

Appendix Q

Northgate to Lynnwood
Light Rail and I-5
Compatibility Report

North Corridor Transit Project

Northgate to Lynnwood Light Rail and I-5 Compatibility Report

Prepared For:



**Washington State
Department of
Transportation**



SOUND TRANSIT

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Acronyms and Abbreviations

DEIS	Draft Environmental Impact Statement
ETLs	express toll lanes
FTA	Federal Transit Administration
HOV	high-occupancy vehicle
HSR	Hard Shoulder Running
I-5	Interstate 5
ITS	Intelligent Transportation Systems
Link	Link light rail system
LRT	Light Rail Transit
NCTP	North Corridor Transit Project
Sound Transit	Central Puget Sound Regional Transit Authority
SR	State Route
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

1.1 Background

Sound Transit is preparing to extend mass transit from Northgate to Lynnwood, which voters approved as part of the Sound Transit 2 Plan in 2008, along with funding to continue planning future service all the way to Everett. The project, called the North Corridor Transit Project (NCTP), will connect to and build on the Link light rail line that opened for service between downtown Seattle and Sea-Tac Airport in 2009.

Sound Transit has just completed an Alternative Analysis (AA) in compliance with Federal Transit Administration guidelines for New Starts grant funding. The AA, entitled the “NCTP Alternatives Analysis Report and SEPA Addendum” (Sept 2011), evaluated a range of potential alternatives for addressing mobility needs within the Project area, including transit modes, routes, stations, and operating features.

The AA concluded that light rail was the only mode that can satisfy the NCTP’s Purpose and Need related to transportation effectiveness in meeting the corridor’s mobility, access, and capacity needs, as well as consistency with Sound Transit’s Long-Range Plan. Interstate 5 (I-5) was one of the corridors evaluated by the AA for light rail service. The proposed I-5 alternative is shown in Figure 1.

The next step for the project is to begin the conceptual design and environmental review activities associated with the NEPA/SEPA Draft Environmental Impact Statement (DEIS). This process will more closely define the footprint requirements for light rail infrastructure and will identify potential impacts associated with alternative alignments.

1.2 Purpose of Report

This report was prepared by North Corridor Transit Partners for the Washington State Department of Transportation (WSDOT) and Sound Transit (Central Puget Sound Regional Transit Authority). This report documents WSDOT and Sound Transit’s agreement on reasonable I-5 highway and light rail areas that will ensure WSDOT’s ability to make future highway improvements while accommodating light rail infrastructure and minimizing impacts to adjacent properties. This report documents WSDOT’s and Sound Transit’s assumptions for beginning the design process of light rail alternatives along I-5.

1.3 Approach

The analysis for this report takes into account previous studies prepared by WSDOT and Sound Transit. WSDOT studies include the I-5 Pavement Replacement Project and the Express Toll Lanes Study. The Pavement Reconstruction Project (Existing Pavement Conditions and Traffic Operations Analysis Results Report, November 2007) identified several operational improvements that included creating four continuous lanes between the Washington Ship Canal Bridge and the northern terminus of the express lanes. The Express Toll Lanes Study, currently in progress, is analyzing the conversion of the existing HOV lane and possible addition of a new lane north of the express lanes that could be available for a tolled lane system.

The Sound Transit Alternatives Analysis Report (September 2011) for the light rail extension from Northgate to Lynnwood identifies the east side of I-5 up to SW 236th Street and the median from SW 236th Street to Lynnwood as a likely location for light rail. For that reason, this report is limited to reviewing the northbound (east side) portion of I-5. This report could be amended in the future if an analysis of the southbound portion of I-5 is determined necessary. Additional details will be developed during the DEIS process to further define issues that are beyond the scope of this report's analysis.

WSDOT's I-5 highway requirements for the I-5 right-of-way include the need for space adjacent to the existing travel lanes to maintain the flexibility for future improvements to the highway infrastructure such as improving safety, upgrading environmental conditions, improving highway technology (ITS), and/or adding capacity.

Sound Transit's needs for light rail include providing adequate space for the rail guideway infrastructure for each direction of travel, a pedestrian walkway, poles to support the overhead catenary system, signal systems, bridge railing, noise walls, and retaining walls. For the NCTP DEIS analysis, the light rail footprint will be located outside of the highway area. The DEIS will evaluate the width and location requirements of the proposed rail alignments, including construction impacts outside of the highway area.

The concepts presented in the following analysis identify a range of possible improvements that support WSDOT's and Sound Transit's interests and do not represent a specific approved or proposed project. These concepts provide a basis to identify a reasonable space allocation that will be flexible for WSDOT to make future highway improvements that would not require relocation of the light rail infrastructure.



Depicted is one of several alternative concepts for light rail service on the I-5 corridor, additional alignment and station alternatives will be considered in the DEIS, but those have not been defined in detail at this time.

Figure 1. NCTP Conceptual I-5 Corridor for Light Rail Service

2 EXISTING ROADWAY CONDITIONS

In addition to the existing mainline general purpose lanes, HOV lanes and interchanges, the I-5 corridor includes infrastructure to support traffic operations, bus operations, safety and environmental requirements.

Within the corridor, infrastructure to support buses includes outside freeway stops and a park-and-ride lot at NE 145th Street, a transit only interchange to King County Metro's North Base, a transit only median freeway station at Mountlake Terrace, and an HOV median direct access ramp system in Lynnwood. Transit also benefits from the high-occupancy vehicle (HOV) lanes located throughout the I-5 corridor. Figure 2 illustrates the existing lane and ramp configuration of I-5 from Northgate to Lynnwood.

Additional highway infrastructure supports safety and operations along the corridor. This infrastructure includes barriers, guardrails, retaining walls, noise walls, drainage piping systems, stormwater treatment and detention, signs, illumination, and intelligent transportation systems (ITS). ITS includes features such as traffic cameras, vehicle data collectors, variable message signs, ramp meters and signals and fiber optic cables, as well as associated electrical cabinets and junction boxes. Landscaping and natural vegetation buffers, although not a specific highway function, are typically important features to communities to provide separation between the highway lanes and the private properties. All of these features occupy additional space beyond the edge of pavement to provide the existing and future functions.

Existing features also use some of the space within the existing right of way. At several locations, local streets were constructed within the I-5 right of way or are located adjacent to the right of way. The terrain has constant variation throughout the project limits and in many cases these slopes and retaining walls take up much of the space between the existing highway pavement and the edge of the I-5 right-of-way.

Existing right-of-way varies along the entire length of this corridor. The greatest variability occurs through the interchanges where additional width is required for the ramps. Between ramps, there is also variability due to the original property boundary lines that existed prior to construction of I-5 and the land purchases that were negotiated to create the I-5 right-of-way. As a result, the right-of-way width is rarely constant along this project corridor. To summarize the right-of-way widths, Table 1 describes the variability in the right-of-way width along mainline I-5 measured approximately from the existing center barrier to the eastern edge of the right-of-way. The data in Table 1 is segmented from one interchange to the next, but does not include the additional width at each interchange to accommodate ramps.

Table 1*. Existing I-5 Northbound Roadway Right-of-Way

Segment	Eastern Half ROW width
Northgate Way to 130 th	125-220 feet
130 th to 145 th	215-220 feet
145 th to North Base	125-150 feet
North Base to 175 th	120-185 feet
175 th to 205 th (County Line)	135-220 feet
205 th to 236 th	185-350 feet
236 th to 220 th	125-320 feet
220 th to 44th	130-210 feet

*The data in Table 1 is segmented from one interchange to the next, and does not include the additional width required at each interchange to accommodate ramps.

3 FUTURE ROADWAY NEEDS

3.1 Maintaining Flexibility for Future Decisions

WSDOT has studied a number of possible modifications to the I-5 corridor between Northgate and Lynnwood but has not adopted specific plans for improvements. As noted previously, space within the I-5 right-of-way and adjacent to the existing travel lanes needs to be reserved to maintain the flexibility for future improvements to the highway infrastructure such as improving safety, upgrading environmental conditions, improving highway technology (ITS), or adding capacity. These improvements could include the following:

- Upgrade existing shoulders and maintain existing 12-foot lanes to meet current design standards,
- Create additional capacity by adding lanes,
- Modify interchanges,
- Upgrade ITS systems (variable speed limits, cameras, tolls, illumination, etc.),
- Update drainage infrastructure to meet current or future stormwater standards,
- Provide additional noise mitigation, and
- Provide additional landscaping buffers and enhancements.

The highway area is based on the ability to add one extra lane from the express lane ramps at Northgate to I-405. The additional lane could be added as an additional general purpose lane, an HOV lane, or as a hard shoulder running lane. Figure 2 shows the existing lane configuration and the future concept of how one additional lane could be added to the corridor. Lane continuity (providing continuous lanes for as long as possible) was also a factor in developing the future concept and as a result the future lane concept includes two additional lanes at the 175th interchange. In summary, the future concept could have six continuous lanes between the north end of the express lanes and the county line at the 205th Street interchange, then five continuous lanes north of the county line.

3.2 Northbound Roadway Cross Sections

Space allocations for potential roadway modifications were evaluated using a series of cross sections for variable quantity of lanes and widths of lanes. Figure 3 shows the existing cross section and four potential options for widening the cross section with additional lanes or widened shoulders. Each option shows the same 84-foot total width cross section, the variability of the lane, shoulder, and buffer widths and the resulting quantity of lanes possible for each option. The table on the right side of the figure shows the total cross section width as a result of varying the quantity of lanes. The four options studied are as follows:

- Option 1- 7 lanes: Minimum widths for lanes and shoulders.

- Option 2 – 6 lanes: Hard Shoulder Running (HSR) option with larger left shoulder and a peak period HSR lane on the right shoulder.
- Option 3 – 6 lanes: Dual Express Lane option with narrower left shoulder and full right shoulder, and narrower lanes.
- Option 4 – 5 lanes: Full Standards option that includes the maximum lane, shoulder, and buffer widths.

Since specific future freeway improvements have not been identified, it is important to define a pavement envelope that will provide reasonable flexibility for a variety of future options. After careful review and analysis of a variety of cross-section options, WSDOT and Sound Transit concluded that a pavement width of 84 feet from the center barrier to the edge of the roadway will provide the desired flexibility. This width allows for future lane configurations that could range between five and seven lanes. With the exception of areas around the freeway interchanges, an 84-foot pavement width for mainline lanes is adequate to provide the desired flexibility along the entire length of the North Corridor Transit Project.

Additional space outside of the pavement may be required for other safety, environmental, and technology highway elements. Space beyond the pavement is required for barriers or guardrails, signs, illumination, ITS infrastructure, fencing, and retaining walls. In general, a 10-foot width on the outside edge of the mainline is recommended for these elements. Where light rail might be located in the median of I-5, specific elements would need to be designed into the light rail infrastructure, which could include barriers, walls, drainage collection, and structure support columns. At isolated locations, the 10-foot space could be reduced or a light rail guideway column could be located within this area if additional design studies provide documentation that the space is not required for highway uses.

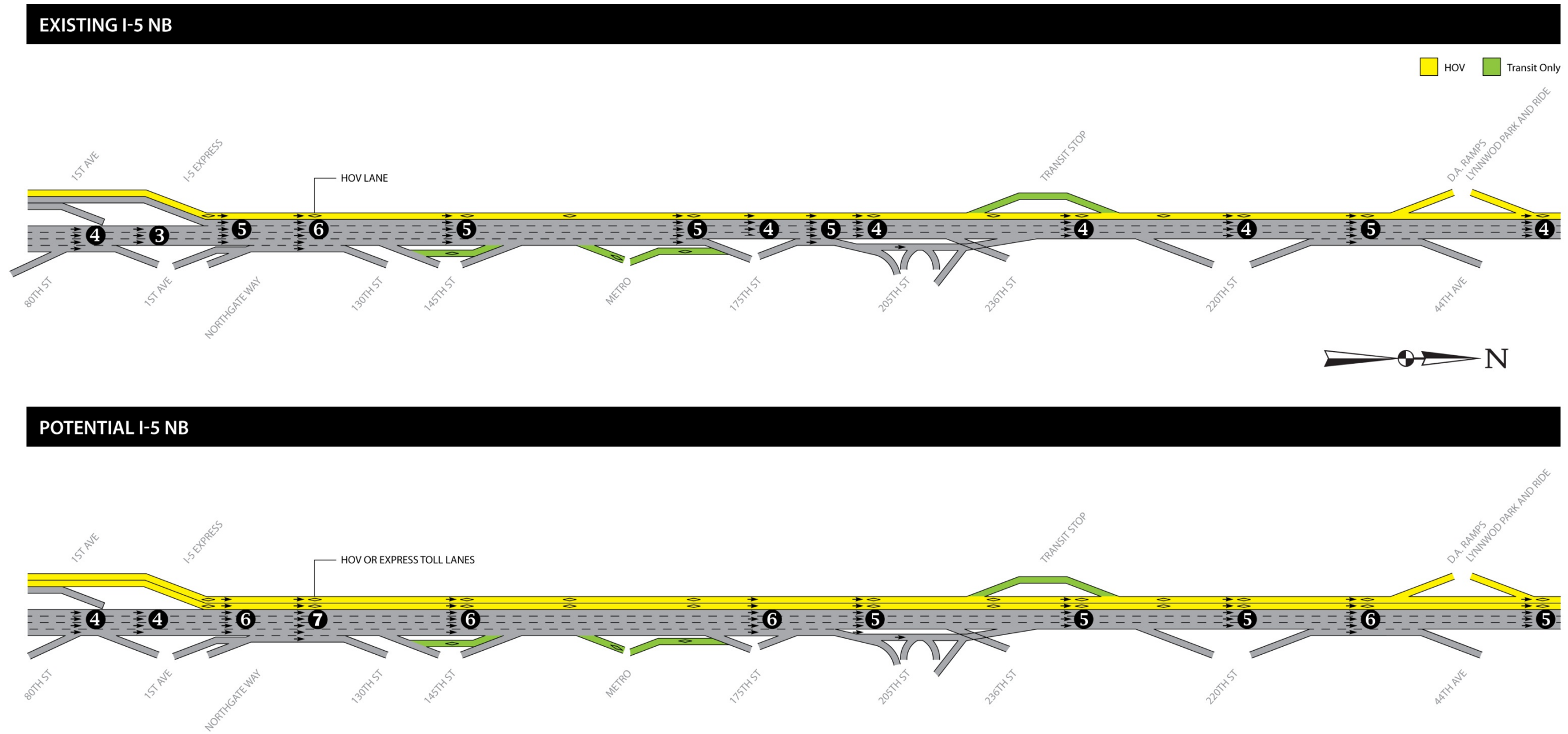


Figure 2. Existing and Potential Future I-5 Northbound Lane Schematics

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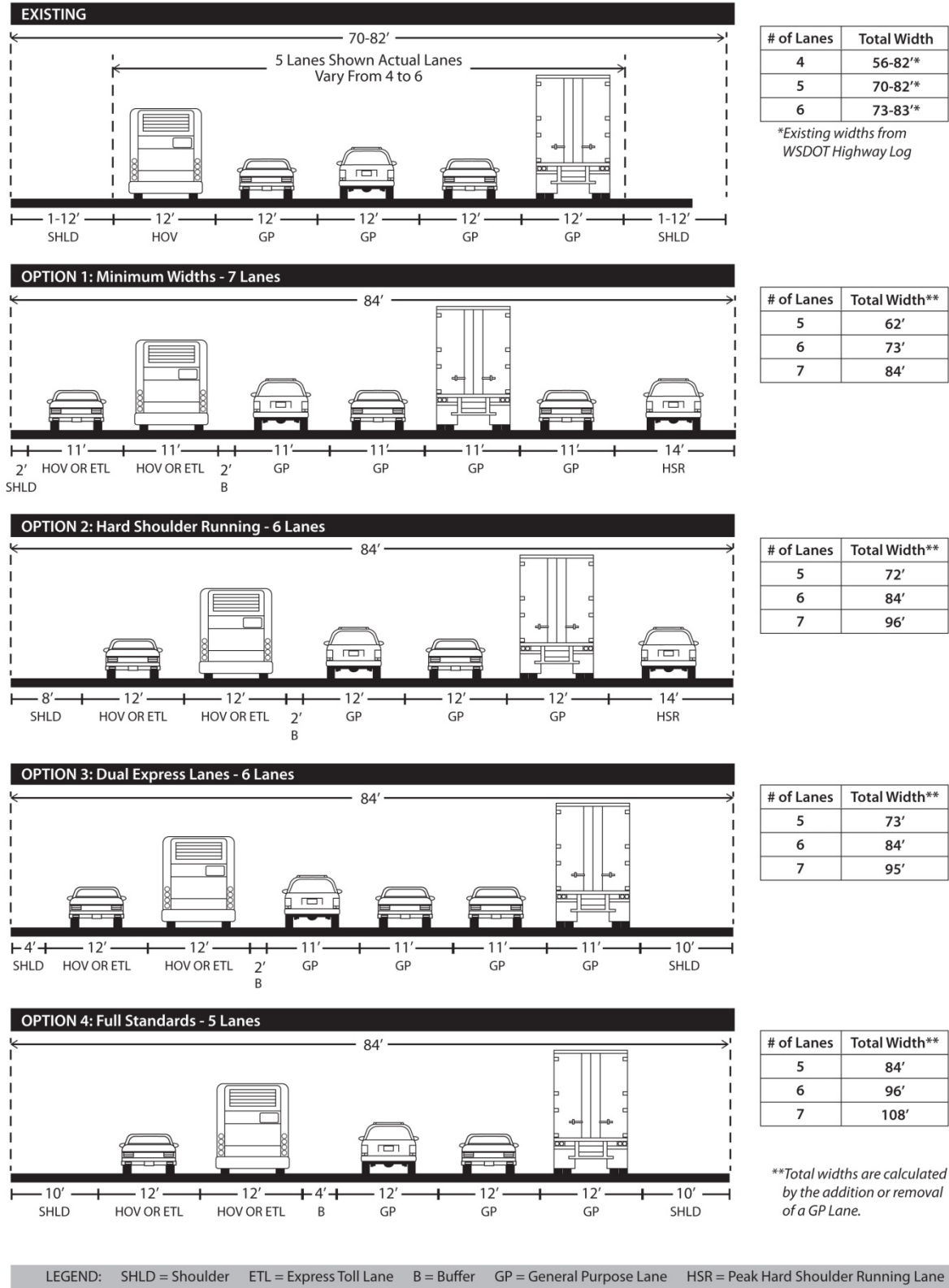


Figure 3. Future Potential Northbound I-5 Roadway Cross Sections

3.3 Interchanges

While an 84-foot roadway width between interchanges is adequate to maintain WSDOT's flexibility to make a range of future freeway improvements, each interchange between Northgate and Lynnwood needs to be evaluated individually to determine the highway area needed for potential mainline lane additions and for potential modifications to the interchange ramps. To accommodate mainline lane additions, further evaluation of the tapers and gore areas is required to define how existing interchanges could be connected to the wider mainline. This area is variable for each ramp at each interchange. WSDOT and Sound Transit will continue to define the space allocation for the I-5 ramps.

At each interchange, space should be preserved for cross-street widening that could include bicycle and pedestrian improvements and safety elements such as clear zone and sight distance. In general along this corridor, interchange ramp terminals are separated from the mainline by slopes and vegetation. If mainline lanes are widened, it is assumed that the widening would occur within the vegetated area and interchange ramp terminals would not be affected. WSDOT may undertake interchange modifications in the future at NE 130th and NE 145th Streets but a specific configuration has not been determined at this time. WSDOT and Sound Transit will work together during Sound Transit's North Corridor Transit Project DEIS process to further define the highway area at these two interchanges or define the modifications needed as a result of impacts from the light rail project. Where ramps are parallel and adjacent to mainline lanes, the reservation area includes space for relocation of the ramps outside the northbound mainline 84-foot width.

Each interchange has been reviewed to identify potential issues that could require modifications and therefore require a reservation for improvements. Each interchange is outlined in the sections that follow with a list of issues that could be considered at each interchange.

3.3.1 NE Northgate Way Interchange

- Southbound collector/distributor ramp weaving and capacity issues may be addressed in the future by WSDOT. The southbound ramp is outside the assumed alignment for light rail.
- Preserve the ability to enhance existing pedestrian and bicycle treatments along the local street.



Figure 4. Northgate Way Interchange

3.3.2 NE 130th Street Interchange

- Northbound ramp intersection configuration at 5th Avenue is not a typical interchange layout and could be considered for eventual modification by WSDOT.
- Roosevelt Way/130th Street/5th Avenue intersection configuration does not meet current standards for intersection alignments due to the curve on the east leg of the intersection.
- Preserve the ability to enhance existing pedestrian and bicycle treatments along the local street.
- Completing the interchange by adding southbound off and northbound on ramps is not under consideration.



Figure 5. NE 130th Street Interchange

3.3.3 NE 145th Street Interchange

- Northbound ramp intersection configuration at 5th Avenue is not a typical interchange layout and could be considered for modifications.
- 145th Street/5th Avenue intersection capacity should be evaluated with the addition of a light rail station and park and ride. Intersection modifications may be necessary to improve the capacity for the potential increase in traffic.
- Preserve the ability to enhance existing pedestrian and bicycle treatments along the local street.
- Existing bus transit freeway stops will be removed once light rail service is in operation.
- WSDOT may consider adding HOV/ETL direct access ramps within this interchange.



Figure 6. NE 145th Street Interchange

3.3.4 Metro North Base Interchange

- No future changes identified.



Figure 7. Metro North Base interchange

3.3.5 NE 175th Street Interchange

- Preserve the ability to enhance existing pedestrian and bicycle treatments along the local street.



Figure 8. NE 175th Street Interchange

3.3.6 SR 104 (NE 205th Street) Interchange

- Preservation of open space for potential stormwater or wetland mitigation is desirable.
- WSDOT may consider adding HOV/ETL direct access ramps within this interchange.



Figure 9. SR 104 (NE 205th Street) Interchange

3.3.7 236th Street SW Interchange

- Preserve the ability to enhance existing pedestrian and bicycle treatments along the local street.
- Completion of interchange by adding southbound off and northbound on ramps is not under consideration.



Figure 10. 236th Street SW Interchange

3.3.8 220th Street SW Interchange

- Potential for intersection widening to improve the intersection level of service.
- Potential addition of southbound mainline auxiliary lane between 44th and 220th Streets.

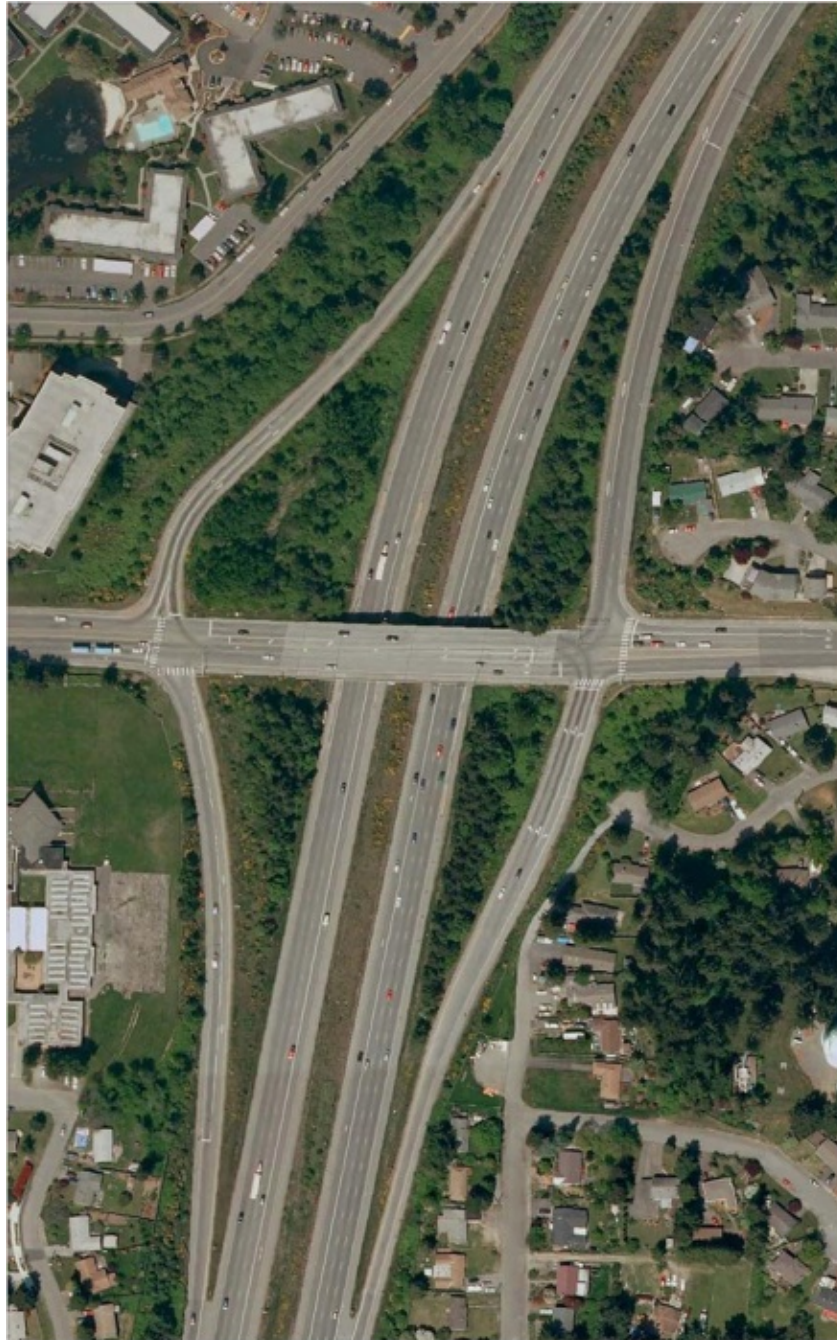


Figure 11. 220th Street SW interchange

3.3.9 Lynnwood Transit Center Direct Access Ramp/44th Avenue W Interchange

- Southbound on-ramp from 44th Avenue W is configured for high vehicle speeds and makes non-motorized travel through the intersection along the south side of 44th difficult. Modified intersection geometry could be considered by WSDOT.

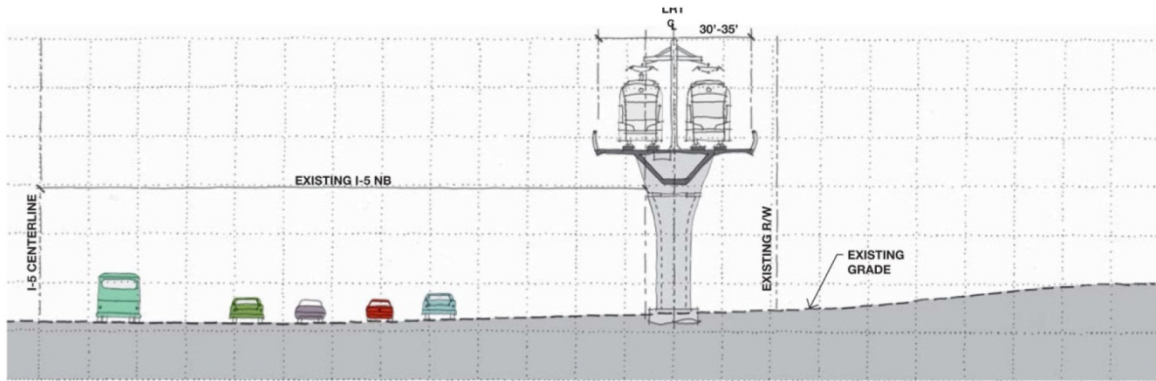


Figure 12. 44th Avenue W Interchange and Lynnwood Transit Center Direct Access Ramp

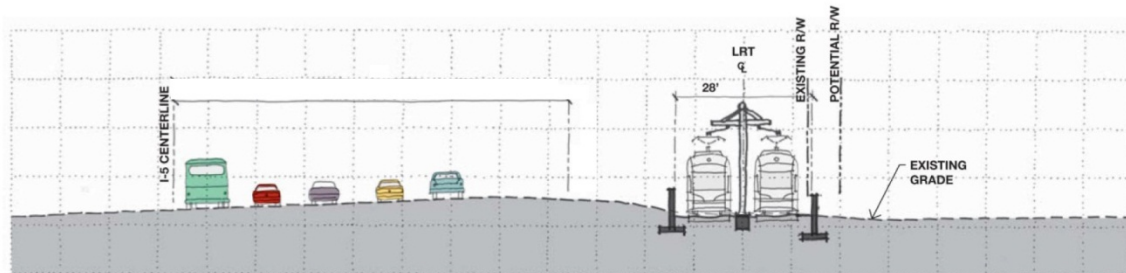
4 LIGHT RAIL AREA

Light rail will extend from the planned Northgate Link light rail station to the existing Transit Center in Lynnwood. Sound Transit's recent North Corridor alternatives analysis process identified the east side of I-5, from Northgate to SW 236th Street in Snohomish County and then the median from SW 236th Street to the Lynnwood Transit Center as a promising general location for a light rail alignment. Additional alignment and station alternatives will be considered in the DEIS, but those have not been defined in detail at this time.

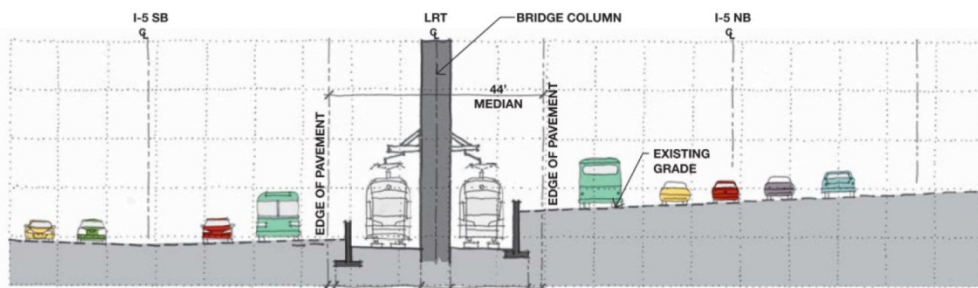
Critical space elements for the light rail include the rail guideway infrastructure for each direction of travel, a pedestrian walkway along the guideway for emergency and maintenance use, poles to support the overhead catenary system, signal systems, drainage systems, bridge railing, noise walls, and retaining walls. Widths to accommodate these elements range between 28 and 35 feet, except in the median of I-5 up to 44-feet may be needed where columns support structures over I-5. Figure 13 illustrates potential cross-section configurations for light rail along the I-5 corridor. In many locations additional space may be required for light rail retaining walls, fencing, noise walls, or relocating freeway infrastructure. The light rail alignment cannot always be located parallel to the edge of the highway due to light rail geometric requirements or other design conflicts; therefore there could be additional space between the highway area and the light rail area. Existing highway noise walls may also need to be relocated nearer the right-of-way line to provide noise abatement for both light rail and highway noises.



TYPICAL CROSS-SECTION OF ELEVATED RAIL ON EAST SIDE OF ROADWAY



TYPICAL CROSS-SECTION OF AT-GRADE RAIL ON EAST SIDE OF ROADWAY



TYPICAL CROSS-SECTION OF AT-GRADE RAIL IN MEDIAN OF ROADWAY

The light rail alignment cannot always be located parallel to the edge of the highway due to light rail geometric requirements; therefore there could be additional space between the WSDOT pavement reservation and the light rail reservation.

Figure 13. Typical Light Rail Cross Sections

5 CONCLUSIONS AND NEXT STEPS

The next step for the North Corridor Transit Project is to begin the conceptual design activities associated with the NEPA/SEPA Draft Environmental Impact Statement (DEIS). This process will more closely define the footprint of the light rail infrastructure and the identification of impacts associated with the project. The footprint will be developed to preserve space for future modifications of I-5 and will provide the I-5 areas described above. In summary, the assumptions that WSDOT and Sound Transit have agreed to are as follows and as shown in Figure 14:

- For the mainline I-5 northbound roadway, provide 84 feet pavement area for future pavement width from center barrier to the edge of I-5 mainline.
- North of 236th Street SW, where I-5 includes a median between the northbound and southbound roadways, sufficient right of way exists to provide the 84 foot pavement area on the outside of the existing highway without encroaching into the median. For this segment, it is contemplated that the light rail infrastructure would be built in the median of I-5.
- Provide an additional 10 feet beyond the outside edge of the roadway to accommodate barriers, ITS, signals, etc. This area could potentially be used for light rail guideway columns.
- Interchange gore area needed to support an additional lane should be defined during the DEIS design development process.
- Additional modifications may be considered by WSDOT and Sound Transit during the DEIS design development. The following locations are currently identified for additional design coordination:
 - 117th/1st Avenue NE
 - 130th interchange
 - 145th interchange
 - Lynnwood Transit Center (direct access and 44th on-ramp vicinity)
- Cross-street improvements may also occur in the future and therefore LRT guideway columns, abutments, etc. should be located away from the existing edge of streets. Specific structure locations will be defined during the final design phase and coordinated with the appropriate jurisdiction.
- Light Rail will be placed outside the minimum highway area and the specific location will vary based on meeting the Sound Transit Design Criteria Manual and project needs.

GENERIC SECTION

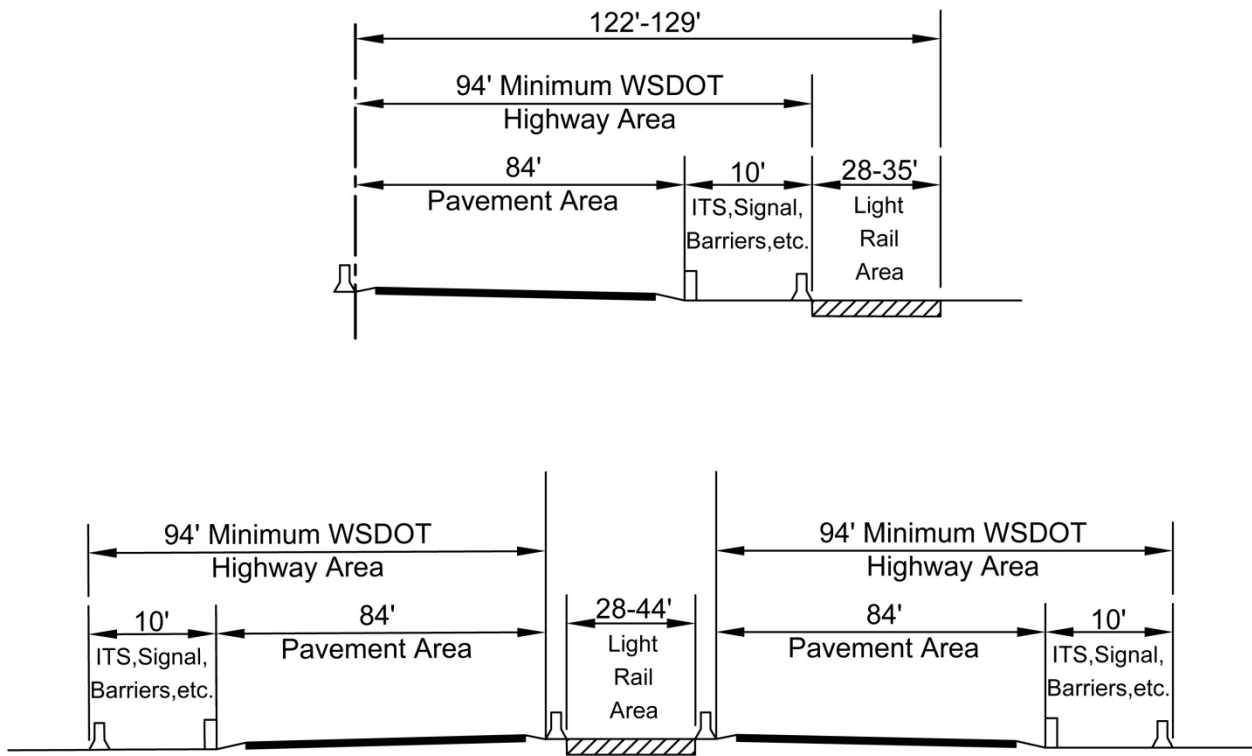


Figure 14. Minimum Highway and Light Rail Areas