SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT
and SECTION 4(F) EVALUATION
SR 520 BRIDGE REPLACEMENT AND HOV PROGRAM

SR 520: I-5 to Medina Bridge Replacement and HOV Project

Transportation Discipline Report
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Acronyms and Abbreviations

AASHTO  American Association of State Highway and Transportation Officials
ADA        Americans with Disabilities Act
APC        automated passenger count
AVO        average vehicle occupancy
AWV        Alaskan Way Viaduct
CBD        Central Business District
CTR        Commute Trip Reduction
EA         environmental assessment
EB         eastbound
EIS        Environmental Impact Statement
ESSB       Engrossed Substitute Senate Bill
FHWA       Federal Highway Administration
GP         general purpose
GTEC       Growth and Transportation Efficiency Centers
HCT        high capacity transit
HCS        high capacity software
HOV        high-occupancy vehicle
ITS        Intelligent Transportation Systems
LOS        level-of-service
LRT        light rail transit
MOE        measure of effectiveness
n/a        not applicable
NEPA       National Environmental Policy Act
SB         southbound
SDEIS      Supplemental Draft Environmental Impact Statement
SEPA       State Environmental Policy Act
SPUI       single point urban interchange
SR         State Route
<table>
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<tbody>
<tr>
<td>TDM</td>
<td>Transportation Demand Management</td>
</tr>
<tr>
<td>TMP</td>
<td>Traffic Management Plan</td>
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<tr>
<td>TRPP</td>
<td>Trip Reduction Performance Program</td>
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<td>UW</td>
<td>University of Washington</td>
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<tr>
<td>V/C</td>
<td>volume-to-capacity</td>
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<td>vph</td>
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<td>WB</td>
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Chapter 1—Background

Why is transportation considered in an environmental impact statement?

Transportation affects everyone. Whether we are working, delivering products, driving children to school, or taking a vacation, all of us depend on a safe, efficient, reliable transportation system. Many people depend on multiple modes of travel, such as driving alone; carpooling; taking a bus, train, or plane; walking; or biking. Good connections between these various travel modes are critical to the efficient movement of people, goods, and services throughout an area.

Understanding the effects of a proposed public project and its alternatives is an important part of any environmental impact statement (EIS) and is required by law. The National and State Environmental Policy Acts (NEPA and SEPA) require federal agencies to integrate environmental values into their decision-making processes.

Federal, state, and local agencies must consider the environmental effects of their proposed actions and reasonable alternatives to those actions. For example, how would each alternative affect traffic operations on the freeways and local streets? Would congestion improve or get worse? How would each alternative affect traffic volumes? How would moving high-occupancy vehicle (HOV) lanes from the outside lane to the inside lane affect traffic operations? Would the project change traffic patterns, causing people to take a different route to work and increasing traffic at one intersection while decreasing traffic at another? Does having a toll on the Evergreen Point Bridge shift traffic patterns? If so, how? Transportation is included in our EIS because of these questions.

What is this report about?

This Transportation Discipline Report—Appendix R to the Interstate 5 (I-5) I-5 to Medina: Bridge Replacement and HOV Project Supplemental Draft EIS (SDEIS)—describes transportation conditions on the State Route (SR) 520 corridor between I-5 to the west and 84th Avenue NE to the east. The report presents transportation information for SR 520 as it exists today and estimates transportation performance and operations
for the No Build and three Build Alternative options under evaluation for this project.

Project build alternatives and options are described below in this chapter. Chapter 1 is followed by:

- **Chapter 2--Key Findings.** Summarizes the most important information and findings of the transportation analysis.

- **Chapter 3--Travel Demand Modeling.** Describes how the project travel demand model was developed, updated during the project, and used to estimate future growth and changes in travel patterns for the Build and No Build Alternatives.

- **Chapter 4--Transportation Forecasts and Operations Analysis Methodology.** Provides the methodology of the detailed project-level forecasts developed and the methodology for conducting the detailed traffic operational analysis.

- **Chapter 5--Freeway Volumes and Operations.** Describes the existing freeway forecasts results and operating conditions for the project corridor. Compares the future No Build Alternative with the 6-Lane Alternative options.

- **Chapter 6--Local Volumes and Operations.** Describes the existing forecast results and operating conditions at local intersections. Compares the future No Build Alternative with the 6-Lane Alternative options.

- **Chapter 7--Nonmotorized Facilities.** Describes existing bicycle, pedestrian, and other nonmotorized transportation facilities as well as improvements proposed as part of the SR 520 Bridge Replacement and HOV Project.

- **Chapter 8--Transit Operations.** Describes and quantifies how the project alternatives affect SR 520 corridor bus service and person-moving capacity.

- **Chapter 9--Parking Supply.** Evaluates the existing parking supply, estimated demand, and estimated use and determines the effects of each alternative’s proposed design on parking supply.

- **Chapter 10--Construction Effects.** Describes the effects of construction on traffic and parking for each of the project alternatives and identifies temporary measures to mitigate the effect of construction on traffic.
• **Chapter 11--Cumulative Transportation Effects.** Identifies the cumulative effects of the project alternatives in combination with a regional package of additional transportation facility improvements (such as the Mercer Corridor Improvements, I-405 Nickel Projects, LInK Light Rail, Alaskan Way Viaduct and Seawall Replacement Project, Seattle Monorail, and improvements to the east end of SR 520).

• **Chapter 12--Traffic and Parking Improvement Guidelines.** Presents the approach and guidelines for determining the extent and timing of mitigation for freeway and local street operations and parking supply.

• **Chapter 13--References.** Lists all of the documentation cited in this report.

**What is the I-5 to Medina: Bridge Replacement and HOV Project?**

The I-5 to Medina: Bridge Replacement and HOV Project is part of the SR 520 Bridge Replacement and HOV Program (described in the right column) and encompasses parts of three main geographic areas: Seattle, Lake Washington, and the Eastside. The project area includes the following:

- **Seattle communities:** Portage Bay/Roanoke, North Capitol Hill, Montlake, University District, Laurelhurst, and Madison Park
- **Eastside communities:** Medina, Hunts Point, Clyde Hill, and Yarrow Point
- **The Lake Washington ecosystem and associated wetlands**
- **Usual and accustomed fishing areas of tribal nations that have historically used the area’s aquatic resources and have treaty rights**

The SR 520 Bridge Replacement and HOV Project Draft EIS, published in August 2006, evaluated a 4-Lane Alternative, a 6-Lane Alternative, and a No Build Alternative. Since the Draft EIS was published, circumstances surrounding the SR 520 corridor have changed in several ways. These changes have resulted in decisions to...
advance planning for potential catastrophic failure of the Evergreen Point Bridge, respond to increased demand for transit service on the Eastside, and evaluate a new set of community-based designs for the Montlake area in Seattle.

To respond to these changes, the Washington State Department of Transportation (WSDOT) and the Federal Highway Administration (FHWA) initiated new projects to be evaluated in separate environmental documents. Improvements to the western portion of the SR 520 corridor—known as the I-5 to Medina: Bridge Replacement and HOV Project (the I-5 to Medina project)—are being evaluated as part of this SDEIS. Project limits for this project extend from I-5 in Seattle to 92nd Avenue NE in Yarrow Point, where it transitions into the Medina to SR 202: Eastside Transit and HOV Project. Exhibit 1-1 shows the project vicinity.

What are the project alternatives?

As noted above, the Draft EIS evaluated a 4-Lane Alternative, a 6-Lane Alternative (including three design options in Seattle), and a No Build Alternative. In 2006, following Draft EIS publication, Governor Gregoire identified the 6-Lane Alternative as the state’s preference for the SR 520 corridor, but urged that the affected communities in Seattle develop a common vision for the western portion of the corridor.

Accordingly, a mediation group convened at the direction of the state legislature to evaluate the corridor alignment for SR 520 through Seattle. The mediation group identified three 6-lane design options for SR 520 between I-5 and the floating span of the Evergreen Point Bridge; these options were documented in a Project Impact Plan (Paramentrix 2008). The SDEIS evaluates the following:

- No Build Alternative
- 6-Lane Alternative
  - Option A
  - Option K
  - Option L

These alternatives and options are summarized below. The 4-Lane Alternative and the Draft EIS 6-lane design options were eliminated from further consideration. More information on how the project has
evolved since the Draft EIS was published in 2006, as well as more detailed information on the design options, is provided in the Description of Alternatives Discipline Report (WSDOT 2009a).

**What is the No Build Alternative?**

Under the No Build Alternative, SR 520 would continue to operate between I-5 and Medina as it does today: as a 4-lane highway with nonstandard shoulders and without a bicycle/pedestrian path. Exhibit 1-2 depicts a cross section of the No Build Alternative. No new facilities would be added to SR 520 between I-5 and Medina, and none would be removed, including the unused R.H. Thomson Expressway ramps near the Washington Park Arboretum. WSDOT would continue to manage traffic using its existing transportation demand management and intelligent transportation system strategies.

The No Build Alternative assumes that the Portage Bay and Evergreen Point bridges would remain standing and functional through 2030 and that no catastrophic events, such as earthquakes or extreme storms, would cause major damage to the bridges. The No Build Alternative also assumes completion of the Medina to SR 202 project as well as other regionally planned and programmed transportation projects (see Chapter 4 for more information). For the transportation analysis included in this report, it was assumed that traffic in the No Build Alternative would not be tolled. The No Build Alternative provides a baseline against which project analysts can measure and compare the effects of each build alternative option.

**What is the 6-Lane Alternative?**

The 6-Lane Alternative would complete the regional HOV connection (3+ HOV occupancy) across SR 520 and implement tolling. For the transportation analysis included in this report, HOVs (3+ carpools and buses) were assumed to be exempt from tolling.
This alternative would include six lanes (two 11-foot-wide outer general-purpose lanes and one 12-foot-wide inside HOV lane in each direction), with 4-foot-wide inside and 10-foot-wide outside shoulders (Exhibit 1-3). The proposed width of the roadway would be approximately 18 feet narrower than the one described in the Draft EIS, reflecting public comment from local communities and the City of Seattle.

Exhibit 1-3. 6-Lane Alternative Cross Section

SR 520 would be rebuilt from I-5 to Evergreen Point Road in Medina and restriped and reconfigured from Evergreen Point Road to 92nd Avenue NE in Yarrow Point. A 14-foot-wide bicycle/pedestrian path would be built along the north side of SR 520 through the Montlake area and across the Evergreen Point Bridge, connecting to the regional path on the Eastside. A bridge maintenance facility and dock would be built underneath the east approach to the Evergreen Point Bridge.

The sections below describe the 6-Lane Alternative and design options in each of the three geographical areas the project would encompass.

**Seattle**

**Elements Common to the 6-Lane Alternative Options**

SR 520 would connect to I-5 in a configuration similar to the way it connects today. Improvements to this interchange would include a new reversible HOV ramp connecting the new SR 520 HOV lanes to existing I-5 reversible express lanes. WSDOT would replace the Portage Bay Bridge and the Evergreen Point Bridge (including the west approach and floating span), as well as the existing local street bridges across SR 520. New stormwater facilities would be constructed for the project to provide stormwater retention and treatment. The project would include landscaped lids across SR 520 at I-5, 10th Avenue East, and Delmar Drive East, and in the Montlake area to help reconnect the
communities on either side of the roadway. The project would also remove the Montlake Freeway Transit Station under all of the options.

The most substantial differences among the three options are the interchange configurations in the Montlake and University of Washington areas. Exhibit 1-4 depicts these key differences in interchange configurations; the following text describes elements unique to each option.

**Option A**
Option A would replace the Portage Bay Bridge with a new bridge that would include six lanes (four general-purpose lanes and two HOV lanes) plus a westbound auxiliary lane. WSDOT would replace the existing interchange at Montlake Boulevard East with a new, similarly configured interchange that would include a transit-only off-ramp from westbound SR 520 to northbound Montlake Boulevard.

The Lake Washington Boulevard ramps and the median freeway transit stop near Montlake Boulevard East would be removed, and a new bascule bridge would be added to Montlake Boulevard NE, parallel to the existing Montlake Bridge. SR 520 would maintain a low profile through the Washington Park Arboretum and flatten out east of Foster Island, before rising to the west transition span of the Evergreen Point Bridge. Citizen recommendations made during the mediation process defined this option to include sound walls and/or quieter pavement, subject to neighborhood approval and WSDOT’s reasonability and feasibility determinations.

Option A suboptions would include adding an eastbound SR 520 on-ramp and westbound SR 520 off-ramp to Lake Washington Boulevard, creating a similar intersection to the one that exists today but northwest of its current location. This suboption would also include adding an eastbound HOV (3+ carpools and buses) direct access on-ramp from Montlake Boulevard East, and providing a constant slope profile from 24th Avenue East to the west transition span.

Additional intersection detail and exhibits for Option A and Suboption A are provided in Chapter 6.

**Option K**
Option K would also replace the Portage Bay Bridge, but the new bridge would include four general-purpose lanes and two HOV lanes with no westbound auxiliary lane. In the Montlake area, Option K would remove the existing Montlake Boulevard East interchange and
Exhibit 1-4. Options A, K, and L: Montlake and University of Washington Areas
I-5 to Medina: Bridge Replacement and HOV Project

Source: King County (2006) Aerial Photo, King County (2005) GIS Data (Streams), City of Seattle (1994) GIS Data (Bike/Ped Trail), Seattle Bicycle Map (2008) GIS Data (Bike/Ped Trail) CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.
the Lake Washington Boulevard ramps and replace their functions with a depressed, single-point urban interchange (SPUI) at the Montlake shoreline. Two HOV direct-access ramps would service the new interchange, and a tunnel under the Montlake Cut would move traffic from the new interchange north to the intersection of Montlake Boulevard NE and NE Pacific Street.

SR 520 would maintain a low profile through Union Bay, make landfall at Foster Island, and remain flat before rising to the west transition span of the Evergreen Point Bridge. A land bridge would be constructed over SR 520 at Foster Island. Citizen recommendations made during the mediation process redefined this option to include quieter pavement for noise abatement instead of sound walls included in the 2006 Draft EIS. However, because quieter pavement has not been demonstrated to meet all FHWA and WSDOT avoidance and minimization requirements in tests performed in Washington State, it cannot be considered as noise mitigation under WSDOT and FHWA criteria. As a result, sound walls could be included in Option K. The decision to build sound walls depends on neighborhood interest, the findings of the Noise Discipline Report (WSDOT 2009b), and WSDOT’s reasonability and feasibility determinations.

A suboption for Option K would include constructing an eastbound off-ramp to Montlake Boulevard East configured for right turns only (see Exhibit 1-5). Additional intersection detail and exhibits for Option K and its suboption are provided in Chapter 6.

**Option L**

Under Option L, the Montlake Boulevard East interchange and the Lake Washington Boulevard ramps would be replaced with a new, elevated SPUI at the Montlake shoreline. A new bascule bridge would span the
east end of the Montlake Cut from the new interchange to the intersection of Montlake Boulevard NE and NE Pacific Street.

This option would also include a ramp connection to Lake Washington Boulevard and two HOV direct-access ramps providing service to and from the east at the new interchange. SR 520 would maintain a low, constant slope profile from 24th Avenue East to just west of the west transition span of the floating bridge. Noise mitigation identified for this option would include sound walls as defined in the Draft EIS.

Exhibit 1-5. Suboptions A, K, and L: Montlake Area

Suboptions for Option L would include adding a left-turn movement from Lake Washington Boulevard for direct access to SR 520 and adding capacity on northbound Montlake Boulevard NE to NE 45th Street. Additional intersection detail and exhibits for Option L and its suboption are provided in Chapter 6.

**Lake Washington**

**Floating Bridge**
The floating span would be located approximately 190 feet north of the existing bridge at the west end and 160 feet north at the east end.
(Exhibit 1-6). Rows of three 10-foot-tall concrete columns would support the roadway above the pontoons, and the new span would be approximately 22 feet higher than the existing bridge. A 14-foot-wide bicycle/pedestrian path would be located on the north side of the bridge.

The design for the new 6-lane floating bridge includes 21 longitudinal pontoons, two cross pontoons, and 54 supplemental stability pontoons. A single row of 75-foot-wide by 360-foot-long longitudinal pontoons would support the new floating bridge. One 240-foot-long by 75-foot-wide cross-pontoon at each end of the bridge would be set perpendicularly to the longitudinal pontoons. The longitudinal pontoons would be bolstered by the smaller supplemental stability pontoons on each side for stability and buoyancy. The longitudinal pontoons would not be sized to carry future high-capacity transit (HCT), but would be equipped with connections for additional supplemental stability pontoons to support HCT in the future.

As with the existing floating bridge, the floating pontoons for the new bridge would be anchored to the lake bottom to hold the bridge in place.

The roadway would be widened near the east approach of the new bridge to accommodate transit ramps to the Evergreen Point Road Freeway Transit Station. Exhibit 1-6 shows the alignment of the floating bridge, the west and east approaches, and the connection to the east shore of Lake Washington.

**Bridge Maintenance Facility**

Routine access, maintenance, monitoring, inspections, and emergency response for the floating bridge would be based out of a new bridge maintenance facility located underneath SR 520 between the east shore of Lake Washington and Evergreen Point Road in Medina. This bridge maintenance facility would include a working dock, an approximately 7,200-square-foot maintenance building, and a parking area.

**Eastside Transition Area**

The I-5 to Medina and Medina to SR 202 projects overlap between Evergreen Point Road and 92nd Avenue NE in Yarrow Point. Work planned as part of the I-5 to Medina project between Evergreen Point Road and 92nd Avenue NW would include moving the Evergreen Point Road Freeway Transit Station west to the lid (part of the Medina to SR 202 project) at Evergreen Point Road, adding new lane and ramp
Source: King County (2006) Aerial Photo, CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.
striping from the Evergreen Point lid to 92nd Avenue NE, and moving and realigning traffic barriers as a result of the new lane striping. The restriping would transition the I-5 to Medina project improvements into the improvements to be completed as part of the Medina to SR 202 project.

**Pontoon Construction and Transport**

If the floating portion of the Evergreen Point Bridge does not fail before its planned replacement, WSDOT would use the pontoons constructed and stored as part of the Pontoon Construction Project for the I-5 to Medina project.

Up to 11 longitudinal pontoons built and stored in Grays Harbor as part of the Pontoon Construction Project would be towed from a moorage location in Grays Harbor to Puget Sound for outfitting (see the sidebar to the right for an explanation of pontoon outfitting). All outfitted pontoons, as well as the remaining pontoons stored at Grays Harbor, would be towed to Lake Washington for incorporation into the floating bridge. Towing would occur as weather permits during the months of March through October. Exhibit 1-7 illustrates the general towing route from Grays Harbor to Lake Washington, and identifies potential outfitting locations.

Did you know?

Pontoon outfitting is a process by which the columns and elevated roadway of the bridge are built directly on the surface of the pontoon.

Exhibit 1-7. Possible Towing Route and Pontoon Outfitting Locations
The I-5 to Medina project would build an additional 44 pontoons needed to complete the new 6-lane floating bridge. The additional pontoons could be constructed at the existing Concrete Technology Corporation facility in Tacoma, and/or at a new facility in Grays Harbor that is also being developed as part of the Pontoon Construction Project. The new supplemental stability pontoons would be towed from the construction location to Lake Washington for incorporation into the floating bridge. For additional information about pontoon construction, please see the I-5 to Medina: Bridge Replacement and HOV Project, Construction Techniques and Activities Discipline Report (WSDOT 2009c).

**Would the project be built all at once or in phases?**

Revenue sources for the I-5 to Medina project would include allocations from various state and federal sources and from future tolling, but there remains a gap between the estimated cost of the project and the revenue available to build it. Because of these funding limitations, there is a strong possibility that WSDOT would construct the project in phases over time.

If the project is phased, WSDOT would first complete one or more of those project components that are vulnerable to earthquakes and windstorms; these components include the following:

- The floating portion of the Evergreen Point Bridge, which is vulnerable to windstorms. This is the highest priority in the corridor because of the frequency of severe storms and the high associated risk of catastrophic failure.
- The Portage Bay Bridge, which is vulnerable to earthquakes. This is a slightly lower priority than the floating bridge because the frequency of severe earthquakes is significantly less than that of severe storms.
- The west approach of the Evergreen Point Bridge, which is vulnerable to earthquakes (see comments above for the Portage Bay Bridge).

Exhibit 1-8 shows the vulnerable portions of the project that would be prioritized, as well as the portions that would be constructed later. The vulnerable structures are collectively referred to in the SDEIS as the
Phased Implementation scenario. It is important to note that, while the new bridge(s) might be the only part of the project in place for a certain period of time, WSDOT’s intent is to build a complete project that meets all aspects of the purpose and need.

The Phased Implementation scenario would provide new structures to replace the vulnerable bridges in the SR 520 corridor, as well as limited transitional sections to connect the new bridges to existing facilities. This scenario would include stormwater facilities, noise mitigation, and the regional bicycle/pedestrian path, but lids would be deferred until a subsequent phase. WSDOT would develop and implement all mitigation needed to satisfy regulatory requirements.

To address the potential for phased project implementation, the SDEIS evaluates the Phased Implementation scenario separately as a subset of the “full build” analysis. The evaluation focuses on how the effects of phased implementation would differ from those of full build and on how constructing the project in phases might have different effects from constructing it all at one time. Impact calculations for the physical effects of phased implementation (for example, acres of wetlands and parks affected) are presented alongside those for full build where applicable.

Exhibit 1-8. Geographic Areas along SR 520 and Project Phasing
Chapter 2—Key Findings

What is in this chapter?

This chapter presents key findings of the transportation effects analysis for the I-5 to Medina: Bridge Replacement and HOV Project. The analysis includes freeway operations, local roadway operations, nonmotorized facilities, transit, parking, construction effects, and cumulative effects. These topics are summarized below and described in detail in Chapters 5 through 12 of this Transportation Discipline Report.

What are the key findings for freeway traffic?

The configuration of SR 520 today, with its narrow shoulders and incomplete HOV lane system, makes the corridor especially prone to traffic congestion. Traffic operations on SR 520 are affected by traffic operations on I-5, I-405, and on- and off-ramp traffic along SR 520 itself. SR 520 congestion lasts for several hours, both in the morning and the afternoon.

SR 520 often becomes congested when there are backups on I-5 through downtown Seattle and on I-405 at the ramps to and from SR 520. Congestion points include “weave” areas where entering and exiting traffic is changing lanes at the same time, places where a lane ends (for example, the end of the westbound HOV lane before the SR 520 bridge), and locations where a high volume of exiting vehicles causes traffic to back up onto the freeway mainline.

A major source of congestion on SR 520 is “non-recurrent” in nature, meaning it is caused by unpredictable incidents such as traffic accidents or stalled vehicles. SR 520’s narrow shoulders do not allow disabled vehicles to pull over out of the travel lane, creating congestion. Emergency vehicles and tow trucks have a difficult time getting through traffic that has backed up behind the incident; as a result, even a simple stall can snarl traffic for a long time.
No Build Alternative

Between now and the year 2030, regional population is estimated to grow by 1.1 million people with possibly 850,000 new jobs being added, and the transportation system will need to accommodate close to 50 percent more traffic (PSRC 2007). In Seattle, the largest increases in population and employment are forecasted in the South Lake Union, Denny Regrade/Triangle, and downtown Seattle areas. The largest forecasted increases on the Eastside are downtown Redmond, the Redmond/Overlake area, and downtown Bellevue. With this growth, traffic volumes and congestion will be affected as described below:

- Daily traffic demand across Lake Washington would increase by 17 percent on SR 520, 34 percent on I-90, and 29 percent on SR 522.

- On SR 520, morning peak period demand would increase 10 percent and afternoon peak period demand would increase 16 percent compared to today. Peak period congestion would be worse than today.

- By the year 2030, I-405 congestion will back up onto SR 520 and have substantial effects on travel times between I-5 and SR 202.
  - Westbound general-purpose travel times will increase approximately 20 to 30 minutes compared to today. Eastbound general-purpose travel times will increase up to 1 hour.
  - Westbound HOV travel times will improve compared to today because of the completion of the SR 520 program’s Medina to SR 202: Eastside Transit and HOV Project.
  - Eastbound HOV travel times between I-5 and SR 202 will worsen up to 30 minutes because I-405 congestion would back up east of 84th Avenue NE, blocking access to the eastbound HOV lane at 108th Avenue NE.

6-Lane Alternative

With the 6-Lane Alternative, the SR 520 corridor would be tolled, which would cause some drivers to change their travel mode (bus or carpool), time of day for travel, or their route. The 6-Lane Alternative options would not generate more regional traffic, but would change traffic circulation patterns to and from SR 520. The greatest effects would occur in the SR 520/Montlake Boulevard interchange area and across the Portage Bay Bridge.
Although there are several interchange options in the Montlake area, they all have a 6-lane corridor with complete HOV lanes and would provide similar regional travel benefits. The different options would result in similar traffic volumes across the SR 520 bridge.

The effects of the 6-Lane Alternative that would occur, regardless of which Seattle interchange option is selected, are discussed below. The effects that are specific to each of the options are discussed in the section that follows. The 6-Lane Alternative and its options are compared to the No Build Alternative.

- The 6-Lane Alternative HOV system and design improvements would substantially reduce congestion at two of the most congested locations on SR 520 compared to the No Build Alternative:
  - Approaching the SR 520 bridge in Medina (westbound)
  - Approaching the SR 520 bridge in Seattle (eastbound)

- Comparing the No Build Alternative with the 6-Lane Alternative, year 2030 congestion and HOV travel times between I-5 and SR 202 would be reduced between an average of 2 to 8 minutes during the morning peak period and 5 minutes during the evening peak period. However, during the peak of the evening commute period, the completion of the eastbound HOV lane could save both general-purpose and HOV vehicles approximately 40 minutes.

- Tolling and the completion of the HOV lane with the 6-Lane Alternative would reduce daily vehicle volumes across SR 520 by up to 4,700 vehicles (or 3 percent) compared to the No Build Alternative. Some people would choose to take other modes of travel (such as transit, carpools, vanpools, and bike), change time of travel, or select a different route.

- Daily person trips across SR 520 would increase by up to 14,400 people (6 percent) because completing the HOV lane system between I-5 and SR 202 and/or tolling the corridor would increase carpools and bus use.

- General-purpose vehicle trips would decrease by up to 10,000 vehicles per day and general-purpose person trips would decrease by up to 13,500 persons per day.
6-Lane Alternative peak period demand would increase by nearly 500 vehicles per hour (vph) and 1,700 people per hour during the commute periods compared to the No Build Alternative.

The 6-Lane Alternative would allow SR 520 to serve more traffic than the No Build Alternative during the peak period: up to approximately 700 more vph and 2,100 more people per hour.

6-Lane Alternative Options

The 6-Lane Alternative options have similar effects on freeway volumes and operations across the SR 520 bridge, but different effects west of the bridge at the following locations.

- In the Montlake area:
  - Option A, which would remove the Lake Washington Boulevard ramps to SR 520. As a result, traffic volumes would increase at the SR 520/Montlake Boulevard interchange ramps.
  - With Option A, some drivers would use the SR 520/I-5/East Roanoke and I-5/NE 45th Street interchanges to travel between SR 520 and the local arterials (up to 450 vph). This diversion would increase traffic in the Harvard/Roanoke neighborhood and increase traffic along the NE 45th Street corridor. The diversion would also decrease traffic volumes north of the Montlake Boulevard NE/NE Pacific Street intersection compared to the No Build Alternative.
  - With Suboption A (with Lake Washington Boulevard ramps), access to SR 520 (and therefore traffic volumes) would be similar to the No Build Alternative.
  - With Options K and L, traffic volumes at the SR 520/I-5/East Roanoke and I-5/NE 45th Street interchanges would be similar to the No Build Alternative.
  - Freeway traffic volumes with Suboptions K and L would be the same as with Options K and L. The suboptions would affect how traffic would distribute to the local street network, which is discussed later in this chapter.
Across the Portage Bay Bridge:

- Option A would increase traffic volumes on SR 520 between Montlake Boulevard and I-5 during morning and afternoon peak hours (300 to 500 vph more than the No Build Alternative) due to removal of the Lake Washington Boulevard ramps.

- Option A adds an auxiliary lane on SR 520 between Montlake and I-5 to help reduce westbound congestion at the merge point with the Montlake on-ramp and approaching I-5.

- Suboption A (with the Lake Washington Boulevard ramps) would have similar traffic volumes as the No Build Alternative because the Lake Washington Boulevard ramps remain open.

- Option K or L would decrease traffic volumes on SR 520 between Montlake and I-5 compared to the No Build Alternative because drivers would shift their travel routes to the new interchange and its associated increase in capacity in the Montlake area.

- Even though SR 520 traffic volumes would decrease between Montlake and I-5, some westbound congestion would remain because neither Option K nor L includes the westbound auxiliary lane.

- With Option K or L, congestion on SR 520 would also affect ramp traffic at the new interchange, spilling back onto the local system.

- Traffic volumes and operations between I-5 and Montlake Boulevard NE for Suboptions K and L would be the same as with Options K and L.

- At the SR 520/I-5/Roanoke and I-5/NE 45th Street interchange areas:

  - Option A would increase freeway ramp volumes by up to 220 vph at these interchange areas due to removal of the Lake Washington Boulevard ramps.

  - Suboption A (with the Lake Washington Boulevard ramps), Options K and L, and Suboptions K and L would have traffic volumes similar to the No Build Alternative.
What are the key findings for local street traffic?

The 6-Lane Alternative options would have the greatest effects on traffic volumes in the Montlake Boulevard interchange area. The effects in the Montlake Boulevard interchange area then result in slight changes in local traffic volumes in the East Roanoke Street and NE 45th Street interchange areas. Overall, intersections operations at 9 of the 39 study intersections would be affected by the project. These intersections include:

**NE 45th Street Interchange Area**
- The NE 45th Street/7th Avenue NE intersection would worsen from LOS D with the No Build Alternative to LOS E during the afternoon peak hour with Option A.

**Roanoke Street Interchange Area**
- The Harvard Avenue East/I-5 northbound on-ramp intersection would worsen from LOS E with the No Build Alternative to LOS F during the afternoon peak hour with all of the 6-Lane Alternative options.
- The Boylston Avenue East/East Lynn Street intersection would worsen from LOS E with the No Build Alternative to LOS F during the morning peak hour with all of the 6-Lane Alternative options.
- The Lakeview/I-5 northbound off-ramp intersection would worsen from LOS C with the No Build Alternative to LOS F during the morning peak hour with all of the 6-Lane Alternative options.

**Montlake Interchange Area**
- The 15th Avenue NE/NE Pacific Street intersection would improve from LOS E with the No Build Alternative to LOS D during the morning peak hour with Option A and its suboption.
- The Montlake Boulevard NE/NE Pacific Street intersection would improve from LOS F with the No Build Alternative to LOS E during the afternoon peak hour with Option A and its suboption.
- The Montlake Boulevard NE/East Shelby Street intersection would improve from LOS F with the No Build Alternative to LOS A
during the afternoon peak hour with all of the 6-Lane Alternative options

- The Montlake Boulevard NE/Lake Washington Boulevard intersection would improve from LOS E with the No Build Alternative to LOS D or better during the morning peak hour with all of the 6-Lane Alternative options. During the afternoon peak hour, this intersection would improve from LOS F with the No Build Alternative to LOS E with Option A, Suboption A, and Option K and to LOS C with Suboption K.

- The Lake Washington Boulevard/SR 520 ramps intersection would improve from LOS E with the No Build Alternative to better than LOS D during the afternoon peak hour with all of the 6-Lane Alternative options except Suboption L. With Suboption L, this intersection would worsen to LOS F.

**Existing Conditions**

Congestion on SR 520 affects local traffic operations on Montlake and Lake Washington Boulevards. The SR 520/Montlake Boulevard interchange ramps, especially the SR 520 eastbound off-ramp/Montlake Boulevard NE intersection, are frequently congested during the morning and afternoon peak hours. Traffic typically backs up on Montlake Boulevard southbound approaching the SR 520 eastbound on-ramp. Traffic congestion can extend across the Montlake Bridge to the Montlake Boulevard NE/NE Pacific Street intersection and as far back as 25th Avenue NE near University Village (approximately 1 mile).

Montlake Boulevard NE is also an important transit corridor, serving both local and regional buses between the SR 520 interchange and the University District. Montlake Boulevard NE, NE Pacific Street, and 15th Avenue NE are considered Urban Village Transit Network (UVTN) corridors as identified in the Seattle Transit Plan (August 2005). Congestion in the Montlake area affects transit service efficiency and reliability, constraining transit service.

Factors that contribute to the congestion in the Montlake Boulevard interchange area are described in more detail below.

- During the morning peak period, congestion occurs on SR 520 eastbound approaching the west transition span of the floating bridge due to roadway curves, sight distance issues, and short
acceleration lengths for the Lake Washington Boulevard and Montlake Boulevard on-ramps.

- SR 520 mainline congestion also affects on-ramp operations, which results in congestion on Montlake and Lake Washington Boulevards.

- Drivers traveling northbound on Montlake Boulevard NE who want to access SR 520 westbound must make a U-turn at the Montlake Boulevard/East Hamlin Street intersection. These vehicles often spill out of the U-turn pocket, blocking the inside northbound lane on Montlake Boulevard.

- Montlake Bridge openings can have long-lasting effects on traffic flow in this area. The bridge does not open during the morning and afternoon peak periods; however, the last opening at 3:30 p.m. can affect traffic operations throughout the afternoon commute.

- Bridge openings compound whatever congestion is present on the local street network and can cause traffic on the SR 520 westbound and eastbound off-ramps to back up onto the SR 520 mainline. Congestion on the eastbound off-ramp can affect traffic on I-5.

- Montlake Bridge opening delays affect travel times and reliability for all travelers. This makes it difficult for bus drivers to keep to their schedules, affects bus travel time reliability, increases transit service costs, and can make transit a less attractive option to driving alone.

**No Build Alternative**

Growing population and employment in the region between now and the year 2030 will cause traffic volumes to increase by up to 24 percent in some of the project study interchange areas.

- The biggest increases in local traffic volumes by the year 2030 would occur in the Montlake (24 percent) and Roanoke (21 percent) interchange areas during the afternoon commute period.

- Without the project, operations would worsen at 2 of the 39 study intersections during the morning commute period and 9 intersections during the afternoon commute period.
6-Lane Alternative

The 6-Lane Alternative options would provide new or revised connections to SR 520 in the SR 520/Montlake Boulevard and Lake Washington Boulevard interchange area. All of the options would add a ramp meter to the Montlake westbound on-ramp to SR 520. As a result of these revised connections, one of the study intersections would improve (compared to the No Build Alternative) in the morning commute period and six would improve during the afternoon commute period. The new or revised connections and their effects in the Montlake and surrounding areas are described below.

- Option A would provide similar SR 520 connections to what currently exists at Montlake Boulevard and remove the ramps to and from Lake Washington Boulevard, which would have the following results:
  - Less traffic in the Arboretum compared to the No Build Alternative (up to 900 vph)
  - Increased traffic volumes and congestion approaching the Montlake Boulevard/Lake Washington Boulevard/SR 520 eastbound on-ramp intersection
  - Increased traffic and congestion at the Harvard/Roanoke intersection and I-5/East Roanoke Street and I-5/NE 45th Street interchange areas

- Suboption A would retain but reconfigure the SR 520 westbound off-ramp and eastbound on-ramp with Lake Washington Boulevard. This would result in traffic volumes and intersection operations in the overall SR 520/Montlake Boulevard interchange area being similar to the No Build Alternative.

- Option K would provide a new SR 520 interchange east of Montlake Boulevard with a tunnel connection between the interchange and the Montlake Boulevard/NE Pacific Street intersection. This configuration would have the following results:
  - Provide a new crossing of the Montlake Cut that would not be affected by boat traffic (i.e., subject to bridge openings)
  - Reduce traffic (up to 2,000 vph) and improve local circulation on Montlake Boulevard between East Roanoke Street and the Montlake Cut
- Increase traffic on Lake Washington Boulevard south of the SR 520 ramps (up to 300 vph) compared to the No Build Alternative because drivers would be able to access the new interchange from both directions on Lake Washington Boulevard.

- Increase traffic on Lake Washington Boulevard northwest of the SR 520 ramps (up to 600 vph) compared to the No Build Alternative.

- Increase congestion at the Montlake Boulevard NE/NE Pacific Street intersection due to increases in traffic volumes to and from the north.

- Suboption K would include an eastbound-to-southbound only off-ramp to Montlake Boulevard NE, with approximately 110 vph in the morning peak hour and 240 vph in the afternoon peak hour.

- With the eastbound off-ramp to Montlake Boulevard NE, traffic volumes at the SR 520/SPUI and on the traffic turnaround roadway would be less than Option K. As a result, driver delay would be reduced during both the morning and afternoon peak hours.

- Option L traffic volumes would be similar to Option K except on Montlake Boulevard (between the Montlake Bridge and East Roanoke Street). Option L would also provide a new interchange east of Montlake Boulevard, but would have a new bascule bridge connection between the SR 520 interchange and the Montlake Boulevard NE/NE Pacific Street intersection. This bridge would:
  - Be subject to openings for boat traffic (unlike the tunnel under Option K)
  - Reduce traffic (up to 1,700 vph) and improve local circulation on Montlake Boulevard between East Roanoke Street and the Montlake Cut compared to the No Build Alternative.

Suboption L would allow drivers to turn left from Lake Washington Boulevard southbound to access SR 520. This results in a shift away from the Montlake Bridge to Lake Washington Boulevard of 710 vph in the morning peak hour and 490 vph during the afternoon peak hour.

These changes would worsen operations at the SR 520 ramps/Lake Washington Boulevard intersection from LOS C to D in the morning.
peak hour and from LOS E to F in the afternoon peak hour compared to the No Build Alternative. Suboption L operations at this intersection would also be worse than with Option L.

- Suboption L would reduce congestion at the Montlake Boulevard NE/NE Pacific Street intersection compared to both Option L and the No Build Alternative. This is because some drivers would use Lake Washington Boulevard and because a northbound through lane to 25th Avenue Northeast would be added on Montlake Boulevard.

- With Suboption L, the SR 520/SPUI intersection operations would degrade from LOS D to E in the morning peak hour (compared to Option L), caused by the increase in volumes from south of the SPUI.

**What are the key findings for nonmotorized travel?**

The new SR 520 bridge would include a 14-foot-wide dedicated right-of-way bicycle/pedestrian path across the bridge to Montlake Boulevard NE. The SR 520 Regional Bike Path would connect regional bicycle and pedestrian facilities on both sides of the lake. Non-motorized travel times could improve, as nonmotorized travelers would no longer have to wait for buses to cross the lake. Bicyclists and pedestrians would continue to reach the SR 520 corridor in Seattle via a combination of trails and on-street bicycle lanes.

Bicyclists who wish to cross Lake Washington by bus, during inclement weather or at night for example, would be able to board on NE Pacific Street near Montlake Boulevard. The number of buses with available bike racks would be reduced because transfers to buses on Seattle routes would not be possible when the Montlake Freeway Transit Station is removed.

The project would improve the nonmotorized travel experience by providing three landscaped lids at:

- SR 520 at I-5
- 10th Avenue East and Delmar Drive East
- the Montlake area
These lids would help reconnect the communities on either side of the roadway.

The goals for nonmotorized travel in the project vicinity are to provide access across Lake Washington between Seattle and the Eastside communities as well as to improve bicycle/pedestrian connections between the neighborhoods of North Capitol Hill, Roanoke/Portage Bay, Montlake, and the University District. The proposed project would fulfill these goals by constructing a bicycle/pedestrian path on the SR 520 bridge as well as bicycle/pedestrian path connections across new lids constructed as a part of the project to increase east-west nonmotorized travel across SR 520.

The options would affect the non-motorized environment in the Arboretum by either decreasing or increasing vehicle volumes. Compared to the No Build Alternative, Option A would reduce vehicle traffic in the Arboretum by up to 900 vph, improving the walking, bicycling, and recreation environment. Suboption A traffic volumes would be similar to the No Build Alternative. Options K and L and their suboptions would increase traffic by up to 300 vph through the Arboretum.

**What are the key findings for transit?**

Traffic congestion along the SR 520 corridor, combined with frequent and highly unpredictable delays caused by traffic accidents and minor incidents, results in widely varying transit travel times in both directions throughout much of the day. With the gaps in the existing HOV lane system, transit cannot reliably bypass this congestion.

Recent travel time data reviewed by King County Metro indicated that actual bus travel times between NE 51st Street in Redmond and the Montlake Freeway Transit Station (approximately 10 miles) during the morning commute can range from 10 to 30 minutes for both westbound and eastbound trips, with most trips (more than 90 percent) taking an average of 16 minutes. During the afternoon commute, westbound transit travel times can range from 10 to 55 minutes, with an average of approximately 22 minutes.

According to King County Metro data from 2008, approximately 20 percent of the westbound transit trips take over 30 minutes to travel between NE 51st Street in Redmond and the Montlake Freeway Transit Station. This high variability means that travelers needing to keep a
regular schedule must plan for the worst conditions and expect a relatively long travel time. It also makes transferring between routes and services difficult and adds to the cost of providing bus service.

With the 6-Lane Alternative, the HOV improvements to the SR 520 corridor would improve transit reliability and travel times and, therefore, connections between transit service and other travel modes. The primary changes in the transit infrastructure for the 6-Lane Alternative are completion of the HOV lanes across the SR 520 floating bridge to the I-5/SR 520 interchange (where direct access would be provided to the I-5 express lanes) and removal of the Montlake Freeway Transit Station.

The following benefits to transit operations are summarized below:

- With the 6-Lane Alternative, the HOV improvements to the SR 520 corridor would improve transit reliability; therefore, connections between transit services and other travel modes would also improve.

- HOV travel times between I-5 and SR 202 would improve by up to 5 minutes for westbound HOV traffic in both morning and afternoon peak periods. Eastbound HOV travel times would improve by nearly 40 minutes during the afternoon peak period compared to the No Build Alternative. Completing the eastbound HOV lanes would allow transit to reliably bypass congestion associated with I-405 that is forecast to extend back onto SR 520 eastbound by the year 2030.

- The 6-Lane Alternative would result in approximately a 14 percent increase in daily transit person trip demand compared to the No Build Alternative. Peak period transit person trip demand would increase similarly (11 percent during the morning commute and 14 percent during the afternoon commute). These increases are due to the HOV lane completion and a toll on general purpose traffic.

- The capacity added across the Montlake Cut with all options would improve local traffic operations and, therefore, travel times and reliability for SR 520 buses compared to the No Build Alternative.
• Option A would add a transit-only direct access ramp between SR 520 westbound and Montlake Boulevard northbound. Suboption A would add a transit and HOV direct access ramp between Montlake Boulevard NE southbound and SR 520 eastbound.

• With Option K or L, the HOV direct-access ramps at the SPUI would ensure that buses would be able to bypass general-purpose traffic congestion on the SR 520 ramps and mainline.

• With Option K, SR 520 buses would no longer be directly delayed by Montlake bridge openings during off-peak hours.

The Montlake Freeway Transit Station is being removed to address the community goal of narrowing the project footprint through the Montlake neighborhood. With the removal of the Montlake Freeway Transit Station, buses destined for or originating from I-5 would continue on SR 520 without exiting at the SR 520/Montlake Boulevard interchange. University District bus routes would continue to operate with direct service as they do today.

The Sound Transit Link rail project would provide service between the University area, downtown Seattle, and Sea-Tac by year 2016. Changes to transit rider connections in the Montlake area are described in the following sections.

**Westbound SR 520 Transit Passengers**

• Riders who currently walk, bus, or bike to the Montlake Freeway Transit Station to board a bus to downtown Seattle could use the same method to access light rail, which is estimated to run every 5 to 15 minutes, at the Montlake Triangle (Sound Transit 2006). It is approximately a half mile between the Montlake Freeway Transit Station and the Montlake Triangle, which is distance and time that would be saved for riders coming from the north and added for riders coming from the south.

• Riders who currently get off at the Montlake Freeway Transit Station to walk, bus, or bike to surrounding destinations could catch a University District route on the Eastside. Riders could transfer to University District buses at either the 92nd Avenue NE or Evergreen Point Freeway Transit Station. Westbound SR 520 University District service was assumed to be approximately every 4 minutes during the morning peak period and every 9 minutes during the afternoon peak period by the year 2030.
• With Option A, a transit stop would be located at the termination of the westbound transit-only direct access ramp at the Montlake overpass, allowing people to make connections in the Montlake area.

• With Options K and L, the first Seattle transit stop for SR 520 University District routes would be at the Montlake Triangle. This could mean some out-of-direction travel for people destined for areas south of the Montlake Cut. Downtown Seattle bus routes would remain on the SR 520 mainline and would not stop in the University District.

• Riders who currently transfer between routes at the Montlake Freeway Transit Station could transfer at the Evergreen Point or 92nd Avenue NE Freeway Transit Station with any of the 6-Lane Alternative options.

**Eastbound SR 520 Transit Passengers**

• With Option A, people who walk, bus, or bike to the Montlake Freeway Transit Station could board an eastbound bus at the traffic island located at the entrance to the eastbound SR 520 on-ramp and, if required, transfer at Evergreen Point Freeway Transit Station. Eastbound SR 520 University District service was assumed to be approximately every 9 minutes during the morning peak period and every 4 minutes during the afternoon peak period by the year 2030.

• With Subption A, SR 520 eastbound buses would use the new eastbound 3+ HOV and transit direct access ramp. Therefore, the HOV lane on the SR 520 eastbound on-ramp would be removed. Transit riders would access eastbound SR 520 routes at the NE Pacific Street bus stop (near the Montlake Triangle).

• With Options K and L, riders transferring between local and SR 520 buses could continue north for a half mile on Montlake Boulevard to the Montlake Triangle to board an eastbound SR 520 bus. This could add approximately 1 to 3 minutes of travel time for riders originating from areas south of the Montlake Cut by car or bus, or approximately 7 to 10 minutes for those who walk.

• Under Options K and L, some passengers could transfer at the Evergreen Point Freeway Transit Station to connect to routes to their final destinations.
• People starting their trip in downtown Seattle and getting off at the Montlake Freeway Transit Station to walk, bus, or bike to other destinations could take light rail to the University Link Station or find alternative routes.

University District Service from Evergreen Point Freeway Transit Station

With relocation of the HOV lanes and freeway transit stations to the inside of SR 520, King County Metro Routes 261 and 271 would no longer be accessible from the Evergreen Point Freeway Transit Station as they would under the No Build Alternative. These routes use the SR 520/84th Avenue NE interchange, which, with the project, would prevent them from being able to access and serve riders using the new median transit at Evergreen Point.

On weekdays, transit riders using the Evergreen Point Freeway Transit Station would have direct all-day service to the University District on Sound Transit Route 540 and peak period service on King County Metro Routes 167, 243, 272, 277, and 555/556. Additional weekday service could be provided by Sound Transit’s new Redmond-University District route (Route 542). This route was funded through Sound Transit 2 and is scheduled to start service in the fall of 2010.

On weekends, no University District bus service would be accessible from the new median transit station at Evergreen Point Road with current transit service and routes.

What are the key findings for parking?

Option L would have the greatest overall parking effect due to the extension of NE Pacific Street to the new SR 520/Montlake area interchange. Option A would have a slightly more of an effect on parking in the Montlake area than Options K or L would, although all three options would require relocation of the Museum of History and Industry (MOHAI).

Many of the affected parking spaces would include removal of the facility that requires the parking; therefore, there would be no net effect on parking supply at these locations. This includes MOHAI, which would have the most affected parking spaces for both Options A and K.

However, some other locations would be substantially affected, depending on the build option. These locations include the Husky
Stadium parking lots for Options K and L, the Hop-In Market for Option A, and the WSDOT Public Lot for Option K. Exhibit 2-1 summarizes parking effects for the design options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Affected Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Build Alternative</td>
<td>0</td>
</tr>
<tr>
<td>Option A</td>
<td>196</td>
</tr>
<tr>
<td>Option K</td>
<td>211</td>
</tr>
<tr>
<td>Option L</td>
<td>337</td>
</tr>
</tbody>
</table>

What are the key findings for construction effects?

Construction effects on transportation would be similar for all of the design options, with exceptions due to differences among the options in the vicinity of the SR 520/Montlake Boulevard interchange. The following sections describe construction effects on local streets, the regional freeways, transit, nonmotorized modes of travel (i.e., bicycles and pedestrians), and parking. This section also summarizes construction mitigation that may be required.

Local Streets

Throughout the construction period of the proposed project, there would be intermittent, short-term local ramp and road closures, including three long-term closures—Lake Washington Boulevard ramps in the SR 520/Montlake interchange area, Delmar Drive bridge over SR 520 (SR 520/I-5/East Roanoke Street interchange area), and NE Pacific Street—which are described below.

Lake Washington Boulevard

The Lake Washington Boulevard ramps would be closed at some time during construction of all design options. Traffic that normally uses the Lake Washington Boulevard ramps would be diverted to the updated Montlake Boulevard interchange for access to and from SR 520. At Montlake Boulevard, queueing onto local streets from the SR 520 eastbound ramp would remain similar to what exists today. This is because the proposed project includes roadway improvements along East Montlake Boulevard to accommodate increased traffic volumes.
The improvements along East Montlake Boulevard must be completed prior to closure of the Lake Washington Boulevard ramps to prevent substantial delays on Montlake Boulevard at SR 520.

**Delmar Drive Bridge**

Traffic would be affected during construction of the Delmar lid. Delmar Drive East would be closed between Roanoke Street and 11th Avenue East for a period of approximately 12 months with all design options. Detour routes would be provided during construction of the Delmar lid, and the project would minimize the duration of these detours.

**NE Pacific Street**

In Options K and L, NE Pacific Street would be closed between the University of Washington Medical Center emergency entrance and Montlake Boulevard NE during construction of the intersection at NE Pacific Street and Montlake Boulevard NE. NE Pacific Place would be widened and its intersection with Montlake Boulevard NE would be improved. Traffic would be detoured onto NE Pacific Place for approximately 12 months, and there would be long delays at the Montlake Boulevard NE intersection.

Temporary access for emergency vehicles to the University of Washington Medical Center may be provided from Montlake Boulevard along a paved pedestrian trail that runs along the south side of the medical center.

**Regional Freeway System**

The regional freeway system would be affected by construction truck traffic and closures of the SR 520 mainline and ramps.

**Construction Truck Volumes**

At times when the most construction activity is occurring, there would be as many as one to two construction truck trips per minute, which would moderately to substantially affect SR 520 traffic operations.

Option K would have a greater effect on SR 520 traffic operations compared to Option A, Suboption A, or Option L. This is because of the high number of estimated truck trips necessary for hauling to and from the tunnel and new interchange sites.
SR 520 Mainline and Ramp Closures

When the Lake Washington Boulevard eastbound on-ramp is closed, conditions on the Montlake eastbound on-ramp would degrade from LOS C to D during the afternoon peak hour due to the volume of traffic that would be detoured from the Lake Washington Boulevard on-ramp.

LOS on the SR 520 eastbound lanes between the Montlake on-ramp and the Lake Washington Boulevard on-ramp would worsen when the Lake Washington Boulevard eastbound on-ramp is closed. This is due to the increased volume of traffic entering the mainline from the SR 520/Montlake interchange area.

Periodic lane closures on SR 520 would be required throughout the duration of the project. Portions of SR 520 and its ramps would be closed at night and on weekends when precast girders are placed for the new lids over SR 520.

Transit

The closure of NE Pacific Street under Options K and L would have substantially greater effects to transit during construction than Option A, including increased delay, removal of layover and turnaround areas, and removal of driver facilities. Electric trolley buses would be prevented from operating in the existing configuration and would require installation of temporary overhead wires, including a turnaround loop, to maintain service.

Under all options, the Montlake Freeway Transit Station on SR 520 would be closed, resulting in the following effects:

- People traveling to Montlake/University of Washington from the east side of Lake Washington would need to transfer buses at one of the Eastside freeway transit stations.
- People who use the Montlake Freeway Transit Station to access buses to downtown Seattle would need to ride a different local bus during the construction time period.
- People traveling to the east side of Lake Washington would need to board their bus at the NE Pacific Street transit stop instead of the freeway transit stop.

This might require some changes to existing routes and could require additional transfers for some users to reach their destination. Additional bus service would be needed between the University...
District and the Eastside to accommodate the passengers affected by the closure of the Montlake Freeway Transit Station.

Under all options, the existing bus stops on Montlake at SR 520 would be closed during construction. Users transferring to and from SR 520 buses would transfer at the Montlake Triangle instead. Local transit access would be served two blocks north at the Shelby/Hamlin stop and two blocks south at the East Roanoke Street stop.

During construction of the east approach with all options, the Evergreen Point Road Freeway Transit Station would be closed for a period of 4 to 6 months. During this period of construction, the 92nd Ave NE freeway transit stops would be required to allow passengers to transfer between buses bound for Seattle and the University District.

With all options, the detour of traffic onto a temporary 10th Avenue East bridge would affect electric trolley buses that travel on 10th Avenue East. Temporary overhead trolley wire or additional diesel coaches would be required to maintain service.

**Nonmotorized Facilities**

The Bill Dawson Trail and the 24th Avenue East bridge would be closed for most of the construction period. Bicycles and pedestrians would be detoured to Montlake Boulevard.

Under Options K and L, existing pedestrian and bicycle routes near NE Pacific Street and Montlake Boulevard would be modified during construction. Pedestrian access would be maintained on one side of Montlake Boulevard NE within the construction zone at all times during construction. A temporary pedestrian overpass is proposed just south of the intersection to help maintain pedestrian access to the east and west sides of Montlake Boulevard.

During construction of the west transition span, the portion of the Foster Island Trail currently under the west transition span would be closed. Access to the Foster Island Trail from East Montlake Park would not be affected.

**Parking**

Under Option K, construction of a cut-and-cover tunnel through the University of Washington E-12 parking lot would have the most overall temporary effects on parking. Construction under Option A and Suboption A would have the least effects on parking.
Construction Traffic Management

Improvements to the intersections and ramps at the SR 520/Montlake Boulevard interchange would be required to accommodate the increase in traffic volume caused by detours from the closed Lake Washington Boulevard ramps.

With Options K and L, the intersection of Montlake Boulevard NE and NE Pacific Place would require added lanes on three legs of the intersection to accommodate traffic detoured from NE Pacific Street. As a result of the additional traffic, the existing signal at the Montlake Boulevard NE/NE Pacific Place intersection would require substantial modifications. NE Pacific Place would be widened to four lanes to accommodate the additional traffic volume while the detour is in place.

What are the key findings for cumulative effects?

This analysis determines the effects of the project alternatives in combination with other improvements to regional transportation facilities that were not included in the direct effects analyses described in Chapters 5 through 10. Because the analysis year for direct effects was 2030, the results included effects of projects that were planned and programmed (funded) to be completed by that time. The cumulative effects analysis also includes projects that are planned to be complete by 2030, but were not programmed or funded at the time of analysis.

Transportation analysts drew the following conclusions about travel demand for the cumulative effects of the project:

- The cumulative effects scenario is expected to result in fewer person and vehicle trips across Lake Washington on SR 520 compared to the No Build and 6-Lane Alternatives because of improved traffic conditions on other routes in the region. This means that the analysis conducted for the I-5 to Medina: Bridge Replacement and HOV Project SDEIS represents a conservatively high estimate of traffic and associated traffic effects. If the regional projects assumed in the cumulative effects scenario are implemented in conjunction with the I-5 to Medina: Bridge Replacement and HOV Project, traffic conditions within the project corridor would be similar or better than those estimated and documented in the SDEIS.
Because the SR 520 Bridge Replacement and HOV Program would complete the HOV lane system between Redmond and Seattle, and assuming carpools and transit would not be required to pay a toll, a considerable increase in HOV demand would occur along SR 520 with the 6-Lane Alternative compared to the No Build Alternative. The combination of reduced travel time and cost avoidance is a powerful incentive for carpool and transit use.

A sizeable increase in carpool/transit demand is also projected in the cumulative effects scenario compared to the No Build Alternative. However, the increase over the No Build Alternative would not be as large as with the 6-Lane Alternative.

Total cross-lake vehicle travel on SR 520, I-90, and SR 522 would be lower with the cumulative effects scenario when compared to Options A, K, and L. The reduction in HOV trips is projected to be lower than the reduction in general-purpose trips.

Vehicle trips decrease at a higher rate than person trips. This means that fewer vehicles would move more people with the 6-Lane Alternative and the cumulative effects scenario than with the No Build Alternative.

Total cross-lake transit travel would increase with the cumulative effects scenario compared to the No Build and 6-Lane Alternatives. This would be due to the increased ridership associated with implementation of the East Link light rail service on I-90.

Internal traffic circulation on the Eastside would improve and more trips would likely remain on the Eastside due to capacity improvements along regional corridors such as I-405, SR 167, and SR 522. Therefore, the volumes across Lake Washington on SR 520 and I-90 are expected to decrease, while volumes on the Eastside are projected to increase with the cumulative effects scenario.
Chapter 3—Travel Demand Modeling

What is in this chapter?

This chapter provides a general overview of travel demand models, how these models estimate future traffic volumes, why there can be multiple versions, and when is the most opportune time to change models during a project’s life time. It also documents the history of the SR 520 demand models and the strategy for potential future changes to demand modeling efforts. Chapter 4, Methodology, describes travel demand modeling assumptions used in our analysis for the I-5 to Medina: Bridge Replacement and HOV Project.

What is travel demand?

Travel demand refers the number of people who want to go from one location to another by each mode of travel. Travel demand is based on a theory of how land use, people, and the transportation network interact. It is estimated using the 4-Step Process, which is shown in Exhibit 3-1 and described below.

Exhibit 3-1. 4-Step Process for Estimating Travel Demand

*Trip generation* – The first step in the 4-Step Process estimates the number of trips that result from a particular place, such as a shopping mall, a residential neighborhood, a business district, and many others.
Trip distribution – The trips generated by each place go to a variety of different areas. This second step estimates the proportion of trips from a given area that goes to each of the other areas in the region. Specific routes and travel modes are not yet determined. Put simply, the number of people who want to go from place to place is determined, but not how they will travel.

Mode choice – The third step estimates the proportion of trips that will use each travel mode. For example, while steps 1 and 2 estimate the number of people that will travel from one area to another, mode choice estimates the percentage who decide to drive alone, take the bus, or ride their bicycles. The mode choice is based on different factors that people consider when choosing how they want to travel for a particular trip. These factors include the cost of parking, travel time, and comfort of the trip.

Trip assignment – The last step determines the specific routes that trips will take through the transportation network from one area to another. The routes are usually freeways and arterial roadways, but may include other alternatives such as railways and passenger ferries.

What is a regional travel demand model?

A regional travel demand model is a software tool that applies the 4-Step Process to large, complex networks of neighborhoods and transportation facilities. These types of models are used by transportation planners to estimate how people are likely to travel throughout a region and how travel patterns in the region would change as a result of different planning actions under consideration. These actions can include changes such as:

- Adding roadway capacity (lanes)
- Adding or changing transit service
- Tolling roadways
- Closing roadways
- Increasing parking rates
- Providing incentives for transit use (e.g., bus passes)
- Changing land development conditions

A regional travel demand model has three primary components: land use data, the transportation network, and a variety of mathematical
formulas (or algorithms) that determine the amount of interaction between all of the transportation network elements.

Land use data consist of population and employment forecasts for any given region. The forecasts are prepared at levels of geographic detail that can be further broken down to perform model analysis for specific purposes.

The second component of the regional travel demand model is the transportation network. This includes freeways, highways, arterials, and bus/rail/ferry transit routes. Local roadways, specific intersection design, and traffic signal operations are not generally included in regional travel demand models.

The third component of the regional travel demand model consists of a variety of mathematical algorithms. These algorithms are formulas, or rules, that determine how travel demand will be distributed between the various destinations, modes, and routes that people can use to complete their trips.

**Who creates this regional travel demand model?**

The Puget Sound Regional Council (PSRC) is the Metropolitan Planning Organization (MPO) for the four-county region of Snohomish, King, Kitsap, and Pierce counties. PSRC works with the state, ports, transit agencies, tribes, local governments, businesses, and citizens to create a long-term vision for the region with respect to land use, economic development, and transportation.

PSRC is responsible for distributing federal transportation funding, developing policies, and making decisions on regional issues. Among other planning activities, PSRC develops and updates a region-wide transportation plan and a regional travel demand model.

The PSRC regional travel demand model covers the Council’s four-county jurisdiction and includes broad information about land use (population and employment data) and primary roadways in the region’s transportation network. Due to the geographic expanse of the model, more localized land use data and roadways are excluded.
Can there be more than one version of a regional travel demand model?

There are a variety of reasons to have different models depending upon the scope of analysis, geography of interest, and the level of detail required in outputs. The goal of every analysis is to answer a specific set of questions that are unique to the situation being examined. Depending on the questions that are being asked, there are a variety of different tools that can be used.

At the core, a model is a complex set of calculations that help estimate the differences resulting between proposed alternatives. As long as the same tools are used to estimate results among a set of alternatives, we can compare them to each other in a valid way. Thus, it is important to ensure that there is a consistent set of assumptions for the general demographic forecast—the foundation of the model.

Why do models change?

Regional travel demand models can change over time for a variety of reasons. Some are as simple as updates to the model networks and population and employment forecasts. Other changes can be more complicated and involve the overall model structure, including changes to functions that estimate how many people will travel between certain locations and how they will choose modes of travel. One example is the addition of tolling into the model, which would affect a decision to drive or take transit as a mode of travel.

Yet another potential reason for multiple versions of a travel demand model is a change in the type of model, such as transitioning from a traditional gravity-based model to a next-generation activity-based model. Many metropolitan agencies, including PSRC, are changing to activity-based models, which allow them to answer more detailed questions about changes in land use and transportation.

The process of transitioning to a new type of model can take several years to complete due to the volume of data involved and the complexity of the testing process. This lengthy process requires that two travel demand models be used by different projects in the region at the same time so that valid analyses can be performed using the previous model while the new model is being tested and validated.
Because there can be multiple versions of a regional travel demand model at one time, a public agency or project could have a variety of versions to choose from. The selection of a demand model version depends on the consistency of the demand model inputs and structure with the assumptions and purpose of the project. Every travel demand model is validated and calibrated for a specific project, at a specific time, and for a specific purpose.

**What are project level models?**

Individual projects that focus on a specific area of the region use the PSRC regional travel demand model as a base model, or starting point. Details are then added to develop a *project-specific* travel demand model. Examples of these details include local roads and intersections, interchange ramps, additional elements of the transit system, and adjustments to reflect how people access the transportation network.

This project-level analysis is the most common reason why multiple versions of a travel demand model are used. Regional travel demand models are built to test long-range plans and transportation policies at the broader four-county scale. As such, they are generally validated to a set of regional measures. This is sufficient for analysis that reports details at the county or regional level; however, further analysis and validation are required at a much finer scale to understand how the model works for localized, project-level improvements.

Corridor projects generally focus on a much smaller subsection of the region. As an example, even though the SR 520 bridge has an effect on regional traffic movements, it is still only one small piece of the overall transportation network. The effects of changes to the SR 520 corridor on parallel facilities and smaller roadways that connect to it need to be understood, but the emphasis at the project level is on the effects of changes near the study area itself.

The scope of every project is different, and it is likely that every project will have some variation in its model. The key component that makes all the models consistent with one another is the long-range demographic forecast.
Can the project travel demand models change during the life of the project?

The project travel demand model can change during the course of the project. When the duration of a project spans several years, modeling information and assumptions become outdated. In these cases, making changes to update the project travel demand model is considered appropriate and desirable.

It is necessary to make changes to the project travel demand model at a specific point or points on the planning timeline. These points occur between phases of the project, after the results of one analysis are complete and before a new analysis begins. For example, on the SR 520 project, a logical time to update the travel demand model occurred between the release of the Draft EIS and the analysis of project design options included in the Supplemental Draft EIS. The timing of these changes is important because of the way the model results are used.

The primary result provided by travel demand models is the change in demand associated with a particular action. Travel demand models are not intended to provide an absolute traffic volume forecast. This is because travel demand models include only major roadways and exclude minor roadways that, obviously, carry traffic as well. Thus, although travel demand models can provide an approximate estimate of future travel demand, the emphasis should be placed on the relative difference between planning alternatives that are being compared. This difference is the effect of implementing an alternative.

Because the conclusions of an analysis are based on the relative difference between alternatives, different versions of the travel demand model can yield slightly different results for a single alternative. Therefore, it is important to use the same version of the model when comparing each alternative to accurately identify its effects.

How has the SR 520 travel demand model changed and how do the versions relate to each other?

Several travel demand models for the SR 520 project have been created to answer questions at different stages of the planning process. The first SR 520 project demand model was based on the 1998 PSRC regional travel demand model and was used for the Draft EIS. The primary
The purpose of this model was to estimate the change of travel demand on the SR 520 corridor given the completion of a 4-lane, 6-lane, or 8-lane Alternative. Each alternative included a toll on the SR 520 corridor as part of its definition.

Prior to analysis for the I-5 to Medina SDEIS, the project demand model was updated to represent the most current transportation network, tolling assumption, land use, and transit data. The SR 520 demand model used for the SDEIS used the same version as the Draft EIS, but with the updates that were developed after publication of that document.

Several other planning efforts have been completed for the SR 520 corridor, such as the High-Capacity Transit (HCT) Plan, the SR 520 Finance Plan, the Lake Washington Urban Partnership Agreement (UPA), and the Tolling Implementation Committee (TIC). The common element in all these versions is that, even though the math may be slightly different among models, the basic inputs are the same. The same land use forecasts as well as local and regional highway and base transit assumptions are internally consistent among the analyses.

The HCT planning effort used the SR 520 project travel demand model as a base to conduct transit forecasting. The SR 520 project travel demand model for the SDEIS No Build and 6-Lane Alternatives did not include Eastlink light-rail across Lake Washington on I-90 because the ST2 proposal was not approved and programmed when the analysis was performed. (Chapter 11, Cumulative Effects, describes the effects of Eastlink light-rail on SR 520 travel demand.) The HCT travel demand model included modifications and infrastructure changes (including Eastlink light rail) that were assumed to be in place if high capacity transit is added to SR 520 in the future.

The SR 520 Finance Plan was released in January 2008 to inform legislators about possible funding that could result from several sources, including tolling. A different version of the SR 520 demand model was developed for that effort to estimate the effects of several tolling scenarios on SR 520 travel patterns. This version of the SR 520 demand model minimized the estimated travel demand on SR 520 to avoid over-estimating revenue.
A related study was completed for the TIC in 2008 to answer questions regarding the effects of tolling cross-lake travel. Transportation data generated by the TIC was used in the Environmental Assessment produced for the UPA. The TIC focused on the differences between several cost structures for tolls. The models used in these studies were based on PSRC’s Version 1.0a travel demand model.

Although several versions of the SR 520 demand model exist, each version was appropriate at the time of the analysis and for its intended purpose. They allowed a sound comparison of the relative differences among alternatives to identify the effects of a particular action.

**What is the strategy for future SR 520 travel demand model efforts?**

The project team will continue to coordinate with all other planning efforts that use travel demand modeling to answer questions about the SR 520 corridor. Examples of such efforts could include an update to the SR 520 Finance Plan and selection of toll rates for SR 520. Project administrators will communicate with PSRC, King County, Sound Transit, and the City of Seattle as necessary to ensure that modeling assumptions for SR 520 are compatible with current, regional planning assumptions.

These agencies will help identify and establish the base PSRC model version and any other data updates, including transportation network changes. If another new PSRC version is adopted in the future, these agencies will help assess the potential need to switch the travel demand model. If an SR 520 project travel demand model update is needed, changes will be incorporated between phases of the SR 520 planning process, such as the period between publication of the SDEIS and development of the Final EIS.
Chapter 4—Transportation Forecasts and Operations Analysis Methodology

What is in this chapter?

This chapter describes the methodologies used in the project’s transportation analysis. The first part of the chapter describes the methods for forecasting freeway traffic volumes and analyzing freeway operations in year 2030 without and with the project. The second part describes the methods for forecasting year 2030 local street volumes and analyzing intersection operations without and with the project.

What is the study area?

Although the project itself is limited to replacing SR 520 between I-5 and Medina, the transportation study area extends beyond project construction boundaries onto I-5 and I-405 to account for traffic interactions between the freeways. Exhibit 4-1 illustrates the difference between the project limits and study area. Traffic volumes and congestion are discussed for SR 520, I-5, and I-405 because SR 520 is affected by how the other two highways operate. The study area for this analysis included the following freeway segments and associated ramps and interchanges:

- SR 520 between I-5 in Seattle and SR 202 in Redmond
- I-5 in Seattle between NE 45th Street and south of the I-90 collector-distributor north connection to the mainline
- I-405 between NE 70th Street in Kirkland and NE 4th Street in Bellevue

How were travel demand and traffic patterns determined?

As described in Chapter 3, the project travel demand model was used to forecast year 2030 freeway traffic volumes without and with the project. The transportation team used these forecasts to assess the potential project effects on roadway operations throughout the
Exhibit 4-1. Transportation Analysis Study Area

I-5 to Medina: Bridge Replacement and HOV Project

Source: King County (2008) GIS Data (Streams, Streets and Waterbodies) and CH2M HILL (2008) GIS Data (Parks). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.
study area. Travel demand models consider changes to the transportation network as well as changes in population and employment.

The SR 520 Bridge Replacement and HOV Project Model Validation Analysis for 2006 Technical Memorandum details the attributes that were updated and refined specifically for this project, such as ramp connections, numbers of lanes, and roadway speeds. More historical information about the SR 520 SDEIS model and its development is provided in the Updated Travel Forecasting Model Validation Report for Base Year (2000) (WSDOT 2005) and Addendum to Updated Travel Forecasting Model Validation Report (WSDOT 2007).

The following paragraphs describe the transportation team’s method of determining existing and forecast future traffic volumes and patterns. This process is summarized in Exhibit 4-2.

Exhibit 4-2. Travel Forecast Process

The first step of the process was to collect existing traffic volume data for the study area freeways and major local streets. The second step was to verify that the regional travel demand model correctly represented existing regional traffic volumes and patterns—a process known as validation. The team calibrated the travel demand model output to within 10 percent of existing traffic count data across select screenlines, which is considered standard practice for this type of analysis.
After the model was calibrated for existing conditions, it was updated to represent year 2030 No Build Alternative conditions. The No Build Alternative includes regional roadway and transit network improvements that were planned and programmed (funded) at the time of analysis. Projects that were planned but not programmed at the time of analysis (such as the Sound Transit ST2 improvements) are included in the transportation cumulative effects analysis described in Chapter 11. The I-5 to Medina year 2030 No Build Alternative is based on the assumption that the following key transportation projects will be completed as planned:

**Freeway**

- The SR 520 Program’s Medina to SR 202: Eastside Transit and HOV Project, which will expand the HOV system, improve transit time and reliability, and enhance public safety
- The SR 520 - West Lake Sammamish Parkway to SR 202 Project, which will widen SR 520 in Redmond from two to four lanes in each direction
- The I-90 Two-Way Transit and HOV Operations Project, which will add HOV lanes to the I-90 outer roadway between Seattle and Bellevue
- I-405 widening and interchange improvements as funded by Nickel and TPA funding sources

**Local Projects**

- Northup Way – 120th to 124th Avenue NE eastbound widening project

**Transit**

- Light rail between SeaTac Airport and Northgate
- Light rail station at Husky Stadium
- Tacoma Light Rail
- Seattle Streetcar
- Sounder Commuter Rail between Everett and Seattle
- Sounder Commuter Rail between Lakewood and Seattle
- King County Transit Now
The SDEIS 2030 No-Build & Cumulative Effects Definition Technical Memorandum (SR 520 Bridge Replacement and HOV Program 2008) and a supplement to that memo issued by the project office on March 28, 2008, contain detailed information about these travel demand model assumptions. They include all projects that were assumed to be complete by 2030, planned transit service, and other assumptions coded into the project’s travel demand model for the No Build Alternative.

Adjustments were also made to reflect expected changes in inflation and land use, specifically future population and employment growth forecasts, for the year 2030. These elements are major factors that influence travel behavior and patterns.

The project’s travel demand model was then used to estimate changes in regional traffic demand volumes and patterns between now and the year 2030 with the No Build Alternative. The project team forecasted traffic demand volumes at several “checkpoints” (screenline locations) along the freeway and at interchange influence areas. Interchange influence areas include the local streets and intersections surrounding an interchange that could be affected by changes to SR 520.

The percent growth in traffic demand between now and the year 2030 was then applied to existing traffic count data to forecast detailed traffic volumes within the project study area. Existing traffic count data were used as a baseline so that forecasts were built on actual volumes and travel patterns.

After forecasting travel demand for the year 2030 No Build Alternative, the transportation networks for Build (6-Lane) Alternative Options A, K, and L were coded into the travel demand model. The network for each option describes the features of the roadways such as numbers and types of lanes (general-purpose and HOV), intersections, and interchange ramp configurations. In addition to the transportation networks, the following operational assumptions were included the 6-Lane Alternative options:

- Electronic tolling on SR 520 between I-5 and I-405
- Toll rates vary by time of day on a fixed schedule
- Transit and carpools (3+) exempt from tolling
- No change in transit service compared to the No Build Alternative

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1 Land use information was developed and provided by Puget Sound Regional Council.
Complete details about the travel demand modeling for the 6-Lane Alternative are published in the 2030 Build Alternatives Travel Demand Forecasts Technical Memorandum (WSDOT 2009e).

After the networks and assumptions were coded, the process described for the No Build Alternative was then repeated to determine how the 6-Lane Alternative options would affect traffic demand compared to the No Build Alternative.

**Identifying Freeway Screenline Locations**

Screenlines were selected to determine key travel patterns adjacent to and within the project limits. Screenlines on SR 520 between I-5 and I-405 represent the locations where traffic enters and exits the project area. Screenlines adjacent to the I-405 and I-5 interchanges with SR 520 were necessary to determine travel patterns to and from the adjacent freeways. A screenline at the middle of Lake Washington on SR 520 was chosen to determine vehicle demand crossing the lake. Screenlines on I-405 and I-5 provide information about the effects that changes on SR 520 might have on adjacent travel routes.

**Identifying Interchange Area Boundaries**

Interchange influence areas were identified as areas where similar growth in traffic was expected. Each influence area includes one or more interchanges. Some interchanges were grouped because of their similarities in serving traffic to and from adjacent neighborhoods.

The following interchange influence areas near SR 520 and I-5 were identified:

- **SR 520/Montlake Boulevard.** Traffic on SR 520 destined to the University District, Madison Park, Capitol Hill, Central District, and Madrona may take either Lake Washington Boulevard or Montlake Boulevard; therefore, these interchanges were grouped together.

- **I-5/NE 45th Street.** This is a single interchange area, and the growth patterns were assigned based solely on information from this location.

- **SR 520/I-5/East Roanoke Street.** This interchange area serves the neighborhoods adjacent to I-5, north Capitol Hill, and Eastlake. Traffic growth in these areas is similar, and they were combined to assess an overall local growth rate for this area.
• I-5/Mercer Street. This interchange serves neighborhoods north of downtown Seattle, including Queen Anne and the growing South Lake Union neighborhood.

• I-5/Stewart Street. This interchange serves traffic to downtown Seattle and has connections to the I-5 mainline and express lanes.

What time periods were evaluated and why?

Traffic volumes were forecasted for three time periods: daily, morning, and afternoon. Daily volumes were forecasted for one location on SR 520, I-90, and SR 522 to provide information on overall crosslake travel changes without and with the project. Morning and afternoon commute period forecasts were completed for the SR 520 mainline and ramps and adjacent arterials to use in the operations models. Comparing the relationship between daily and peak period traffic volumes helps define how people might react to increases in congestion (longer travel times) and changes in travel costs (tolling).

Morning and afternoon traffic forecasts were prepared for two 5-hour periods: 5 a.m. to 10 a.m. and 2:30 p.m. to 7:30 p.m. Congestion currently occurs along SR 520 for several hours during both the morning and afternoon commutes. Because traffic volumes are expected to increase over the next 30 years, the project team selected a 5-hour peak period for traffic volume forecasting and analysis. This allowed us to determine how the peak period might change with traffic volume increases by the year 2030. Traffic forecasts and operational analysis results are reported here for the peak 3 hours (6:00 to 9:00 a.m. and 3:00 to 6:00 p.m.).

In what terms do we discuss traffic volumes and patterns?

Traffic forecast volumes are generally described in terms of vehicle demand, person demand, and mode choice. The purpose and need statement for the SR 520 Bridge Replacement and HOV Project states: “the purpose of the project is to improve mobility for people and goods across Lake Washington.” The best way to measure the improvement of mobility is two-fold. First, assess the person demand associated with any specific action on the corridor; and second, measure how many of those people are actually served during a specified time period.
The process of forecasting traffic volumes estimates person demand with the year 2030 No Build and Build Alternatives, while the freeway operations analysis measures how many people are served, or throughput. Demand is discussed below. Throughput is discussed in more detail later in this chapter.

**Demand**

Demand refers to the number of vehicles or people that want to use the freeway during a given time period. Traffic demand volumes are based on the project’s travel demand model. The project team calculated person-trip demand based on the HOV (carpool and bus) and general-purpose vehicle demand and throughput, and assumed average vehicle occupancy (AVO) that was consistent with the project travel demand model.

**Mode Choice**

Mode choice refers to the type of transportation a person chooses to use, such as driving alone (general-purpose), taking a bus, or carpooling. Person demand and vehicle demand can both be described by mode (i.e., the number of people taking the bus or the number of vehicles that can be classified as carpools). The mode choices used in the traffic forecasts include general-purpose, carpool (3+), and bus.

**How was transit demand estimated?**

Vehicle- and person-trip forecasts for buses were based on the travel demand model forecasts. The number of buses was estimated using the following information provided by the transit agencies:

- For King County Metro, it was assumed that the increase in transit service planned for the Transit Now program will account for growth between 2006 and 2016, and a 1 percent per year increase in service hours between the year 2016 and 2030.

- For Sound Transit, an approximate 14 percent increase in total service hours between the base year (2006) and 2013 (or about 1/2 percent per year), and no increase after 2013, was assumed.

The transit person demand forecasts were not constrained by transit volume and service forecasts. In other words, the transit demand volumes represent how many people would choose transit regardless of how many buses were forecasted to be on the roadway. This provides
data for the local transit agencies to use when determining future bus service, such as route changes (additions, deletions, extensions in routes), improved frequencies, or bus type (standard or articulated).

## How were freeway traffic operations analyzed?

Travel demand forecasts help determine how many vehicles and people would like to use the roadway. These volumes are input into a traffic simulation model to help engineers determine how much of the vehicle and people demand may actually be served by the proposed roadway design. The amount of traffic served is referred to as throughput. While the travel demand model uses planning level roadway capacity to estimate route travel time information (two of the biggest factors that influence corridor demand), it does not consider the more detailed throughput effects of roadway operations such as lane changes, grades, merges, and shoulder widths.

The team used the same methodology to conduct the SDEIS freeway operations analysis as the Draft EIS, with the exception of the following two elements:

1. In the Draft EIS, the CORSIM software model included I-5 south to Spokane Street. However, in the SDEIS, the analysis ended at the northern terminus of the collector-distributor lanes, just south of the Convention Center. The operations analysis leading into the Draft EIS included the 8-Lane Alternative, which affected traffic volumes on I-5 near I-90 when compared to the No Build Alternative. The 8-Lane Alternative is not being considered further in the SDEIS. The 6-Lane Build Alternative had similar volumes as the No Build Alternative south of downtown Seattle and north of the I-90 collector-distributor ramps, so the additional travel demand modeling was not necessary.

2. The SDEIS includes the 6th Street HOV ramps in downtown Bellevue, which were constructed following the Draft EIS analysis.

The team used the CORSIM software program, a micro-simulation package developed by the Federal Highway Administration (FHWA), to simulate traffic operations on the SR 520 corridor as well as sections of the I-5 and I-405 corridors. CORSIM provides detailed simulation output, including animation and performance data, for freeway, ramp,
and HOV operations. The team used this information to evaluate operational differences among the Build Alternative options. Exhibit 4-3 shows an example of the CORSIM model animation screen.

Exhibit 4-3. CORSIM Micro-Simulation Model Animation Screen

Exhibit 4-4 outlines the process the team used to analyze the alternatives. The first step in the process was to verify that the simulation model correctly represented existing freeway operations—a process known as calibration. The team calibrated the CORSIM model against existing WSDOT freeway count data to ensure that the model’s output for the morning and afternoon peak periods was accurately
representing current volumes and operations of the freeway mainline and ramps. Most locations were calibrated to within 5 percent of actual volumes. The team verified that the congestion and travel times from the model reasonably matched field observations and data from WSDOT loop detectors. Existing data from October of 2008 were used in the calibration effort.

What are the measures of effectiveness for the freeway operational analysis?

WSDOT and the transportation team developed the following five measures of effectiveness (MOEs):

1. Congestion (queuing)
2. Speeds
3. Travel times
4. Vehicles served (or vehicle throughput)
5. Persons served (or person throughput)

These MOEs were used to evaluate and compare traffic operations among the No Build Alternative and Build Alternative options. Exhibit 4-5 shows how the MOEs were used to define freeway congestion. Each MOE is described in greater detail below.

![Exhibit 4-5. Understanding Congestion and Measures of Effectiveness](image)

### Congestion

Congestion and backups occur at locations where traffic demand exceeds the capacity of the roadway, limiting how many vehicles and people can be served. Congestion is defined as taking place in freeway
sections that operate at speeds of less than 50 mph. Congestion may occur at on- or off-ramps because of weaving activity or changes in the number of lanes, lane widths, grades, or other physical characteristics.

Congestion is measured by its duration (minutes or hours) and its length (in feet or miles). The team identified congestion locations for the No Build Alternative and Build Alternative options based on CORSIM model results.

**Speed**

Travel speeds are a function of congestion and roadway design. Freeway traffic operating at speeds exceeding 50 mph is considered a free-flow condition. Traffic operating at speeds between 30 and 50 mph indicates moderate congestion, while speeds below 30 mph indicate a highly congested condition. Traffic operations along the freeways are summarized in 10-mph intervals between zero and 50+ mph.

The CORSIM model provided speed data in 15-minute intervals at each location along the SR 520 corridor. The data were then plotted on charts at various locations to provide a three-dimensional perspective of corridor operations, including time, space, and speed. These charts are called congestion diagrams and are shown for SR 520 in Chapter 5, which also presents the results of the CORSIM analysis.

**Travel Time**

The team calculated travel time for the No Build Alternative and Build Alternative options to measure the delay that drivers would experience on the corridor. Travel time is directly related to corridor speed, which was calculated using the CORSIM model corridor speed data. We calculated travel time between I-5 and SR 202, which extends beyond the project limits. The study area was extended to SR 202 because some of the benefits of the Build Alternative would be realized outside of the project limits. Comparing the travel times between SR 202 and I-5 is an effective way to identify those benefits.

**Throughput**

Throughput refers to the number of vehicles or people that are moving beyond a point of reference during a given time period. This number is compared to the forecasted vehicle and person demand, which helps
determine the effectiveness of the different Build Alternative options compared to the No Build Alternative.

Vehicle throughput is controlled by the roadway capacity, which is determined by several factors, including number of lanes, roadway geometry, and traffic control devices. For uncongested locations, vehicle demand equals vehicle throughput. For congested locations, demand is always higher than throughput because of over-capacity conditions. Demand that cannot “get through” is not served and backs up, creating congestion. These vehicles are eventually served during later time periods. A funnel analogy showing the relationship between traffic demand and throughput is illustrated in the right hand column.

People throughput is controlled by two factors: vehicle throughput and vehicle occupancy. Vehicle occupancy refers to the average number of people traveling in a vehicle. If more people travel in each vehicle, people throughput increases. The capacity for people throughput may be thought of as the number of available “seats” in vehicles. This is why transit is very effective at moving people—because transit vehicles have many seats, they have the capacity for high occupancy per vehicle.

When HOVs are included in the transportation system, an analysis of mode choice is performed to estimate how many people are likely to choose alternative modes of travel, such as buses. When people choose to travel by high-occupancy modes, the people-moving capacity of the roadway is increased.

**How were local traffic volumes forecasted?**

Using the same methodology as the Draft EIS, the SR 520 transportation team took the following steps:

1. Identify growth rates for interchange influence areas. Growth in local traffic volumes was calculated using an area-wide growth rate that encompassed major arterials within an interchange influence area.

2. Identify interchange peak hour. The transportation team forecasted future traffic volumes on local streets for one morning and one afternoon peak hour within the peak periods identified for the freeway. The local street volumes were forecasted for each Build Alternative option.
3. Distribute freeway ramp traffic. Future freeway volumes were distributed through the local roadway system during the morning and afternoon peak hours using existing intersection turning movement ratios.

4. Forecast local traffic. After ramp traffic was distributed through the system, local traffic volumes not associated with the freeway ramps (e.g., people traveling between their home and a local shopping area) were increased to reach the growth rate identified in the influence area.

**How did we apply our methodology to local traffic forecasts?**

Growth in local traffic volumes was calculated using an area-wide growth rate that encompassed many local roads within each interchange influence area. The interchange area boundaries were defined by where the influence of the freeway ramp volumes on the local street system decreased to where growth in traffic was similar to the No Build Alternative. This process is discussed further later in this chapter.

**Identifying the Interchange Peak Hour**

The peak hour was allowed to vary between interchange areas to preserve their individual peaking characteristics. For instance, one interchange may peak at 4:00 p.m., while another interchange 1/2 mile away may peak at 5:30 p.m.

Similarly, the volume of traffic on local streets not accessing the freeway can peak at different times in different areas regardless of when the adjacent freeway is peaking. Generally, local arterials peak for a single hour in the morning and in the afternoon.

Exhibit 4-6 depicts the relationship between the peak period and peak hour.

**Distributing Freeway Ramp Traffic**

Traffic on local streets is comprised of two types: 1) traffic using local streets to primarily access the freeway, and 2) traffic using local streets to access other local locations. The SR 520 transportation team identified traffic patterns for both types by reviewing existing travel patterns and
traffic volumes, and by considering the effect of new road connections and facilities.

Exhibit 4-6. Peak Hour Versus Peak Period

Once the interchange peak hour and travel patterns were identified, freeway-related traffic volumes were distributed through the local network based on existing turning movement ratios observed at the intersections. For example, under existing conditions, if 10 percent of vehicles turn left at a given freeway ramp intersection, 60 percent go through, and the remaining 30 percent turn right, it was assumed that these ratios would be similar in the future.

**Forecasting Local Street Traffic**

After freeway traffic was distributed through the system, the transportation team applied the local area target growth rate to the local access traffic volumes. Local access traffic volumes were assumed to follow patterns similar to existing conditions, meaning that the turning movement ratios would not change substantially in the future except for where project options change the roadway network. For options that change the local roadway network, turning movement ratios were adjusted to reflect the new travel patterns based on changes to local traffic volumes throughout the interchange area.

**Forecasting Pedestrian Volumes**

Future pedestrian volumes were assumed to remain consistent with existing volumes; where pedestrian counts were unavailable, estimates were based on data provided in the Highway Capacity Manual for central business district (CBD) and non-CBD areas.
How were local traffic operations analyzed?

Once the transportation team forecasted the year 2030 traffic volumes, they were input into a model that analyzed intersection operations. Project team engineers studied traffic operations at each ramp terminal intersection in the project. Exhibit 4-7 shows the interchange areas and intersections that were included in the traffic analysis. The engineers also studied intersections adjacent to the ramp terminal intersections that would be affected by the project alternatives.

The team analyzed current local street traffic operations to provide a point of comparison to estimated future operations. The analysis results will enable local jurisdictions to know if, and to what degree, each alternative would meet their established standards for traffic operations.

A traffic modeling software package called Synchro was used to analyze local street traffic operations. Intersection operations were also evaluated because intersections control the capacity of the local street network. The evaluation used the forecasted traffic volumes during peak commute periods (specifically the morning and late afternoon) for conditions in the base year (2008) and the design year (2030). Peak-hour traffic volumes were collected from the cities of Kirkland and Bellevue; for those areas where volumes were not readily available, traffic data collection companies conducted traffic counts.

Traffic conditions for street systems are typically measured for a single peak hour during the longer morning and afternoon weekday commuter peak periods. During the morning commute period, traffic volumes in the study area generally peak from 7:45 to 8:45 a.m.; during the afternoon commute period they peak from 5:00 to 6:00 p.m. The team compared peak-hour local traffic volumes with peak-hour freeway ramp volumes to ensure that our operations analysis included data that would represent the most conservative conditions (when both local street and freeway ramp volumes are at their highest).

The analysis of existing intersection operations used current signal timing and phasing information obtained from local jurisdictions. All operational analyses for future conditions used optimized signal and network settings (except phasing) to provide a similar comparison of operations for the alternatives.
Source: King County (2008) GIS Data (Streams, Streets and Waterbodies) and CH2M HILL (2008) GIS Data (Parks). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 4-7. Interchange Areas and Intersections Included in the Local Operations Analysis

I-5 to Medina: Bridge Replacement and HOV Project
Signal phasing was also revised and optimized at a few freeway ramp intersections to improve operations. The project team used intersection level of service (LOS) to compare traffic operations between project alternatives. At locations where the operations fell to LOS F, the team also used critical volume-to-capacity (V/C) ratios and queue spillback locations to compare traffic operations across the alternatives. LOS, V/C ratio, and queue spillback are defined and described below.

**What is level of service and how is it applied?**

Level of service rates the quality of traffic operations on a given transportation facility. The LOS rating scale uses the letters A through F (see Exhibit 4-8). The letter grades are based on the levels of delay that drivers experience at an intersection, with the letter A representing the least-delayed conditions and the letter F representing the most delayed.

<table>
<thead>
<tr>
<th>Unsignalized Intersections</th>
<th>Signalized Intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td>LOS A</td>
</tr>
<tr>
<td>Average Control Delay (sec/vehicle)</td>
<td>Average Control Delay (sec/vehicle)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Exhibit 4-8. Delay Ranges Associated with LOS Ratings**

For intersections controlled by signals and all-way stops, LOS represents an average delay for the entire intersection. LOS is what is reported for the SR 520 local traffic analysis.

For two-way, stop-controlled intersections, LOS is typically reported for the most delayed leg of the intersection. For this report, the overall intersection LOS is reported for all unsignalized intersections, regardless of the type of intersection (four-way, two-way, or uncontrolled ramp termini where left turns yield to oncoming traffic). For two-way, stop-controlled, and uncontrolled "yield" intersections, Synchro provides an average delay (in seconds per vehicle) for the
overall intersection, and a "letter" LOS only for the approach that must either stop or yield. The team used the average intersection delay range (Exhibit 4-8) to apply an overall intersection LOS and provide a relative comparison between stop or yield intersections to other types of intersections (signalized and all-way, stop-controlled).

What is a volume-to-capacity ratio and what does it mean?

The V/C ratio compares the amount of traffic on a roadway (traffic volume) to the roadway’s available capacity. If the V/C ratio is greater than 1.0, it means that the traffic volumes exceed the roadway capacity. Conversely, if the V/C ratio is less than 1.0, it means the roadway is carrying less than its full capacity. For instance, a V/C ratio of 1.07 means that traffic volumes exceed the roadway capacity by 7 percent.

At intersections, the capacity of a single lane depends on its physical layout (width, uphill/downhill grade, etc.) as well as the type and duration of traffic control (stop sign, signal, cycle length, and other factors). For instance, the longer a signal is set for green in a given intersection, the more vehicles can move through the intersection and thus the greater its capacity.

What is queue spillback?

A queue spillback occurs in an area where vehicles cannot proceed through an intersection because vehicles ahead are backed up from the next intersection. As shown in Exhibit 4-9, the location at which a vehicle is blocked from moving through an intersection is referred to as the queue spillback location. Queue spillback also happens when vehicles exiting via off-ramps back onto the freeway. This latter type of queue spillback is what the SR 520 team has identified on this project.

Exhibit 4-9. Queue Spillback Location