buses.

Advisory group evaluation comparing which strategies "improve the availability and/or capacity of alternate routes to I-5".

With the lack of a quantitative measure of system resilience from the model, the study team worked with the technical advisory group to create a group evaluation of how well each scenario improves the availability and/or capacity of alternate routes to I-5. This was done using a "forced pair" exercise. Each member of the study's Technical Advisory Group was given the opportunity to fill out the table shown below which resulted in a score for each scenario. Scores from all TAG members who provided input were then averaged and ranked in order from highest to lowest.

Unit of measure: Rank

Time Period: Not applicable

Geographic Extent: Study area

Source of Data: Study Technical Advisory Group

Additional Information:

Appendix H – Evaluation Methods & Results for Strategies That Were Not Modeled

The study team, in collaboration with advisory groups, determined that modeling was not possible for 45 strategies. However, the team developed an alternate group scoring and review process to evaluate their potential as discussed in Chapter 7 of the report. This appendix provides a more in depth description of "Step Three – Score Strategies" mentioned on page 43 and provides further detail of the actual evaluation from the study team and advisory group.

Scoring method for strategies that were not modeled

As discussed in Chapter 7, the study team and advisory groups evaluated strategies given the green light by relevant agencies and subject matter experts for their effectiveness by study goal area. The study team gave a high-level rating for each idea's effectiveness for achieving desired performance outcomes by study goal area using these categories: very positive; somewhat positive; neutral; somewhat negative; and very negative. The technical advisory group then reviewed and revised the scores both in group meetings and individually through a comment process.

For example, the TAG evaluated the strategy of improving local active transportation infrastructure as having a neutral effect on the I-5 Travel Times & Reliability study goal, a very positive effect for the Efficiency & Equity and Accessibility goals, and a somewhat positive effect for Environment and Resilience goals.

The study team then assigned a number value for the evaluations ranging from +2 for very positive to -2 for very negative. The study goal weighting, discussed in Chapter 3 on pages 44-45, was then applied to these scores to create an overall effectiveness score similar to the method for modeled scenarios. Also similar to the modeled scenarios, these scores were used as a tool for facilitating discussions with the study advisory groups on recommendations.

The table below gives the recommendation and overall effectiveness score for strategies that were not modeled.

Strategy Information		Scoring	Evaluation	
Strategy	Specifics	Overall effectiveness	Proposed disposition	Notes
Implement tolling or congestion pricing on all of I-5 through study area		◕	Recommended for further study	Recommendation based on TAG input on strategy
Improve bike infrastructure	Establish active transportation routes between major destinations	◕	Recommended for further study	The current non-motorized networks precludes most users from commuting to/from some major destinations by bike such, particularly between Thurston and Pierce counties. Potential lead agencies could include WSDOT and/or TRPC
Develop mechanism for WSDOT to be involved in land use decisions that impact the state system		–	Recommended for further study	TAG was interested in possible approaches outside of GMA as being studied by WSU Ruckelshaus Center - https://ruckelshauscenter.wsu.edu/a-roadmap-to-washingtons-future/
Evaluate alternate routes for and local traffic impacts from non-recurring congestion		–	Recommended for further study	By WSDOT

Improve access to Amtrak and Sounder services		◕	Consider for further study	Recommendation based on TAG input on strategy
Expand transit services – shuttle services	Employee shuttle or bus system for capitol campus like Google bus	◑	Consider for further study	
Update signal timing and channelization on local network		◕	Consider for further study	
Centralize traffic management		◕	Consider for further study	While recommendation did not change, heard concern within TAG about different traffic management goals among local jurisdictions
Keep the Mounts Road access gate to JBLM open longer		◔	Consider for further study	WSDOT working with JBLM on project that would render this strategy unneeded
Camera-based speeding enforcement on local network		◔	Consider for further study	Reducing speeding issues on local roads would increase viability of active modes, this is a primary recommendation from the Traffic Safety Commission's Pedestrian Safety and Bike Safety Councils
Complete refined origin/destination study to evaluate local system improvements		–	Consider for further study	
Improve signing to help distribute traffic	13 - I-5 SB at Henderson to guide through traffic away from weaving	◑	WSDOT to review for implementation	Pass on to WSDOT OR Traffic Office
	14 - US 101 between Crosby and I-5	◑		
	7 - Variable message signs with travel time information	◑		
Improve interchange operations	Add speed limit signs at I-5 exit 104 NB entrance to US 101	○	WSDOT to review for implementation	Pass on to WSDOT OR Traffic Office
	I-5 Exit 104 NB - Add high-friction surfacing to improve operations	◔		
Improve bike infrastructure	Improve local network bike infrastructure	◑	Further study currently proposed	By TRPC
Offer childcare and/or schools at major employment sites		◑	Further study currently proposed	By Thurston EDC

Expand transit services – High-Capacity Transit	Commuter Rail: 39 - DuPont to Centennial Station; 40 - DuPont to downtown Olympia via existing lines; 41 - New line down I-5 median)	◕	Further study currently proposed	By TRPC - High-capacity transportation alternatives analysis identified as unfunded need in TRPC's UPWP https://www.trpc.org/DocumentCenter/View/6722/SFY-2020-Unified-Planning-Work-Program-PDF
	Light rail transit: 45 - between Hawks Prairie and DuPont, - 46 Between Olympia and Tacoma	●	Further study currently proposed	
	Monorail, Subway/BART-type system	●		
Expand transit services - Shuttle services	Create direct shuttles/micro transit in rural areas to high-demand sites	◑	Not recommended for further study	Based on input from TRPC. Viability of expanded rural transit will depend on future funding.
Adjust pickup/drop off hours to off-peak times at Ports		◑	Not recommended for further study	Based on input from Port of Olympia on rules around shifts negotiated with longshoreman’s union
Add capacity to local roads	Waddell Creek Road	○	Not recommended for further study	Based on discussion w/ Thurston County, expansion of Waddell Creek would not provide significant benefit to the transportation system.
Move Thurston County's Waste and Recovery Center south to rail access station to improve local network operations		–	Not recommended for further study	
Reduce vertical and horizontal curves of I-5		◔	Not recommended for further study	Due to low expected benefit and very high expected cost and impacts to local community during construction.
Close the truck weigh station north of Mounts Road during peak periods		○	Not recommended for further study	Based on discussion w/ WSDOT Freight Office; closing weigh stations on a predictable schedule would be detrimental to enforcement purposes and illegal loads may attempt to make it through during those periods.
Stripe/add a motorcycle lane		○	Not recommended for further study	Motorcycles make up a small portion of traffic and are allowed to use HOV lanes which would be preferable to an exclusive motorcycle lane.
Expand transit services - Ferry services	Create direct shuttles/micro transit in rural areas to high-demand sites	◔	Currently being studied	By PSRC

Expand transit services - Rapid Transit Systems	55 - statewide; 56 - Portland to Bellingham; 57 - Portland to Vancouver B.C.	-	Currently being studied	By WSDOT - https://www.wsdot.wa.gov/planning/studies/ultra-high-speed-travel/ground-transportation-study
	60 - Ultra high-speed transportation (Hyperloop)	-		
Study freight needs and traffic origins/destinations		-	Currently being studied	By WSDOT - https://www.wsdot.wa.gov/Freight/systemplan.htm
Air taxi service to Tacoma, Seattle, and Everett		○	Studied previously	By Port of Olympia
Increase driver testing requirements (mandatory tests every 5 years, higher standards, etc…)		-	Studied previously	By WSTC
Increase gas tax to discourage driving		-	Outside study scope	Requires legislative action

Appendix I – Scoring Methodology Detail and Data

As mentioned in Chapter 7, the study team and advisory groups developed a methodology for scoring the performance data outputs from the modeled scenarios. This included the following basic elements:

- **For each performance measure, give the best performing scenario a score of 100 and then score all other scenarios relative to it.**
  Scores for each performance measure were determined relative to the best performing scenario when comparing changes from the prior modeled scenario and the 2040 baseline scenario, respectively. The desired outcome for each measure, listed on page 45 of the main report and discussed in Appendix G, guided the determination of which scenario performed "best". For example, the desired outcome for the greenhouse gas emissions measure was to decrease total emissions measured in carbon dioxide equivalents (CO_2e). Change in emissions was measured as a percent change in total emissions so the best performing scenario was the one that reduced emissions by the greatest percentage when compared to the prior scenario and the 2040 baseline, respectively. Change in performance was measured compared to the prior modeled scenario and the 2040 baseline scenario. The study team allowed for scenarios to have a negative score but used a "cap" of -100. This method allowed for consideration of both positive and negative tradeoffs of each scenario.

- **Average each scenario's performance measure scores within study goal areas.**
  The scores calculated form the prior step were averaged by study goal. The number of performance measures for each study goal area ranged from one to six. Averaging the measures gave them equal weight within a study goal.

- **Apply the study goal weighting**
  As discussed on pages 44-45, the study team developed study goal weighting factors with the technical advisory group and public input. These factors were applied to the goal area effectiveness scores from the previous bullet.

The following sections detail the performance measure outcomes and calculations for each measure that lead to scoring by study goal and then overall.

Travel Times and Reliability measures

The Travel Times and Reliability study goal had three performance measures: 1) Corridor travel times; 2) Maximum Throughput Travel Time Index – All Traffic; and 3) Maximum Throughput Travel Time Index (MT^3I) – HOV. All of these measures are described in detail in Appendix G.

Corridor Travel Times

The corridor travel times measure score was calculated using the percent change in combined travel times on I-5 between 41st Division Drive (Joint Base Lewis McChord main gate) and SR 121 (Exit 199) in both directions. Only changes in travel time greater than one minute were considered to compensate for "model noise" as described on page 46. The desired outcome was a decrease in travel times so positive scores were given to negative percent changes in travel times.

Exhibit I-1: Corridor Travel Times (minutes) – All Traffic Scoring

Scenario	- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Northbound Morning (6-9am)	23.3	23.6	22.8	23.8	25.4	25.0	27.9	33.6	28.6	25.3	23.2
Southbound Evening (3-6pm)	43.0	41.8	39.0	40.3	38.5	30.0	35.3	36.7	35.2	28.1	25.1
Percent change	-	-1.9%	-4.3%	3.8%	-0.3%	-13.3%	14.7%	11.4%	-9.3%	-16.2%	-28.8%

Comparing to prior scenario	Score	-	**6.5**	**14.9**	**-13.2**	**1.2**	**46.2**	**-51.1**	**-39.5**	**32.4**	**56.3**	**100.0**
Comparing to 2040 Baseline	Percent change	-	-1.9%	-6.2%	-4.4%	-3.8%	-17.6%	-5.7%	6.4%	-3.6%	-20.2%	-33.5%
	Score	-	**5.6**	**18.5**	**13.1**	**11.2**	**52.6**	**17.1**	**-19.0**	**10.7**	**60.3**	**100.0**

Maximum Throughput Travel Time Index – All Traffic

As discussed in Appendix G, MT^3I is an index calculated by dividing the average measured travel time by the travel time at maximum throughput speed. The study team used 51 mph as the maximum throughput speed based off the methodology used in WSDOT's *Corridor Capacity Report* and *Handbook for Corridor Capacity Evaluation*. This measure looked at travel times between the same end points as the Corridor Travel Times measure for all traffic. The desired outcome was a decrease in MT^3I down to 1.0 (average travel time equals maximum throughput travel time). Scoring was calculated based on the percent decrease in MT^3I for both directions of travel down to 1.0. Any decrease beyond 1.0 was not considered.

Exhibit I-2: Maximum Throughput Travel Time Index – All Traffic Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Northbound Morning (6-9am)		1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.2	1.0	1.0	0.9
Southbound Evening (3-6pm)		1.5	1.5	1.4	1.4	1.4	1.1	1.4	1.5	1.4	1.0	1.0
Comparing to prior scenario	Average percent change	-	2.5%	-3.2%	1.2%	-2.6%	-9.7%	11.0%	12.5%	-8.0%	-15.4%	-17.1%
	Score	-	**-14.8**	**18.8**	**-7.2**	**15.3**	**56.6**	**-64.2**	**-72.7**	**46.7**	**89.9**	**100.0**
Comparing to 2040 Baseline	Average percent change	-	2.5%	-0.7%	0.4%	-2.2%	-11.3%	-3.3%	9.1%	-0.1%	-15.0%	-16.7%
	Score	-	**-15.2**	**4.1**	**-2.6**	**13.5**	**67.8**	**19.7**	**-54.9**	**0.4**	**90.1**	**100.0**

Maximum Throughput Travel Time Index – HOV

This measure used the same methodology as MT^3I but only considered HOV traffic. This included carpools of two or more people and vanpools.

Exhibit I-3: Maximum Throughput Travel Time Index – HOV Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Northbound Morning (6-9am)		1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9
Southbound Evening (3-6pm)		1.5	1.5	1.4	1.4	1.4	1.1	1.0	1.0	1.0	0.9	0.9
Comparing to prior scenario	Average percent change	-	2.5%	-3.7%	1.6%	-2.6%	-9.7%	-5.8%	-0.6%	1.6%	-1.5%	-1.5%
	Score	-	**-25.5**	**38.4**	**-16.7**	**26.9**	**100.0**	**59.9**	**5.7**	**-16.5**	**15.6**	**15.6**
Comparing to 2040 Baseline	Average percent change	-	2.5%	-1.2%	0.2%	-2.4%	-11.4%	-15.9%	-16.5%	-15.5%	-16.5%	-16.5%
	Score	-	**-14.9**	**7.5**	**-1.3**	**14.8**	**69.2**	**96.6**	**100.0**	**93.7**	**100.0**	**100.0**

Travel Times and Reliability overall scores

Scores from each measure compared to the prior modeled scenario and 2040 funded baseline were averaged to create an effectiveness score for the Travel Times and Reliability study goal.

Exhibit I-4: Travel Times and Reliability Overall Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Comparing to prior scenario	Corridor Travel Times	-	6.5	14.9	-13.2	1.2	46.2	-51.1	-39.5	32.4	56.3	100.0
	MT3I – All	-	-14.8	18.8	-7.2	15.3	56.6	-64.2	-72.7	46.7	89.9	100.0

	MT3I – HOV	-	-25.5	38.4	-16.7	26.9	100.0	59.9	5.7	-16.5	15.6	15.6
	Average	-	**-11**	**24**	**-12**	**14**	**68**	**-18**	**-35**	**21**	**54**	**72**
Comparing to 2040 Baseline	Corridor Travel Times	-	5.6	18.5	13.1	11.2	52.6	17.1	-19.0	10.7	60.3	100.0
	MT3I – All		-15.2	4.1	-2.6	13.5	67.8	19.7	-54.9	0.4	90.1	100.0
	MT3I – HOV		-14.9	7.5	-1.3	14.8	69.2	96.6	100.0	93.7	100.0	100.0
	Average	-	**-8**	**10**	**3**	**13**	**63**	**44**	**9**	**35**	**83**	**100**

Efficiency and Equity measures

The Equity and Efficiency study goal had six performance measures: 1) Person Throughput – All Traffic; 2) Person Throughput – HOV; 3) Mode Split; 4) Vehicle Miles Traveled; 5) I-5 Traffic Balance; and 6) Access to Jobs and Commercial Services for Environmental Justice Populations. All of these measures are described in detail in Appendix G.

Person Throughput – All Traffic

Person throughput is the number of people moved in a given amount of time. This measure looked at person throughput on I-5 between 93rd Ave/SR121 south of Tumwater and Main Gate Interchange near Lakewood per hour for all traffic in both directions. The measure used for scoring was the percent change in the sum of person throughput per hour on the four study corridor segments as shown in Appendix G. The desired outcome was an increase in person throughput so positive percent change was given positive scoring.

Exhibit I-5: Person Throughput – All Traffic Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Northbound Morning (6-9am)		27,700	29,460	27,820	30,190	30,560	30,500	28,420	26,270	29,460	30,990	30,110
Southbound Evening (3-6pm)		26,920	27,630	27,320	27,370	27,510	29,430	28,310	27,780.0	27,220	30,470	30,390
Comparing to prior scenario	Average percent change	-	4.5%	-3.3%	4.4%	0.9%	3.4%	-5.3%	-4.7%	5.1%	8.6%	6.9%
	Score	-	**52.5**	**-39.0**	**50.8**	**10.1**	**39.6**	**-62.0**	**-55.1**	**59.1**	**100.0**	**80.9**
Comparing to 2040 Baseline	Average percent change	-	4.5%	1.0%	5.3%	6.3%	9.7%	3.9%	-1.0%	3.7%	12.5%	10.8%
	Score	-	**35.9**	**7.7**	**42.5**	**49.9**	**77.5**	**31.0**	**-7.9**	**29.8**	**100.0**	**86.1**

Person Throughput – HOV

This measure used the same methodology as Person Throughput – All Traffic but only considered HOV traffic including carpools of two or more people, vanpools, and transit.

Exhibit I-6: Person Throughput – HOV Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Northbound Morning (6-9am)		12,650	13,910	13,140	14,650	15,000	14,710	14,950	14,370	15,400	15,440	14,830
Southbound Evening (3-6pm)		11,900	12,320	12,040	12,230	12,170	13,180	14,940	14,620	14,430	14,720	14,060
Comparing to prior scenario	Average percent change	-	6.7%	-3.9%	6.5%	0.9%	3.2%	7.5%	-3.0%	2.9%	1.1%	-3.1%
	Score	-	**90.0**	**-52.1**	**87.2**	**12.7**	**42.5**	**100.0**	**-40.2**	**39.2**	**15.1**	**-41.8**
Comparing to 2040 Baseline	Average percent change	-	6.7%	2.5%	9.3%	10.4%	13.5%	21.9%	18.2%	21.5%	22.9%	17.7%
	Score	-	**29.5**	**11.0**	**40.6**	**45.6**	**59.1**	**95.6**	**79.7**	**94.0**	**100.0**	**77.3**

Mode Split

Mode split looked at the percent of all trips made by single occupant vehicles in Thurston County. The desired outcome was a decrease in the percent of trips made by SOV so negative changes in SOV mode split were given positive scores.

Exhibit I-7: Mode Split Scoring

	-	1	2	3	4	5	6	7	8	9	10

Scenario		2040 Baseline	Operations	Sustainable Thurston Land Use	Transportation Demand Management	Intercity Transit Long-Range Plan	Part Time Shoulder Use	HOV Conversion	RTP Local Projects	Interchange Improvements	Widen I-5 – Retain HOV	Widen I-5 – All GP
Percent of trips by SOV		51.5%	51.5%	51.0%	50.6%	50.1%	50.1%	50.0%	50.0%	50.0%	50.0%	50.1%
Comparing to prior scenario	Change	-	0.0%	-0.5%	-0.4%	-0.5%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
	Score	-	**0.0**	**84.2**	**70.7**	**100.0**	**-0.5**	**21.2**	**-2.2**	**-0.6**	**-4.5**	**-6.7**
Comparing to 2040 Baseline	Change	-	0.0%	-0.5%	-0.8%	-1.4%	-1.4%	-1.5%	-1.5%	-1.5%	-1.4%	-1.4%
	Score	-	**0.0**	**30.6**	**56.2**	**92.5**	**92.3**	**100.0**	**99.2**	**99.0**	**97.4**	**95.0**

Vehicle Miles Traveled

Vehicle Miles Traveled measured total VMT in Thurston County. The desired outcome was a decrease in VMT so negative percent change in VMT was given a positive score.

Exhibit I-8: Vehicle Miles Traveled (VMT) Scoring

Scenario		-	1	2	3	4	5	6	7	8	9	10
		2040 Baseline	Operations	Sustainable Thurston Land Use	Transportation Demand Management	Intercity Transit Long-Range Plan	Part Time Shoulder Use	HOV Conversion	RTP Local Projects	Interchange Improvements	Widen I-5 – Retain HOV	Widen I-5 – All GP
Average Annual VMT in 1,000s		3,285,800	3,291,000	3,236,200	3,202,700	3,203,700	3,237,200	3,186,300	3,188,600	3,175,600	3,237,900	3,255,600
Comparing to prior scenario	Percent change	-	0.2%	-1.7%	-1.0%	0.0%	1.0%	-1.6%	0.1%	-0.4%	2.0%	2.5%
	Score	-	**-9.5**	**100.0**	**62.2**	**0.0**	**-62.8**	**94.4**	**-4.3**	**24.5**	**-100.0**	**-100.0**
Comparing to 2040 Baseline	Percent change	-	0.2%	-1.5%	-2.5%	-2.5%	-1.5%	-3.0%	-3.0%	-3.4%	-1.5%	-0.9%
	Score	-	**-4.72**	**45.01**	**75.41**	**74.50**	**44.10**	**90.29**	**88.20**	**100.00**	**43.47**	**27.40**

I-5 Traffic Balance

I-5 Traffic Balance measured the percent of trips on I-5 between Sleater-Kinney Avenue and Martin Way that originated and ended outside of the northern urban area in Thurston County, called “through traffic”. The desired outcome was an increase in the percent of through traffic so positive changes in the percentage were given positive scores.

Exhibit I-9: I-5 Traffic Balance Scoring

Scenario		-	1	2	3	4	5	6	7	8	9	10
		2040 Baseline	Operations	Sustainable Thurston Land Use	Transportation Demand Management	Intercity Transit Long-Range Plan	Part Time Shoulder Use	HOV Conversion	RTP Local Projects	Interchange Improvements	Widen I-5 – Retain HOV	Widen I-5 – All GP
Percent through traffic		31.7%	32.3%	32.0%	32.6%	32.5%	30.9%	27.8%	27.2%	28.8%	31.0%	30.8%
Comparing to prior scenario	Change	-	0.5%	-0.2%	0.6%	-0.1%	-1.6%	-3.1%	-0.6%	1.5%	2.2%	2.1%
	Score	-	**24.8**	**-11.1**	**27.0**	**-5.6**	**-74.5**	**-100.0**	**-26.5**	**69.2**	**100.0**	**94.3**
Comparing to 2040 Baseline	Change	-	0.5%	0.3%	0.9%	0.8%	-0.9%	-3.9%	-4.5%	-3.0%	-0.8%	-0.9%
	Score	-	**60.9**	**33.7**	**100.0**	**86.3**	**-96.6**	**-100.0**	**-100.0**	**-100.0**	**-85.9**	**-99.8**

Access to Jobs and Commercial Services for Environmental Justice populations

This measure looked at the ease of reaching jobs and environmental justice populations in the study area by SOV, HOV, and transit. As described in Appendix G, this analysis included population experiencing poverty, minority population, disabled population, and population without access to a vehicle. The analysis for population without access to a vehicle only measured access to jobs and commercial services by transit. The desired outcome was an increase in access to jobs and services. A score was calculated for each EJ population individual and then averaged to create a final score. Within each population, the change in access to jobs and commercial services by mode was averaged. The average percent change for the two destination types was then averaged to create the final score for the population.

Exhibit I-10: Example Calculations Access to Jobs and Commercial Services for Population Experiencing Poverty

Scenario		-	1	2	3	4	5	6	7	8	9	10
		2040 Baseline	Operations	Sustainable Thurston Land Use	Transportation Demand Management	Intercity Transit Long-Range Plan	Part Time Shoulder Use	HOV Conversion	RTP Local Projects	Interchange Improvements	Widen I-5 – Retain HOV	Widen I-5 – All GP
Access to jobs by	SOV	216,904	215,419	218,971	218,313	221,076	221,286	218,564	216,043	216,960	221,435	224,770
	HOV	225,284	225,439	228,260	227,993	227,972	229,743	232,062	231,630	232,007	232,025	231,868

	Transit	95,126	95,126	97,058	97,058	102,745	102,745	112,697	112,697	112,697	112,848	112,615
Average percent change		-	-0.2%	1.6%	-0.1%	2.4%	0.3%	3.2%	-0.4%	0.2%	0.7%	1.2%
Access to commercial services by	SOV	2,875	2,849	2,899	2,889	2,935	2,921	2,895	2,847	2,867	2,934	2,981
	HOV	2,990	2,991	3,029	3,032	3,038	3,048	3,091	3,074	3,090	3,092	3,093
	Transit	1,302	1,302	1,325	1,325	1,408	1,408	1,568	1,568	1,568	1,570	1,566
Average percent change		-	-0.3%	1.6%	-0.1%	2.7%	0.0%	3.9%	-0.7%	0.4%	0.8%	1.3%
Comparing to prior scenario	Average Percent change	-	-0.2%	1.6%	-0.1%	2.5%	0.1%	3.5%	-0.6%	0.3%	0.8%	1.2%
	Score	**-**	**-6.9**	**45.7**	**-3.0**	**71.2**	**3.5**	**100.0**	**-16.7**	**8.5**	**22.2**	**35.1**
Comparing to 2040 Baseline	Average Percent change	-	-0.2%	1.4%	1.3%	3.8%	4.0%	7.8%	7.2%	7.5%	8.3%	8.7%
	Score	**-**	**-2.8**	**15.7**	**14.5**	**43.9**	**45.3**	**89.2**	**82.3**	**85.8**	**94.9**	**100.0**

Exhibit I-11 provides the average percent change in access scores and effectiveness score calculated for each population and the average score calculated by scenario that was used as the final score for this measure.

Exhibit I-11: Access to Jobs and Commercial Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Poverty	Average percent change in access	-	-0.2%	1.6%	-0.1%	2.5%	0.1%	3.5%	-0.6%	0.3%	0.8%	1.2%
	Score	-	-6.9	45.7	-3.0	71.2	3.5	100.0	-16.7	8.5	22.2	35.1
Minority	Average percent change in access	-	1.1%	-0.3%	2.5%	0.2%	3.3%	-0.5%	0.2%	1.0%	1.5%	-0.1%
	Score	-	34.4	-8.1	75.6	7.0	100.0	-13.9	6.8	31.7	45.0	-4.3
Disabled	Average percent change in access	-	-0.23%	1.89%	-0.19%	2.45%	0.08%	3.66%	-0.44%	0.29%	0.67%	1.08%
	Score	-	-6.2	51.8	-5.1	67.0	2.1	100.0	-12.1	8.0	18.3	29.5
No vehicle access (transit only)	Average percent change in access	-	0.0%	2.4%	0.0%	3.8%	0.0%	10.5%	0.0%	0.0%	0.0%	-0.2%
	Score	-	0	23	0	36	0	100	0	0	0	-2
Average Score		-	**-4**	**39**	**-4**	**62**	**3**	**100**	**-11**	**6**	**18**	**27**

Efficiency and Equity overall scores

Scores from each measure compared to the prior modeled scenario and 2040 funded baseline were averaged to create an effectiveness score for the Efficiency and Equity study goal.

Exhibit I-12: Efficiency and Equity Overall Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Comparing to prior scenario	Person Throughput - All	-	52.5	-39.0	50.8	10.1	39.6	-62.0	-55.1	59.1	100.0	80.9
	Person Throughput - HOV	-	90.0	-52.1	87.2	12.7	42.5	100.0	-40.2	39.2	15.1	-41.8
	Mode split	-	0.0	84.2	70.7	100.0	-0.5	21.2	-2.2	-0.6	-4.5	-6.7
	VMT	-	-9.5	100.0	62.2	0.0	-62.8	94.4	-4.3	24.5	-100.0	-100.0
	I-5 Balance	-	24.8	-11.1	27.0	-5.6	-74.5	-100.0	-26.5	69.2	100.0	94.3
	EJ access to jobs and services	-	-4.3	38.7	-4.1	62.5	3.1	100.0	-10.7	5.8	18.1	26.9
	Average	**-**	**26**	**20**	**49**	**30**	**-9**	**26**	**-23**	**33**	**21**	**9**
Comparing to 2040 Baseline	Person Throughput - All	-	35.9	7.7	42.5	49.9	77.5	31.0	-7.9	29.8	100.0	86.1
	Person Throughput - HOV	-	29.5	11.0	40.6	45.6	59.1	95.6	79.7	94.0	100.0	77.3
	Mode split	-	0.0	30.6	56.2	92.5	92.3	100.0	99.2	99.0	97.4	95.0
	VMT	-	-4.7	45.0	75.4	74.5	44.1	90.3	88.2	100.0	43.5	27.4
	I-5 Balance	-	60.9	33.7	100.0	86.3	-96.6	-100.0	-100.0	-100.0	-85.9	-99.8

	EJ access to jobs and services	-	-1.8	15.1	13.4	40.9	42.2	90.9	86.5	88.9	96.3	99.7
	Average	-	**20**	**24**	**55**	**65**	**36**	**51**	**41**	**52**	**59**	**48**

Accessibility measures

Accessibility measures look at the ease of reaching valued destinations by different modes of travel, as discussed for the previous performance measure. This study goal includes three performance measures: 1) Access to Jobs; 2) Access to Commercial Services; and 3) Travel Times on Freight Access Routes.

Access to jobs

Access to jobs measures the ease of reaching jobs by SOV, HOV and Transit for all population within the study area. Access scores were calculated according to the method described in Appendix G. The average percent change in access to jobs between the modes was used to calculate scores for this measure. The desired outcome was an increase in access to jobs so a positive scores were given to positive average percent changes.

Exhibit I-13: Access to Jobs

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Access to jobs by	SOV	215,933	214,836	218,727	217,411	220,383	220,651	218,452	216,618	217,425	221,861	225,020
	HOV	224,779	224,898	227,409	227,390	227,464	228,907	231,522	231,651	231,835	231,823	231,811
	Transit	91,838	91,838	93,939	93,939	98,480	98,480	107,431	107,431	107,431	107,561	107,346
Comparing to prior scenario	Average Percent change	-	-0.2%	1.7%	-0.2%	2.1%	0.3%	3.1%	-0.3%	0.2%	0.7%	1.1%
	Score	-	**-4.9**	**56.5**	**-6.6**	**67.5**	**8.2**	**100.0**	**-8.5**	**4.9**	**23.3**	**36.9**
Comparing to 2040 Baseline	Average Percent change	-	-0.2%	1.4%	1.3%	3.7%	4.0%	7.4%	7.0%	7.2%	7.9%	8.3%
	Score	-	**-2.5**	**17.3**	**15.6**	**44.6**	**48.2**	**89.2**	**83.8**	**86.2**	**95.1**	**100.0**

Access to commercial services

Access to Commercial services used the same methodology as the Access to Jobs measure except for the type of destination (commercial services) included in the analysis.

Exhibit I-14: Access to Commercial Services

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Access to jobs by	SOV	2,068	2,858	2,838	2,893	2,874	2,923	2,910	2,890	2,853	2,870	2,937
	HOV	2,098	2,980	2,982	3,015	3,021	3,029	3,034	3,081	3,071	3,085	3,087
	Transit	824	1,264	1,264	1,289	1,289	1,355	1,355	1,498	1,498	1,498	1,501
Comparing to prior scenario	Average Percent change	-	-0.2%	1.7%	-0.1%	2.4%	-0.1%	3.8%	-0.5%	0.4%	0.8%	1.3%
	Score	-	**-5.8**	**44.6**	**-3.9**	**62.0**	**-2.6**	**100.0**	**-14.1**	**9.5**	**21.9**	**34.4**
Comparing to 2040 Baseline	Average Percent change	-	-0.3%	1.3%	1.2%	4.0%	3.9%	8.2%	7.4%	7.8%	8.7%	9.2%
	Score	-	**-3.1**	**14.3**	**13.4**	**43.2**	**42.7**	**89.2**	**81.0**	**85.5**	**94.8**	**100.0**

Travel times on freight access routes

This measure looked at changes in travel times for all traffic on local routes providing access to important freight destinations like ports, industrial lands, and warehousing. This measure used a similar method to corridor travel times where negative changes in travel times were given positive scores. Unlike the corridor travel times, this measure did not consider changes in travel times unless they were greater than one minute. This choice was made to try and compensate for "model noise", discussed on page 46, due to the sensitivity of the local roadway network to small changes.

Exhibit I-15: Travel Times on Freight Access Routes

	-	1	2	3	4	5	6	7	8	9	10

Scenario		2040 Baseline	Operations	Sustainable Thurston Land Use	Transportation Demand Management	Intercity Transit Long-Range Plan	Part Time Shoulder Use	HOV Conversion	RTP Local Projects	Interchange Improvements	Widen I-5 – Retain HOV	Widen I-5 – All GP
College St SE	Northbound	8.9	9.8	9.1	9.0	9.0	9.2	8.9	9.0	9.2	9.0	8.8
	Southbound	12.3	13.0	12.1	11.4	11.7	10.6	11.0	11.6	10.1	11.1	10.8
Marvin Rd	Eastbound	9.7	10.0	9.2	8.9	9.0	9.3	9.8	9.1	9.3	9.0	9.2
	Westbound	18.7	18.5	15.2	16.9	15.9	16.3	15.6	13.9	15.1	14.1	15.3
Nisqually Road/ Old Pacific Hwy	Eastbound	5.1	5.1	5.0	5.0	5.0	5.0	5.0	5.1	5.0	5.2	4.9
	Westbound	5.2	5.1	5.2	5.1	5.1	5.3	5.0	4.6	4.5	4.5	4.5
Plum Street	Northbound	2.6	3.2	3.1	3.2	3.1	3.0	3.1	3.3	3.1	3.1	3.0
	Southbound	3.0	6.2	5.6	3.9	5.7	4.4	3.5	6.5	3.3	4.9	5.5
Comparing to prior scenario	Sum of Changes over 1 minute	-	0.0	-5.0	3.5	-1.3	-1.1	3.0	-4.8	1.2	0.0	0.0
	Score	**-**	**0**	**100**	**-71**	**26**	**22**	**-61**	**97**	**-24**	**0**	**0**
Comparing to 2040 Baseline	Sum of Changes over 1 minute	-	0.0	-5.8	-2.8	-4.5	-6.8	-4.4	-7.6	-7.1	-5.8	-4.8
	Score	**-**	**0**	**76**	**36**	**60**	**89**	**58**	**100**	**94**	**76**	**64**

Overall Accessibility scoring

Scores from each measure compared to the prior modeled scenario and 2040 funded baseline were averaged to create an effectiveness score for the Accessibility study goal.

Exhibit I-16: Accessibility Overall Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Comparing to prior scenario	Access to Jobs	-	-4.9	56.5	-6.6	67.5	8.2	100.0	-8.5	4.9	23.3	36.9
	Access to Services	-	-5.8	44.6	-3.9	62.0	-2.6	100.0	-14.1	9.5	21.9	34.4
	Freight Route Travel Times	-	0.0	100.0	-70.7	26.2	22.0	-60.7	97.3	-23.6	0.0	0.0
	Average	**-**	**-4**	**67**	**-27**	**52**	**9**	**46**	**25**	**-3**	**15**	**24**
Comparing to 2040 Baseline	Access to Jobs	-	-1.9	19.6	17.1	43.3	46.5	87.3	84.0	85.9	94.9	100.0
	Access to Services		-2.5	16.7	15.0	42.2	41.0	87.1	81.0	85.1	94.7	100.0
	Freight Route Travel Times		0.0	76.2	36.2	59.7	89.3	58.3	100.0	93.9	76.3	63.5
	Average	**-**	**-1**	**38**	**23**	**48**	**59**	**78**	**88**	**88**	**89**	**88**

Environment measures

The environment study goal only had one performance measure; greenhouse gas emissions. As stated on page 45, WSDOT is working with the Nisqually Indian Tribe to develop other measures for addressing the study's other environmental goals particularly around salmon habitat and flood protection.

Greenhouse gas emissions

This measure looks at the annual emissions in each scenario in metric tons of carbon dioxide equivalents (CO_2e). To compensate for potential model noise, the measure did not consider any changes in annual emissions less than 2,000 metric tons. The measure used to calculate scores was the percent change in emissions. The desired outcome was a decrease in emissions so negative percent changes were given positive scores.

This was the only measure for the environment study goal so the scores given in Exhibit G-X are also the overall scores.

Exhibit I-17: Greenhouse Gas Emissions

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Metric Tons of CO_2e per year		826,700	828,100	814,600	806,100	807,400	815,400	802,600	803,100	799,700	816,100	821,000
	Change <2,000 MT	-	0	-13,500	-8,500	0	8,000	-12,800	0	-3,400	16,400	21,300
	Percent Change	-	0.0%	-1.6%	-1.0%	0.0%	1.0%	-1.6%	0.0%	-0.4%	2.1%	2.7%

Comparing to prior scenario	Score	-	**0**	**100**	**64**	**0**	**-61**	**96**	**0**	**26**	**-100**	**-100**
Comparing to 2040 Baseline	Change <2,000 MT	-	0	-12,100	-20,600	-19,300	-11,300	-24,100	-23,600	-27,000	-10,600	-5,700
	Percent Change	-	0.0%	-1.5%	-2.5%	-2.3%	-1.4%	-2.9%	-2.9%	-3.3%	-1.3%	-0.7%
	Score	-	**0**	**45**	**76**	**71**	**42**	**89**	**87**	**100**	**39**	**21**

Resilience measures

Resilience measures look at the transportation system's ability to operate during disruption and recover from it. This study goal includes two performance measures: 1) a forced-pair comparison scoring conducted by the study technical advisory group; and 2) travel times on alternate routes to I-5 through the study area.

Forced Pair Comparison of "improving availability and/or capacity of alternate routes"

The study team used a forced-pair comparison activity, the same as used for developing study goal priorities with advisory groups as described on page 44, to score and rank how well each scenario improved the "availability and/or capacity of alternate routes." The desired outcome was increased availability and/or capacity of alternate routes.

Unlike the other measures for modeled scenarios, this measure was qualitative in nature. The scoring from each member of the technical advisory group was used to create an average score. These scores were then ranked one through then. Rank was multiplied by ten to calculate score. There were no negative scores in this measure and the score was the same for comparing to the prior modeled scenario and to the 2040 baseline.

Exhibit I-18: Forced-Pair Comparison of "Improving Availability and/or Capacity of Alternate Routes"

Scenario	- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Average forced-pair score	-	5.4	7.7	5.1	6.6	4.6	3.2	9.5	5.5	3.9	3.2
Rank	-	6	9	5	8	4	1	10	7	3	2
Score	-	**60**	**90**	**50**	**80**	**40**	**10**	**100**	**70**	**30**	**20**

Alternate route travel times

This measure looked at changes in travel times on local alternate routes to I-5 through the study area including Martin Way and Capitol Way/Boulevard. This measure used the same methodology as the Corridor Travel Times measure using percent change in the sum of travel times on the two routes in both directions to create scoring. Only changes in travel times greater than one minute were considered. The desired outcome was a decrease in travel times on alternate. Negative percent changes in travel times were given positive scores.

Exhibit I-19: Travel Times on Freight Access Routes

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Martin Way	Northbound	21.2	35.5	25.3	27.1	25.1	25.0	24.8	26.4	24.7	25.8	24.3
	Southbound	21.4	29.5	29.4	30.5	29.9	30.2	25.8	30.1	29.0	28.9	25.5
Capitol Way/ Boulevard	Eastbound	9.4	10.4	11.1	10.5	10.2	10.5	11.1	11.4	11.5	13.0	15.9
	Westbound	3.6	14.0	12.2	12.7	12.1	13.6	13.4	12.2	11.8	11.9	15.3
Comparing to prior scenario	Percent Change	-	-13.4%	3.8%	-2.4%	2.0%	-5.6%	6.4%	-3.5%	3.3%	1.7%	-2.9%
	Score	-	**100.0**	**-28.5**	**18.1**	**-14.7**	**41.7**	**-47.8**	**26.2**	**-24.5**	**-12.4**	**21.6**
Comparing to 2040 Baseline	Percent Change	-	-13.4%	-11.0%	-15.1%	-13.5%	-18.1%	-14.3%	-14.7%	-11.9%	-10.5%	-14.0%
	Score	-	**73.9**	**61.0**	**83.3**	**74.3**	**100.0**	**79.2**	**81.2**	**65.5**	**58.2**	**77.4**

Overall Resilience scoring

Scores from each measure compared to the prior modeled scenario and 2040 funded baseline were averaged to create an effectiveness score for the Resilience study goal.

Exhibit I-20: Resilience Overall Scoring

Scenario		- 2040 Baseline	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Comparing to prior scenario	Access to Jobs	-	-4.9	56.5	-6.6	67.5	8.2	100.0	-8.5	4.9	23.3	36.9
	Access to Services	-	-5.8	44.6	-3.9	62.0	-2.6	100.0	-14.1	9.5	21.9	34.4
	Average	**-**	**-4**	**67**	**-27**	**52**	**9**	**46**	**25**	**-3**	**15**	**24**
Comparing to 2040 Baseline	Access to Jobs	-	-1.9	19.6	17.1	43.3	46.5	87.3	84.0	85.9	94.9	100.0
	Access to Services		-2.5	16.7	15.0	42.2	41.0	87.1	81.0	85.1	94.7	100.0
	Average	**-**	**-1**	**38**	**23**	**48**	**59**	**78**	**88**	**88**	**89**	**88**

Overall effectiveness score calculation

The study goal weightings described on page 44 were applied to study goal effectiveness scores to arrive at an overall effectiveness score for each modeled scenario that reflect stakeholder and community priorities.

Exhibit I-21: Efficiency and Equity Overall Scoring

Scenario		Weighting Factor	1 Operations	2 Sustainable Thurston Land Use	3 Transportation Demand Management	4 Intercity Transit Long-Range Plan	5 Part Time Shoulder Use	6 HOV Conversion	7 RTP Local Projects	8 Interchange Improvements	9 Widen I-5 – Retain HOV	10 Widen I-5 – All GP
Comparing to prior scenario	Travel Times & Reliability	23.8%	-11	24	-12	14	68	-18	-35	21	54	72
	Efficiency & Equity	25.0%	26	20	49	30	-9	26	-23	33	21	9
	Accessibility	16.2%	-4	67	-27	52	9	46	25	-3	15	24
	Environment	14.4%	0	100	64	0	-61	96	0	26	-100	-100
	Resilience	20.5%	80	31	34	33	41	-19	63	23	9	21
	Overall Score	-	**20**	**42**	**21**	**26**	**15**	**20**	**3**	**21**	**8**	**13**
Comparing to 2040 Baseline	Travel Times & Reliability	23.8%	-8	10	3	13	63	44	9	35	83	100
	Efficiency & Equity	25.0%	20	24	55	65	36	51	41	52	59	48
	Accessibility	16.2%	-1	38	23	48	59	78	88	88	89	88
	Environment	14.4%	0	45	76	71	42	89	87	100	39	21
	Resilience	20.5%	67	75	67	77	70	45	91	68	44	49
	Overall Score	-	**17**	**36**	**43**	**53**	**54**	**58**	**58**	**64**	**64**	**63**