ENVIRONMENTAL ASSESSMENT
SR 520 BRIDGE REPLACEMENT AND HOV PROGRAM

DECEMBER 2009

SR 520, Medina to SR 202: Eastside Transit and HOV Project

Appendix Q

Transportation Discipline Report

Washington State Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

Medina to SR 202: Eastside Transit and HOV Project Environmental Assessment

Transportation Discipline Report

Prepared for

Washington State Department of Transportation
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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
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
HOV	high-occupancy vehicle
I-405	Interstate 405
I-5	Interstate 5
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

TDM	Transportation Demand Management
TMP	Traffic Management Plan
TRPP	Trip Reduction Performance Program
UW	University of Washington
V/C	volume-to-capacity
vph	vehicles per hour
WB	westbound
WSDOT	Washington State Department of Transportation

Chapter 1–Background

Why is transportation considered in an Environmental Assessment?

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 assessment (EA) and is required by law. The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision-making processes.

Federal, state, and local agencies must consider the environmental impacts 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? It is because of these questions that transportation is included in our EA.

What is this report about?

This Transportation Discipline Report, Appendix R to the State Route (SR) 520 Eastside Transit and HOV Project EA, describes transportation conditions along the SR 520 corridor from approximately Evergreen Point Road in Medina eastward to SR 202. The report presents transportation information for SR 520 as it currently exists and estimates transportation performance for the No Build and Build

Alternatives (described below) under evaluation in the EA for this project.

What is the project history?

The current project expands on the work of previous studies that examined mobility and environmental issues in the corridors crossing Lake Washington. The Washington State Department of Transportation's (WSDOT) Urban Corridors Office conducted the Trans-Lake Washington Study from June 1998 to August 1999 and the Trans-Lake Washington Project from March 2000 to December 2002. The Trans-Lake Washington Project made recommendations that led to the 4-Lane and 6-Lane alternatives, which were evaluated in the 2006 SR 520 Bridge Replacement and HOV Project Draft Environmental Impact Statement (EIS).

Some of the improvements included in the proposed Medina to SR 202: Eastside Transit and HOV Project were originally part of the SR 520 Bridge Replacement and HOV Project. The environmental process for the SR 520 Bridge Replacement and HOV Project began in 2000 with the issuance of a Notice of Intent to prepare an EIS. The original project limits were from I-5 in Seattle to SR 202 in Redmond. However, project funding was eliminated in 2002 and only partially reinstated in 2003. For this reason, the eastern project limit was changed to 108th Avenue NE in Bellevue.

The Washington State Department of Transportation (WSDOT) published the SR 520 Bridge Replacement and HOV Project Draft EIS in August 2006. The Draft EIS describes the evaluation of three corridor alternatives: a No Build Alternative, a 4-Lane Alternative (four general-purpose lanes), and a 6-Lane Alternative (four general-purpose plus two HOV lanes).

In late 2006, after considering the findings described in the Draft EIS, Washington Governor Chris Gregoire identified the 6-Lane Alternative (also known as the "4+2" Alternative) as the state's preference for moving forward. This preference was endorsed by the Washington State Legislature in 2007. Although within Seattle there remained considerable controversy about the specific configuration of the project, on the Eastside there was relatively widespread public support for the 6-Lane Alternative. Additional legislation passed in 2008 (ESHB 2878) directed WSDOT to study the potential for accelerating improvements

on the Eastside. In March 2008, Governor Gregoire highlighted the importance of the SR 520 project to the region and state by announcing an accelerated project schedule. A new floating bridge is now projected to open in 2014, with the full corridor expected to be complete in 2016.

Since the Notice of Intent for the SR 520 corridor was issued in 2000, a number of circumstances have changed. The Eastside has experienced significant economic growth. This growth has substantially increased demand for transit service.

Transit agencies are responding with plans for enhanced service. These plans rely on SR 520 to provide the backbone for linking east–west traffic flow from east King County to Seattle and for connections to the north–south corridors along Interstates 5 and 405 (I-5 and I-405). Current transit planning calls for increased service on Eastside routes, including two major bus rapid transit routes on or near the SR 520 corridor.

On June 18, 2008, the Federal Highway Administration (FHWA) authorized WSDOT to develop the Medina to SR 202: Eastside Transit and HOV Project as an independent project. The project includes a study area from approximately Evergreen Point Road in Medina, east along SR 520 to SR 202 in Redmond.

On June 18, 2008, WSDOT received concurrence from the FHWA that the Medina to SR 202: Eastside Transit and HOV Project meets the criteria of a new stand-alone project as specified by federal regulations (23 CFR 771.111(f)). This allowed the team to proceed with environmental review, design, and construction of the Eastside project independent of the Seattle and floating bridge portions of the SR 520 corridor within a newly defined SR 520 Bridge Replacement and HOV Program.

With concurrence from FHWA, the project team decided to pursue an EA rather than an EIS because it is anticipated that all significant unavoidable adverse impacts would be mitigated. Thus, the EA will incorporate and build upon prior planning efforts and environmental studies related to SR 520.

What is the project?

The Washington State Department of Transportation (WSDOT) is proposing to construct the SR 520, Medina to SR 202: Eastside Transit

and HOV Project to reduce transit and high-occupancy vehicle (HOV) travel times and to enhance travel time reliability, mobility, access, and safety for transit and HOVs in rapidly growing areas along the State Route (SR) 520 corridor east of Lake Washington. Exhibit 1 shows the project vicinity. Some of the improvements included in this project were originally part of the SR 520 Bridge and HOV Project. On June 18, 2008, the Federal Highway Administration (FHWA) authorized WSDOT to develop the SR 520, Medina to SR 202: Eastside Transit and HOV Project as an independent project. The project includes building a complete HOV system between Lake Washington and 108th Avenue NE and restriping the existing HOV lanes from the outside lanes to the inside lanes between the 108th Avenue NE interchange and SR 202 in Redmond.

The portion of the project between Evergreen Point Road and 108th Avenue NE was previously part of the SR 520 Bridge Replacement and HOV Project. The SR 520, Medina to SR 202: Eastside Transit and HOV Project has been an independent project to address needs specific to the portion of SR 520 east of Lake Washington. The project limits extend approximately 8.8 miles along SR 520 from the east shore of Lake Washington (vicinity of Evergreen Point Road) to the interchange with SR 202 in Redmond.

WSDOT is considering two alternatives for the project: the Build Alternative and the No Build Alternative.

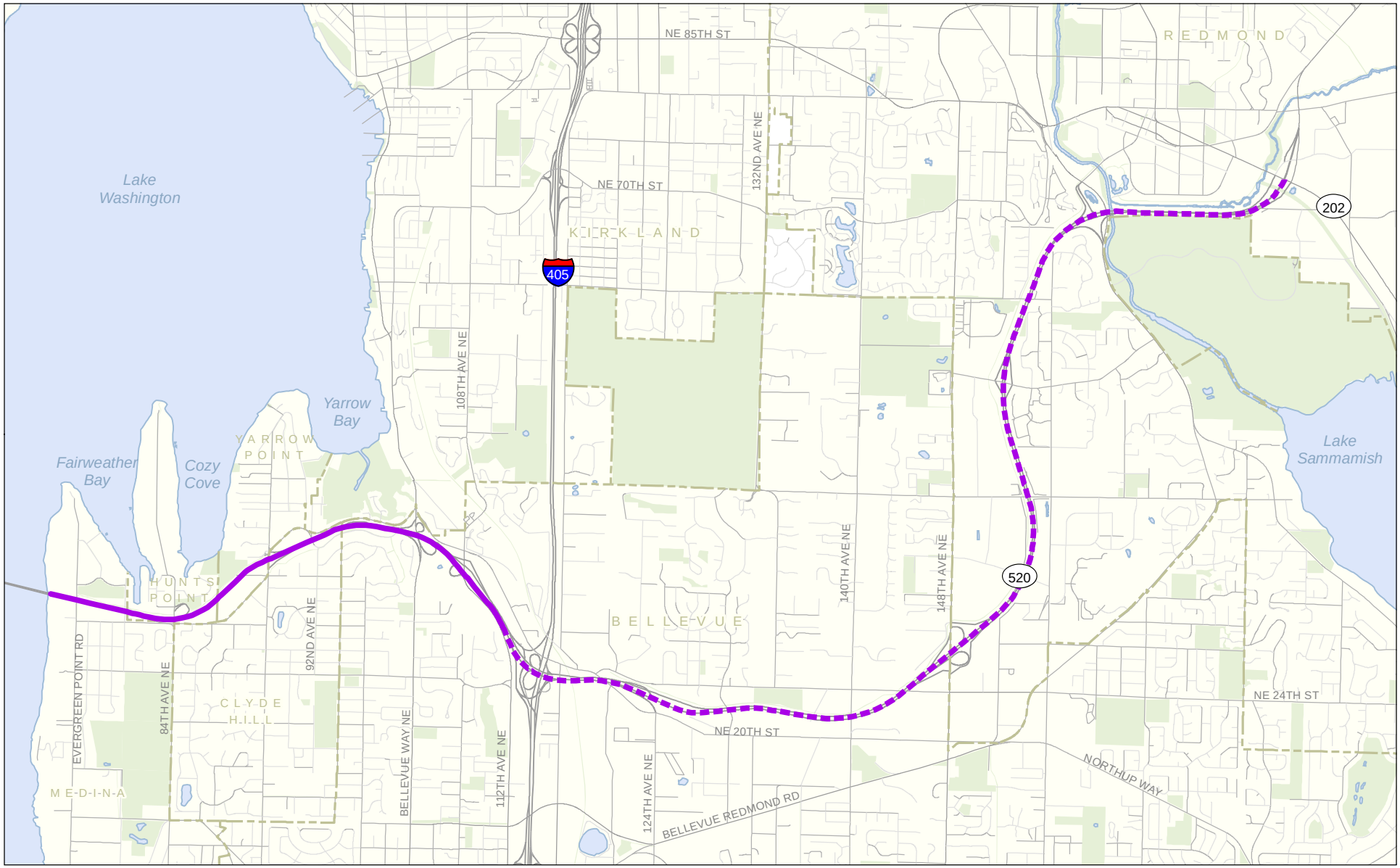
Build Alternative

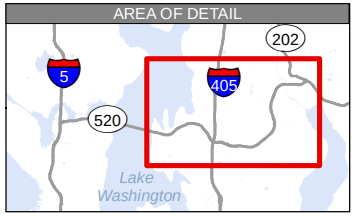
Under the Build Alternative, the proposed project would include the improvements described below.

SR 520 Improvements from Lake Washington to I-405

The proposed project would reconstruct SR 520 from just west of Evergreen Point Road to just east of 108th Avenue NE. Elements constructed as part of this section include the following:

- Construct a new eastbound HOV lane from Lake Washington to the existing eastbound HOV lane west of the I-405 interchange. This improvement would complete the currently discontinuous HOV network on the Eastside and improve travel time reliability for buses and carpools.





Construction Extent

Restriping Extent

Park

City Limits

N

0 0.5 1 Miles

Source: King County (2005) GIS Data (Streets), King County (2007) GIS Data (Waterbody) and CH2M HILL (2008) GIS Data (Parks and Streams). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 1. **Project Vicinity**

Medina to SR 202: Eastside Transit and HOV Project

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- Relocate the existing westbound HOV lane from the outside lane to the inside lane from Lake Washington to I-405. This change would enhance safety by eliminating the need for merging vehicles to weave across the faster-moving HOV lanes to reach the general-purpose lanes.
- Construct a lid with inside transit stop over SR 520 at Evergreen Point Road.
- Construct a new lid and modify the existing half-diamond interchange at 84th Avenue NE.
- Construct a new lid with inside transit stop over SR 520 at 92nd Avenue NE and modify the existing interchange.
- Reconfigure the existing interchange at Bellevue Way NE.
- Construct new HOV direct access ramps at 108th Avenue NE. This improvement would create a more efficient connection for transit and HOV from SR 520 to the South Kirkland Park-and-Ride via local streets.
- Add a bike/pedestrian path from Lake Washington to approximately 108th Avenue NE. This improvement would facilitate nonmotorized use of SR 520, provide transit connections for bikes and pedestrians, and complement the existing nonmotorized transportation network on the Eastside.

What is a lid?

The term "lid" is short for "lidded highway". Lids are long bridges that cover a length of highway. Lid surface areas can carry paths and trails to connect communities across the highway, landscaping to create open space and places for passive recreation, and items such as pergolas, seating, and transit waiting areas.

SR 520 Improvements from I-405 to SR 202

- Restripe existing eastbound and westbound HOV lanes from the outside to the inside lane. This change would enhance safety by eliminating the need for merging vehicles to weave across the faster-moving HOV lanes to reach the general-purpose lanes.

Other Improvements

- Provide noise walls between Evergreen Point Road and Bellevue Way NE.
- Provide retaining walls and stormwater management system improvements.
- Improve stream habitat by realigning portions of the Yarrow Creek channel and shortening some culverts.

- Improve fish passage culvert crossings to restore fish passage and open up habitat that was previously inaccessible to salmon and other fish species.
- Mitigate the project's effects on wetlands and streams at a site or sites as determined through future negotiations with permitting agencies.

No Build Alternative

Under the No Build Alternative, the project would not be built. Only routine maintenance, repair, and minor safety improvements would take place on SR 520 in the study area over the next 20 years. The No Build Alternative would not improve transit reliability and transit and HOV travel times on SR 520. Also included in the No Build Alternative for traffic modeling purposes is the assumption that the SR 520, Bridge Replacement and HOV Project would not be built until this project is complete.

WSDOT is evaluating the No Build Alternative to provide a reference point for comparing the effects, both positive and negative, associated with the proposed project.

What is in this report?

Following Chapter 1—Background, are the following chapters:

- ***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 and updated during the project. The project model was 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***. Describes the methodology for developing detailed project-level forecasts and conducting traffic operational analysis.
- ***Chapter 5—Freeway Volumes and Operations***. Describes existing and forecasted freeway and operating conditions for the project corridor. Compares the future No Build Alternative with the Build Alternative (also referred to as the 6-Lane Alternative).

- ***Chapter 6—Local Roadway Operations***. Describes the existing and forecasted operating conditions at local intersections. Compares the future No Build Alternative with the Build Alternative.
- ***Chapter 7—Nonmotorized Facilities***. Describes existing bicycle, pedestrian, and other nonmotorized transportation facilities as well as improvements proposed as part of the Medina to SR 202: Eastside Transit and HOV Project.
- ***Chapter 8—Transit***. 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 each alternative's effects on parking supply.
- ***Chapter 10—Construction Effects***. Describes the effect of construction on traffic and parking for each of the project alternatives and identifies temporary mitigation measures.
- ***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 I-405 Nickel Projects and improvements to the east end of SR 520).
- ***Chapter 12—References***. Lists all of the documentation cited in this report.

Chapter 2–Key Findings

What is in this chapter?

This chapter presents key findings from the transportation analysis completed by the SR 520 Program transportation team. Key findings are presented for freeway traffic, local traffic, nonmotorized traffic, transit operations, parking supply, construction effects, and cumulative effects.

How will the project affect freeway traffic?

Today, there are sections of SR 520 that do not meet current WSDOT design guidelines, which affects freeway capacity and operations. For example, today's outside HOV lanes are on what was originally the freeway shoulder. Operations and safety in the HOV lanes are also affected by drivers who must cross them to reach on- and off-ramps or general-purpose lanes.

The SR 520 corridor has narrow shoulders, reduced sight distance through some sections, and substandard acceleration and deceleration lane lengths at most on- and off-ramps. These conditions, along with a current traffic demand that exceeds capacity, create congestion on the corridor and reduce transit and HOV trip reliability. On the Eastside, between the floating bridge and SR 202, this congestion and reduced reliability are particularly evident today at the following locations:

- In Medina, beginning where the HOV lane terminates east of the SR 520 bridge, during the westbound morning and evening commutes
- Between 124th Avenue NE and I-405 during the westbound evening commute
- Beginning at the SR 520 terminus at Avondale Road during the eastbound evening commute

This congestion, as well as the weaving activity between the ramps and outside HOV lanes, contributes to an accident rate up to 1.84 accidents per million vehicle miles traveled for westbound traffic between I-405 and Medina. This rate is notably higher than the average accident rate for the entire SR 520 corridor (1.11).

To determine how the project would affect future freeway traffic conditions, the transportation team analyzed both the No Build and Build (6-Lane) Alternatives to develop key findings. The following sections describe our key findings for each alternative.

No Build Alternative

By the year 2030, the region will grow by an additional 1.1 million people, add over 850,000 new jobs, and need to accommodate close to 50 percent more traffic. Freeway traffic congestion will worsen over today's conditions, with congestion lasting longer at existing bottlenecks. Accident rates are expected to continue to increase.

I-405 will become severely congested due to substantial growth in regional population and employment, affecting SR 520 freeway operations without or with project. The following conditions would be typical for both the No Build Alternative and the Build Alternative.

- Eastbound, I-405 congestion in the afternoon would back onto the SR 520 corridor and extend as far back as the floating bridge.
- This congestion would also affect westbound SR 520 traffic as far back as the 51st/40th Street NE interchange.

Build Alternative

The Build Alternative would improve many of today's substandard conditions along the SR 520 corridor and relocate the HOV traffic to the inside lanes of the corridor. These improvements would have substantial travel time, reliability, and safety benefits—especially for buses and carpools.

The project improvements described in Chapter 1 would result in the following effects to the SR 520 corridor in the year 2030:

- Improved travel time reliability for buses and carpools between I-5 and SR 202, particularly during the afternoon commute. Up to 5,500 carpool and bus users per hour during the afternoon commute would benefit from this improvement and bypass general-purpose lane congestion.
- In the afternoon commute, westbound HOV travel times would improve between 18 and 45 minutes over the No Build Alternative and be 29 to 44 minutes faster than general-purpose travel times. Eastbound HOV travel times would improve between 5 and 16

minutes over the No Build Alternative and be 5 to 8 minutes faster than general-purpose travel times.

- Safety would be improved due to wider shoulders and the HOV lane at the inside of the corridor, which reduces higher-speed HOV/general-purpose conflict points.
- Freeway mainline operations at merge points with ramps, transit stations, and HOV lane terminations would improve due to deceleration and acceleration lane improvements, including the addition of auxiliary lanes between ramps. Capacity, speeds, and safety would be improved as a result.
- With improved merge points, more traffic would be served on the on-ramps at the 84th, 92nd, and Bellevue Way NE/108th Avenue NE interchanges. This would reduce congestion on the local streets.
- HOV traffic to and from the west would have a more direct transit and HOV connection between SR 520 and the South Kirkland Park-and-Ride lot. This connection would improve transit travel times and reliability.

How will the project affect local traffic?

The project's interchange areas are typically congested during the morning and afternoon peak hours at the following locations:

- 84th Avenue NE northbound is congested during the afternoon commute period due to congestion on SR 520 that backs up onto and beyond the westbound on-ramp.
- Bellevue Way southbound and Northup Way westbound are affected by congestion on westbound SR 520, which backs up onto and beyond the on-ramps during the afternoon peak hour.
- Bellevue Way northbound traffic is affected by a lane drop north of NE 38th Place.
- The Northup Way/108th Avenue NE intersection operates over capacity, which can back up traffic on the westbound 108th Avenue NE off-ramp from SR 520.

No Build Alternative

Between now and the year 2030, regional traffic volumes will increase as population and employment increases. In the vicinity between 84th

Avenue NE and 108th Avenue NE, traffic volumes would increase up to 28 percent. Local street traffic congestion is likely to worsen over today's conditions. Three of the ten study intersections will operate at LOS E or worse compared to none today.

Build Alternative

The project would alleviate some of the freeway-related congestion on local streets and improve transit and HOV access to SR 520 from local streets. However, intersection LOS would be the same as without the project. Although there would still be congestion with the Build Alternative, it would not last as long as the No Build Alternative. Overall, the project would improve mobility for people traveling in the SR 520 corridor.

Morning and afternoon peak hour traffic volumes on local streets would be slightly higher with the Build Alternative (approximately 5 percent). SR 520 project improvements would change freeway access by shifting traffic patterns, thereby increasing traffic volumes on some local streets. The greatest increase would be 150 vehicles per hour (vph) on Northup Way.

- At 84th Avenue NE, freeway mainline improvements would allow the on-ramp to serve more vehicles (50 vph) while maintaining SR 520 mainline operations. There would be less congestion on the on-ramp and, therefore, less congestion on 84th Avenue NE and NE 28th Street during the afternoon peak hour. While 50 vph does not seem substantial, 50 vph in stop-and-go traffic conditions can result in approximately 1,250 feet (nearly a quarter mile) of congestion.
- At 92nd Avenue NE, the Build Alternative would improve traffic circulation with a new roundabout at the intersection of the westbound SR 520 off-ramp and a new drop-off and pick-up area on the interchange lid.
- At Bellevue Way NE, the Build Alternative's new ramp reconfiguration would eliminate the weave condition between the loop ramps on northbound Bellevue Way NE, reducing congestion during the afternoon commute.
- At 108th Avenue NE, the existing SR 520 westbound off-ramp to this avenue would be reconstructed to the south to create a new intersection with the HOV direct access ramps. The effects of this change on local traffic are:

- Improved operations for both SR 520 westbound off-ramp and 108th Avenue NE northbound traffic because of the increased distance between the westbound off-ramp and the Northup Way/108th Avenue NE intersections.
- Northbound traffic on 108th Avenue NE would no longer be able to turn left onto the SR 520 westbound on-ramp and would travel to Bellevue Way NE for that access.

How would the project affect nonmotorized facilities?

The project's nonmotorized improvements would substantially enhance both the commuting and recreational opportunities in the SR 520 corridor. The project would be consistent with regional planning efforts. Design of the nonmotorized facilities would retain flexibility for future roadway and nonmotorized facility design in the region and would facilitate future connections to regional and local trail systems. More specifically, the project would have the following effects on nonmotorized facilities.

- The project would add approximately 2 miles of paved trail for the exclusive use bicycles, pedestrians, and other nonmotorized means of travel between Bellevue Way NE and Evergreen Point Road.
- The SR 520 regional path would provide a more direct, ADA compliant commuting option compared to the No Build Alternative.
- The project would reconstruct the Points Loop Trail between Evergreen Point Road and 92nd Avenue NE, improving conditions through the interchanges with lids and tunnels.
- The interchange lids will also provide green space, allow access to the SR 520 median transit stations, and enhance community connectivity.
- The SR 520 regional path and the Points Loop trail will improve cross-corridor routes and connections between neighborhoods. They will also provide direct connections for pedestrians and cyclists to access transit facilities.

How would the project affect transit operations?

The SR 520 transportation team worked with local transit agencies to identify planned and programmed (funded) transit improvements to the current SR 520 corridor service structure. Transit service reliability is currently affected by traffic congestion on SR 520, especially during the afternoon commute. For example, westbound transit travel times can range between 10 and 55 minutes and approximately 20 percent of transit trips take over 30 minutes to travel between NE 51st Street in Redmond and the Montlake Freeway Transit Station. This delay is primarily due to congestion through the I-405 interchange and approaching the floating bridge.

No Build Alternative

With the growth in regional population and employment and resulting traffic volumes, congestion will increase between now and the year 2030, further worsening transit travel time reliability. Westbound congestion is forecasted to extend back to the NE 40th/51st Street interchange and eastbound congestion to the floating bridge during the evening commute. As a result, HOV travel times between I-5 and SR 202 are expected to range from 40 to 70 minutes westbound and 20 to 30 minutes eastbound.

Build Alternative

Relocating the HOV lane to the inside of the SR 520 corridor between Medina and SR 202 would allow carpools and buses to reliably bypass congestion. HOV lane operations and safety would also improve as general-purpose drivers would no longer need to merge across the lane to access ramps. The project would have the following effects on transit operations compared to the No Build Alternative:

- Travel time savings with the project would be the greatest for westbound buses and carpools during the afternoon peak period, which is when the westbound general-purpose lanes would be congested as far east as the NE 40th/51st Street interchange.
- HOV travel times between I-5 and SR 202 are expected to reliably average 20 minutes westbound and 15 minutes eastbound. This is a 20 to 50 minute improvement for westbound traffic and 5 to 15

minute improvement eastbound compared to the No Build Alternative.

- Westbound, HOV travel would be 30 to 45 minutes faster than general-purpose travel. Eastbound, HOV travel would be 5 to 10 minutes faster. This travel time benefit, along with the reliability improvements, would increase the attractiveness of transit as an alternative to driving alone.
- With the movement of the HOV lane to the inside of SR 520, the addition of an HOV direct access ramp at 108th Avenue NE would improve access between SR 520 and the South Kirkland Park-and-Ride, especially for eastbound buses.
- Without a direct access ramp, buses would have to make three lane changes (between the inside HOV lane to the ramp) when traveling between SR 520 and the South Kirkland Park-and-Ride.
- The 92nd Avenue NE and Evergreen Point Freeway Transit Stations would be moved to the inside improved deceleration and acceleration lanes, enhancing transit operations and safety.
- The Build Alternative's transit station design and access would be incorporated into the interchange lids, making the stations integral parts of the local communities served. The transit station design features would improve the waiting experience for transit users and be ADA-compliant.

How would the project affect parking?

The SR 520 Draft EIS parking analysis was updated to reflect the current design of the Medina to SR 202: Eastside Transit and HOV Project. The analysis was performed by comparing the current design footprint to aerial photography and conducting site visits to determine changes in parking supply effects. The project would result in a loss of 32 parking spaces from two locations:

- The entire 19-space state-owned lot in Medina would be eliminated. This lot is available only to official state vehicles and is minimally used. Parking at this facility would be replaced by a new state maintenance facility with a parking garage under the east bridge abutment.
- The 13-space parking lot adjacent to the By the Way Espresso Stand in Kirkland has been purchased since the Draft EIS was published

(2005). This parking lot was minimally used and will not be replaced.

What are the construction effects associated with the project?

The SR 520 transportation team used preliminary design and construction staging plans to evaluate the key construction activities that would affect traffic on and adjacent to the SR 520 corridor. The key findings of our evaluation are summarized below.

- SR 520 would remain open between 5:00 a.m. and 9:00 p.m. on weekdays throughout construction and operate with all lanes, including the westbound HOV lane.
- Construction effects to SR 520 traffic during the weekday morning and afternoon commute times would be minimal.
- Construction would take approximately 3 years and include approximately 5 phases.
- Multiple full-weekend closures are expected; however, closure hours and dates would be restricted to avoid special events and other freeway closures that might occur.
- The primary detour route for an SR 520 closure is the I-90 bridge. However, traffic conditions on I-5, I-405 and SR 522, as well as primary arterials surrounding Lake Washington, will also be affected.
- Night-time lane and ramp closures would occur outside of peak commute hours.
- Traffic on the Evergreen Point Road NE, 84th Avenue NE, and 92nd Avenue NE overpasses would be maintained at all times during construction of the proposed lids because there are no alternative detour routes on the north side of the freeway.
- The Bellevue Way NE overpass would also remain open throughout construction; however, there will be stages where the roadway is reduced from five to three lanes (approximately 10 months) and four lanes (approximately 1 year).
- The southbound Bellevue Way NE to westbound on-ramp may be closed for 2 to 3 months and the 108th Avenue NE westbound on-

ramp for 6 to 9 months during construction. Construction restrictions would be in place to prevent closures of both ramps at the same time. A detour route between the two ramps via Northup Way would be in place during the ramp closures.

- Sidewalks along all arterials would be maintained during construction.
- The Evergreen Point Road and 92nd Avenue NE Freeway Transit Stations may need to be closed for short durations (4 to 6 months). Construction restrictions would be in place to prevent closure of both stations at the same time.
- The freeway transit stations would remain on the outside shoulders of SR 520 during Phases 1 through 4 of construction and would not shift to the inside of the freeway until Phase 5, when all supporting infrastructure is in place. This phasing would minimize disruption to current commuters and ensure that full and safe access is available to the new facilities.

What are the cumulative and indirect effects of the project?

The cumulative and indirect effects of the project were evaluated to determine if the project would induce transportation changes or contribute to a cumulative effect on the transportation system. To do this, the transportation team analyzed the transportation effects of the project's year 2030 Build Alternative project against a cumulative effects scenario. The project's Build Alternative included only those transportation projects (roadway and transit) that were planned and funded to be complete by the year 2030. The cumulative effects scenario revised the transportation network to include those transportation projects that are currently unfunded.

Land use assumptions were not modified for the transportation cumulative effects analysis because changes in land use patterns werenot expected to occur based on findings from the 2006 SR 520 Draft EIS Transportation Discipline Report. Much of the land use surrounding the SR 520 corridor is built up to the point where demand on the corridor already exceeds capacity.

- The cumulative effects scenario is expected to result in fewer person and vehicle trips across SR 520 compared with the No Build and Build Alternatives. This means that the analysis conducted for the

Medina to SR 202: Eastside Transit and HOV Project EA represents a conservatively high estimate of traffic and associated effects. If the regional projects assumed in the cumulative effects scenario are implemented in conjunction with the SR 520 Bridge Replacement and HOV Project, traffic conditions within the project corridor are expected to be similar or improved.

- While there would be fewer person and vehicle trips across SR 520 with the cumulative effects scenario, more of those trips would be carpool and transit trips. The completed HOV lane system across the SR 520 bridge to I-5 and the toll would be powerful incentives for HOV and transit use in the cumulative effects scenario. As expected, without those incentives, there was little change in carpool/transit demand between the No Build and Build Alternatives.
- Overall, the cumulative effects scenario is expected to decrease traffic volumes across Lake Washington and increase traffic volumes on the Eastside. This is likely due to the increased roadway capacity along regional corridors—including I-405, SR 167, and SR 522—that was assumed in the cumulative effects scenario as well as more people living and working on the Eastside.
- Total cross-lake transit and HOV travel would increase and total cross-lake general-purpose travel would decrease with the cumulative effects scenario as compared with the No Build and Build Alternatives. This is due to the increased ridership associated with implementation of the East Link rail service on I-90 and completion of the HOV lane system across the SR 520 floating bridge to I-5.
- Vehicle trips decrease at a higher rate than person trips. This means that more people would be moved by fewer vehicles with the cumulative effects scenario than with the No Build and Build Alternatives. Regional person moving capacity would be improved.

Chapter 3–Travel Demand Modeling

What is in this chapter?

This chapter provides an 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 timeline. This chapter also documents the history of the SR 520 demand models and the strategy for potential changes to the demand modeling effort in the future.

What is travel demand?

Travel demand refers to 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.

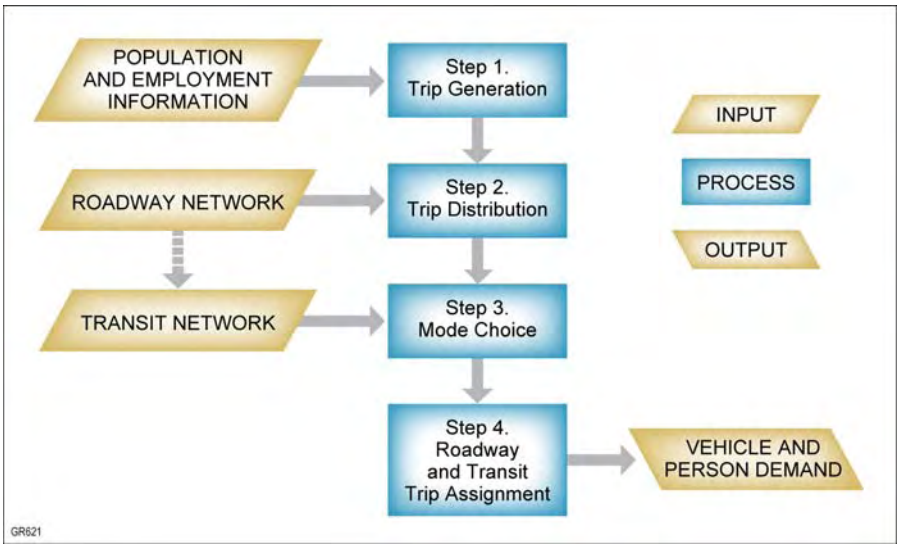


Exhibit 3-1. 4-Step Process for Estimating Travel Demand

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, frequency and type of transit service available, number of roadway lanes, and comfort of the trip.

Did you know?

Travel "mode" refers to the type of transportation vehicle or means of moving from one point to another. For example, cars, buses, trains, bicycles, and walking are different types of travel modes.

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 the changes in regional travel patterns that would result from different actions. These actions can include:

- Adding roadway capacity (lanes)
- Adding transit service
- Tolling
- Roadway closure
- Increasing parking rates
- Programs that provide incentives for transit use (e.g., bus passes)
- Land development
- Other factors

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.

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 among 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 the region-wide transportation plan and the regional travel demand model.

The PSRC regional travel demand model covers its 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.

Did you know?

Metropolitan Planning Organizations are required by federal regulation for urban areas, larger than 50,000 people, that receive federal transportation funds. Each MPO has a board that represents local agencies and a staff of planners and other professionals who develop the regional transportation plan.

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 could be used.

At the core, a model is a complex set of calculations that help estimate the differences resulting among 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 population and employment 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 could be 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.

Did you know?

Traditional gravity models analyze aggregate, or grouped, trips from one area to another. The number of trips between areas is based on distance between areas, the cost of the trip, and the "weight" of each area. Weight refers to density of population or employment in an area.

Activity-based models estimate the behavior of people based on the activities that typical individuals engage-in throughout the day. These models use complex sets of economic data describing how people make decisions about how they will travel based on the value of trips.

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.

Since 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 corridor has an effect on regional traffic movements, it is still only one small 13-mile 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 population and employment forecast.

Can the project travel demand models change during the life of the project?

The project travel demand model can change multiple times 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 SDEIS. The timing of these changes is important because of the way the results of the model 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, do carry traffic. 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

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 Medina to SR 202: Eastside Transit and HOV Project EA, 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 EA was the same as the Draft EIS, but with updates 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 HCT travel demand model included modifications and infrastructure changes.

The SR 520 Finance Plan was released in January 2008 to inform legislators about possible funding amounts 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. The UPA EA used the transportation data generated by the TIC to evaluate potential effects a toll would have on congestion. 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.

Did you know?

A Tolling Implementation Committee was required by state legislation to evaluate the regional effects of various tolling alternatives on SR 520 and I-90 crossing Lake Washington.

Did you know?

The Urban Partnership Agreement is part of federal program to study and evaluate congestion management strategies for SR 520, including tolling. It may result in federal funding for congestion relief elements on SR 520.

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.

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.

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 to assess potential project effects on roadway operations throughout the study area. Travel demand models consider changes to the transportation network, population, and employment.

The *SR 520 Bridge Replacement and HOV Project Model Validation Analysis for 2006 Technical Memorandum* (WSDOT 2008a) 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 project 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). Regional travel demand models are also discussed in Chapter 3—Travel Demand Modeling.

The following paragraphs describe the transportation team's method of determining existing and forecasting future traffic volumes and patterns. This process is summarized in Exhibit 4-1.

The first step in the process was to collect existing traffic volume data for the study area freeways and major local streets. The second step in the process was to verify that the regional travel demand model

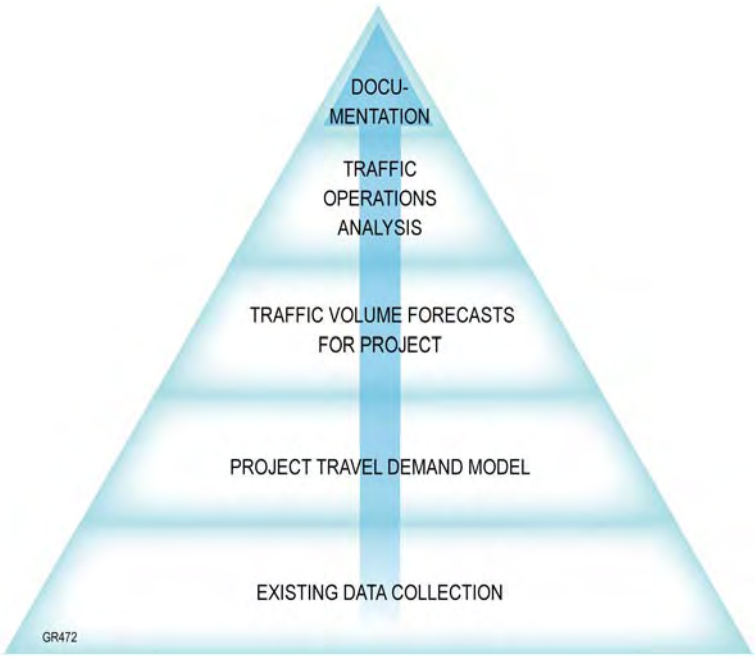


Exhibit 4-1. Travel Forecast Process

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 with future planned and programmed roadway and transit network improvements in the region and along the SR 520 corridor. Adjustments were also made to reflect expected changes in inflation and land use for the year 2030, specifically future population and employment growth forecasts (WSDOT 2008; WSDOT 2009). These elements, along with transit service quality, are major factors that influence travel behavior and patterns. The SDEIS 2030 No-Build and Cumulative Effects Definition Technical Memorandum (WSDOT 2008b) and a supplement to that memo issued by the project office on March 28, 2008 (WSDOT 2008c) provide details about the changes and assumptions coded into the project's travel demand model for the No Build Alternative.

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 demand volumes at several "checkpoints" (screenline locations) along

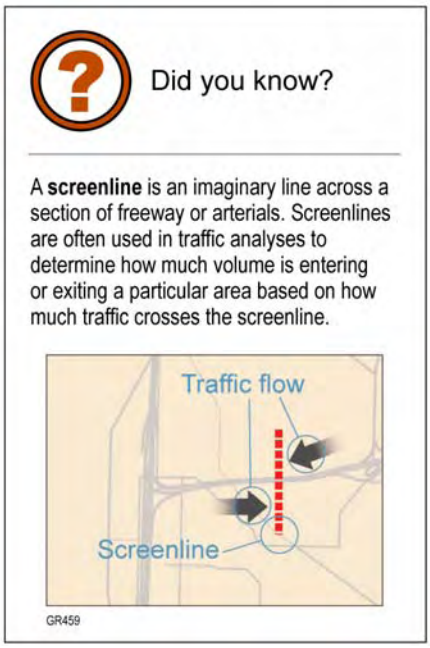
the freeway and at interchange influence areas. Interchange influence areas include the local streets and intersections surrounding an interchange that could be affected by changes to SR 520.

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

After forecasting travel demand for the year 2030 No Build Alternative, network modifications for the Build Alternative were coded into the travel demand model. The process described for the No Build Alternative was then repeated to determine how the Build Alternative would affect traffic demand compared with the No Build Alternative.

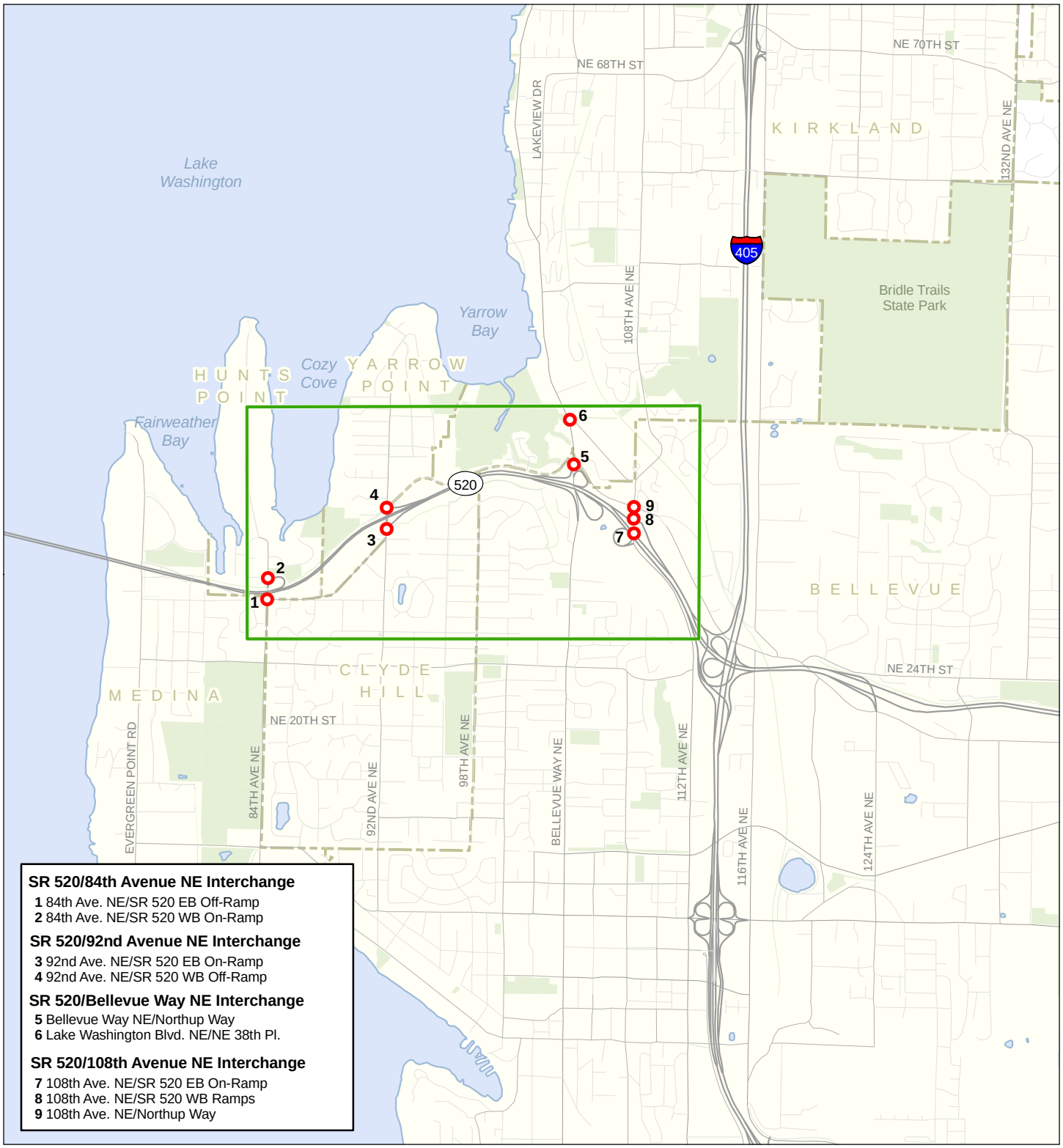
Identifying Freeway Screenline Locations

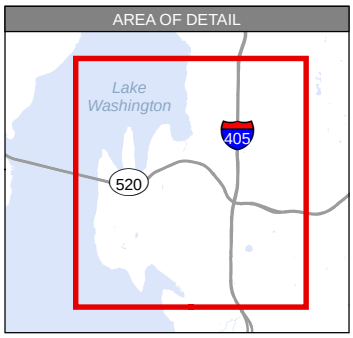
Screenlines were selected to determine key travel patterns adjacent to and within the project limits. The screenlines on SR 520 between Medina and SR 202 represent the locations where traffic enters and exits the project area. Screenlines adjacent to the I-405 and I-5 interchanges with SR 520 were necessary 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 Influence Area Boundaries

Growth in local traffic volumes was calculated using an area-wide growth rate that encompassed many local roads within an interchange influence area. Interchange influence areas are areas where similar growth in traffic is expected, and include one or more interchanges. The influence area for the I-5 to Medina: Eastside Transit and HOV Project, shown on Exhibit 4-2, is comprised of four interchanges: 84th Avenue NE, 92nd Avenue NE, Bellevue Way NE, and 108th Avenue NE. These interchanges were grouped because of their similarities in serving traffic to and from Bellevue and the adjacent neighborhoods.





Intersection

Interchange Influence Area

Source: King County (2008) GIS Data (Streams, Streets, Water Bodies), CH2M HILL (2008) GIS Data (Parks). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

N

0 1,000 2,000 4,000 Feet

Exhibit 4-2. **Eastside Interchange Influence Area and Study Intersections**

Medina to SR 202: Eastside Transit and HOV Project

Bellevue Way NE and 108th Avenue NE are also similar in their service of traffic to the north.

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 cross-lake travel changes without and with the project. Morning and evening commute period forecasts were completed for SR 520 mainline and ramps and adjacent arterials to use in the operations models. Comparing the relationship between daily and peak period traffic volumes help explain how people might react to increases in congestion and changes in travel costs.

Morning and afternoon forecasts include 5-hour periods: 5:00 a.m. to 10:00 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 over-capacity conditions already exist along the SR 520 and I-5 corridors, and traffic volumes are expected to increase over the next 30 years, the project team selected a methodology for traffic volume forecasting and analysis that would account for these conditions throughout multiple hours.

In what terms do we discuss traffic volumes and patterns?

Traffic forecast volumes are generally described in terms of vehicle and person demand and mode of travel choice. The purpose and need statement for the Medina to SR 202: Eastside Transit and HOV Project is to reduce transit and HOV travel times and enhance travel time reliability, mobility, access, and safety for transit and HOVs in rapidly growing areas along the SR 520 corridor east of Lake Washington. The best way to measure the improvement of mobility is, first, to assess the person demand associated with any specific action on the corridor, and second, measure how many of those people are actually served in 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). 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 vehicle occupancy that was consistent with the travel demand model.

Average vehicle occupancy (AVO) is used to describe the average number of persons per vehicle. The following AVO assumptions were made for the operations analysis:

- 1.33 persons per general-purpose vehicle
- 3.15 persons per high-occupancy vehicle
- 65 persons per bus

Mode Choice

Mode choice refers to the type of transportation a person chooses to use, such as driving alone, 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 assumptions:

- 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 Service we assumed 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.

The transit person demand forecasts were not constrained by transit volume and service forecasts; 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 travel demand forecasts used to estimate freeway volumes?

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 EA freeway operations analysis as the 2005 SR 520 Bridge Replacement and HOV Project Draft EIS exceptthat the EA analysis includes the 6th Street HOV ramps in downtown Bellevue, which were constructed following the Draft EIS analysis.

How were the alternatives analyzed?

The team used the CORSIM software program, a micro-simulation package developed by the FHWA, to simulate traffic operations on the SR 520 corridor and 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 the operational differences between the No Build and Build Alternatives. Exhibit 4-3 shows an example of the CORSIM 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

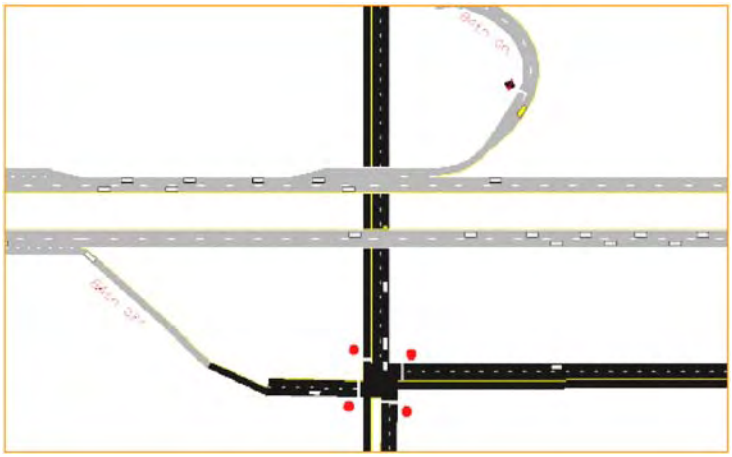


Exhibit 4-3. CORSIM Micro-Simulation Model Animation Screen

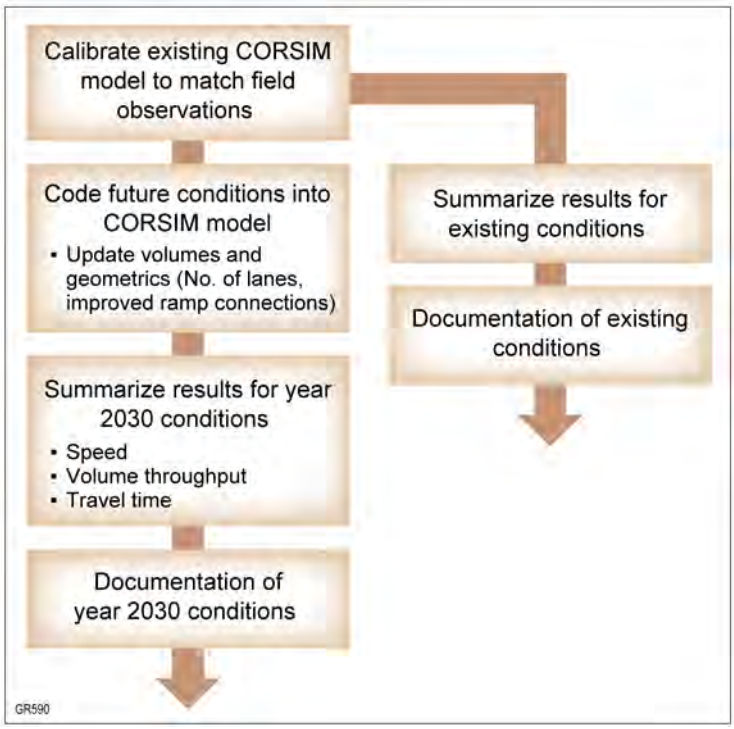


Exhibit 4-4. Alternatives Analysis Process

using WSDOT freeway count data from October 2008 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.

What are the measures of effectiveness for the operational analysis?

The transportation study team, together with WSDOT, developed the following measures of effectiveness:

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

We used these MOEs to evaluate and compare traffic operations among the No Build and Build Alternatives. Exhibit 4-5 shows how the MOEs were used to define thresholds for identifying freeway congestion. Each MOE is described in greater detail below.

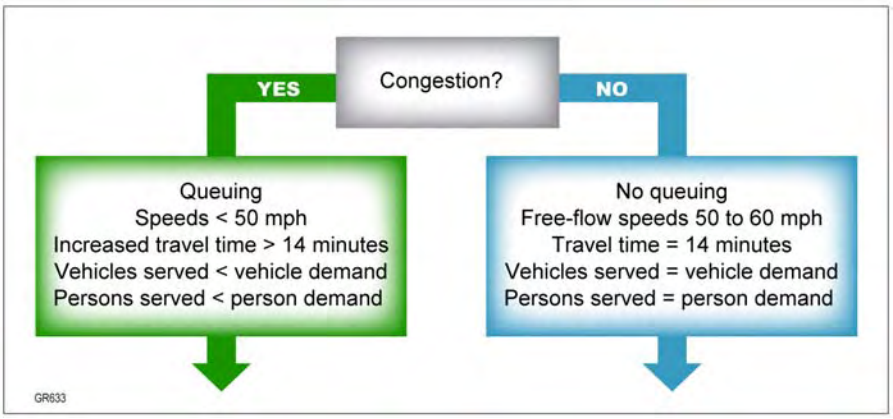


Exhibit 4-5. Understanding Congestion and Measures of Effectiveness

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 and Build Alternatives based on CORSIM model results.

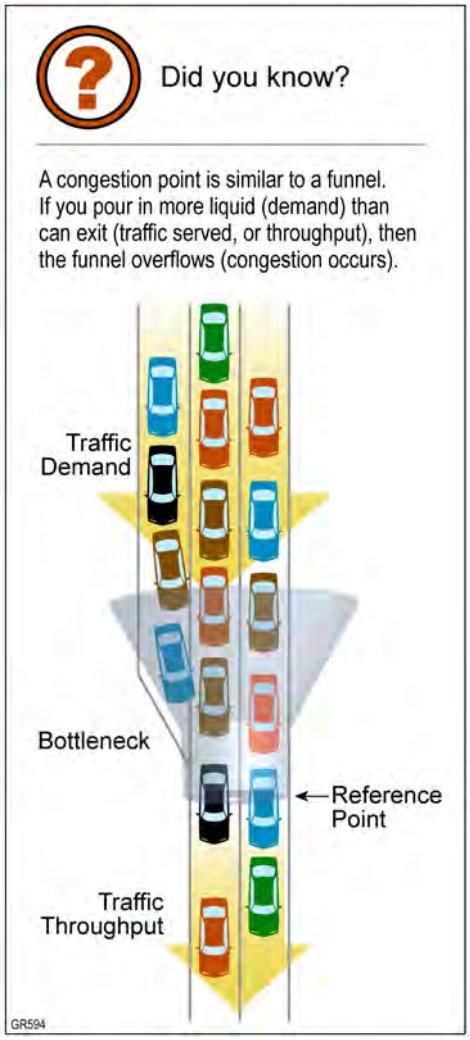
Speed

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 I-5 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 high-occupancy vehicles 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 estimated?

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 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 the interchange influence area. The interchange area boundary was 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.

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 again in the afternoon.

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

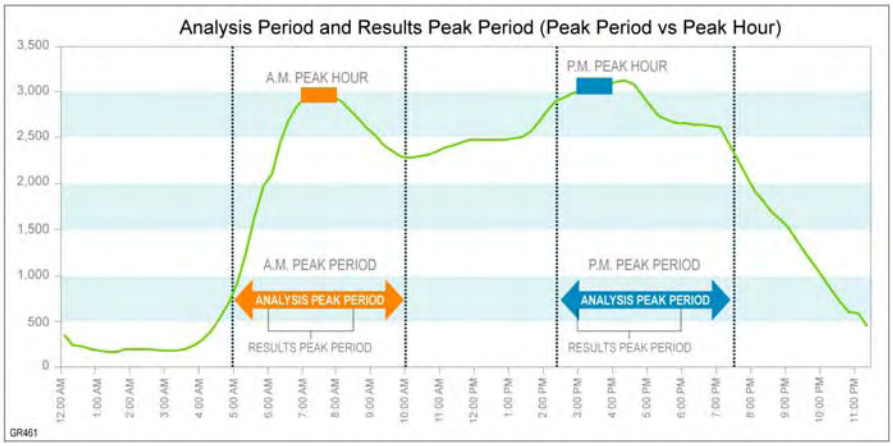


Exhibit 4-6. Peak Period Versus Peak Hour

Distributing Freeway Ramp Traffic

Traffic on local streets is comprised of two types: 1) traffic using local streets to 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.

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 turning movement ratios would not change substantially in the future except for where the project changes the 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 4-2 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 No Build and Build 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 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.

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 (with LOS A representing best traffic conditions and LOS F representing the worst). At locations where 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 rating scale uses the letters A through F (see Exhibit 4-7). 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. For intersections controlled by signals and all-way stops, LOS represents an average delay for the entire intersection.

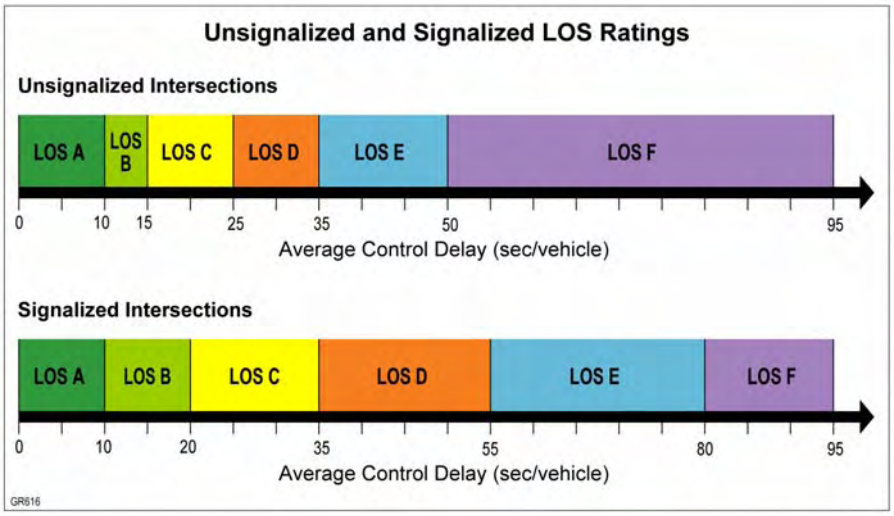


Exhibit 4-7. Delay Ranges Associated with LOS Ratings

For this report, the overall intersection delay 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 to 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, and other factors) as well as the type and duration of traffic control (stop sign, signal, cycle length, and others). For instance, the longer a signal is set for green in a given intersection, the more vehicles can move through the intersection and the greater its capacity.

What is a queue spillback location?

A queue spillback occurs in an area where vehicles cannot proceed through an intersection because traffic ahead is backed up from the next intersection. As shown in Exhibit 4-8, the location at which a vehicle is blocked from moving through an intersection is referred to as the queue spillback location. Queue spillback also occurs when vehicles exiting via off-ramps are backed onto the freeway. This latter type of queue spillback is what the SR 520 team has identified on this project.

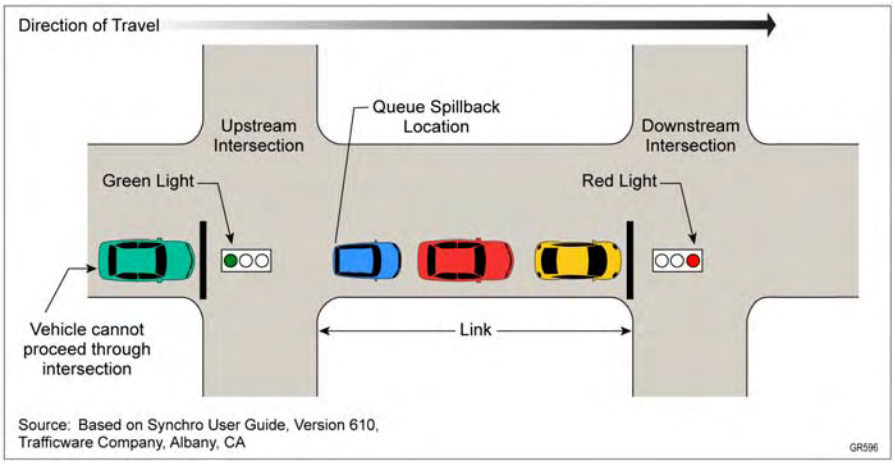


Exhibit 4-8. Queue Spillback Location