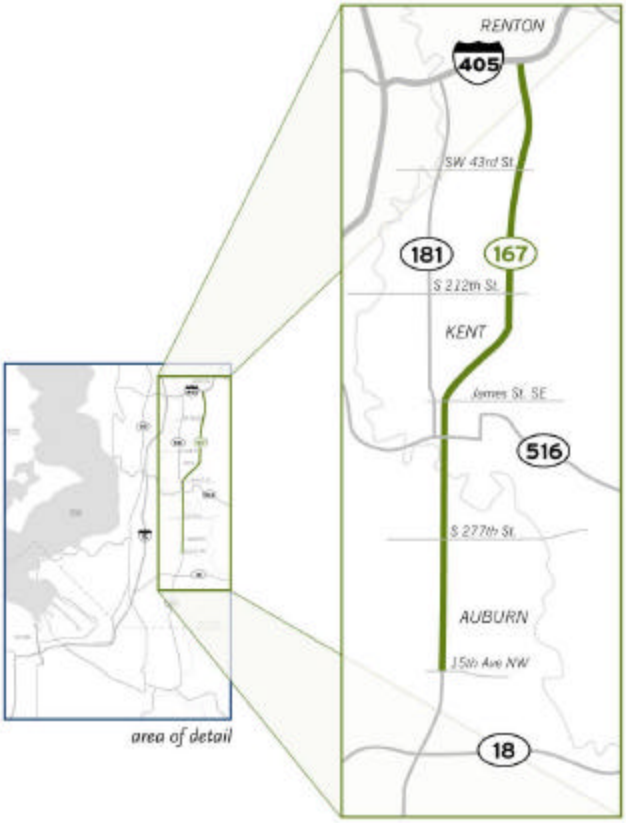
HOT Lanes

Pilot Project Analysis

Draft

November 13, 2003



Washington State
Department of Transportation

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In January 2003 the Washington State Transportation Commission adopted a resolution directing WSDOT to evaluate the feasibility and potential benefit of converting one or more HOV (High Occupancy Vehicle) lanes to a High Occupancy Toll (HOT) lane. This report presents the results of an evaluation to convert the HOV lanes to HOT lanes on State Route 167 between Renton and Auburn. SR 167 was selected for several key reasons: it is congested during peak periods, it has available space in the HOV lane, and the roadway can accommodate the HOT lane design. The report includes one percent design, traffic modeling, operational evaluation, preliminary capital costs and revenue estimates.

WSDOT provided the following guiding principles to direct the HOT lanes Pilot project:

- Maintain transit and HOV speed and reliability
- Improve traffic flow in all lanes
- Manage Congestion
- Collect revenue to pay for HOT lanes operations

What is being proposed?

WSDOT is proposing a pilot HOT lane project on SR 167. HOT lanes on SR 167 would be the first HOT lane project on Washington State.

Solo drivers would be allowed to use the existing capacity in the HOV lane by paying a toll using an electronic toll-collection system. No tollbooths will be used. Toll prices would vary depending on traffic volumes as a way to maintain HOT lane travel speed and reliability. Access into the HOT lanes will remain free for transit, carpools and vanpools.

HOT lanes are being considered on SR 167 as a way to provide “congestion insurance” – solo drivers can be assured they can avoid congestion by buying their way into the HOT lane. Variable tolling provides a way to manage the number of solo vehicles entering the HOT lanes, providing the traveling public an alternative to congested lanes and improving the flow of the general purpose lanes. As congestion increases in the general purpose lanes, fees for entering the HOT lane increase. If traffic volumes cause travel speeds in the HOT lane to drop, fees will also be increased to reduce the number of vehicles.

Why did we choose SR 167 for the Hot Lanes Pilot Project?

Out of 205 HOV lane miles in the Puget Sound Region, WSDOT considered several HOV corridors as possible candidates for the HOT Lane Pilot project including:

- I-405: SR 520 to I-5 (N)
- I-5: I-405 (South end I-405 to I-90 junction)
- I-90: I-405 to Issaquah
- SR 167: between Renton and Auburn

WSDOT chose SR 167 because of its characteristics, including:

- Peak hour congestion
- Available space in the HOV lanes
- Only minor improvements needed to implement HOT lanes

Today, SR 167 experiences strong peak direction congestion during both the morning and evening peak periods. SR 167 carries approximately 120,000 vehicles a day. Morning congestion occurs in the northbound direction as SR 167 approaches I-405 in Renton. Afternoon southbound congestion occurs primarily as SR 167 approaches SR 18 in Auburn. During peak periods, neither northbound nor southbound HOV lanes operate to capacity; there is significant space for more vehicles in both.

The charts below show that there is room for 450 more vehicles in the HOV lane before the 1,500 vehicles per mile threshold is reached. The space available to sell is determined by the location with the lowest capacity available to ensure a consistent, nearly free flow trip along the entire route. Congestion is expressed as speeds reduce below 60mph in the general-purpose lanes.

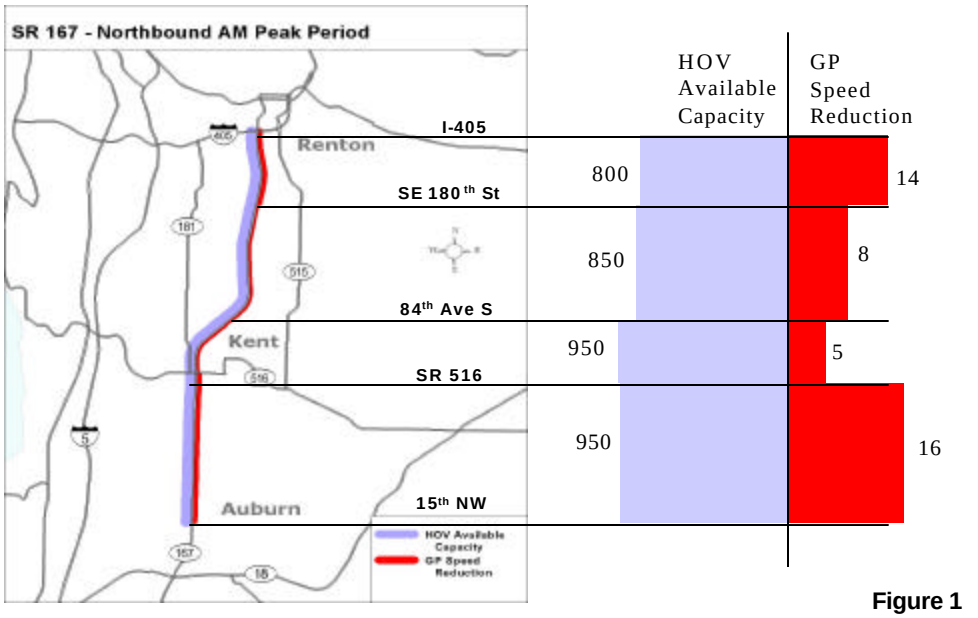


Figure 1

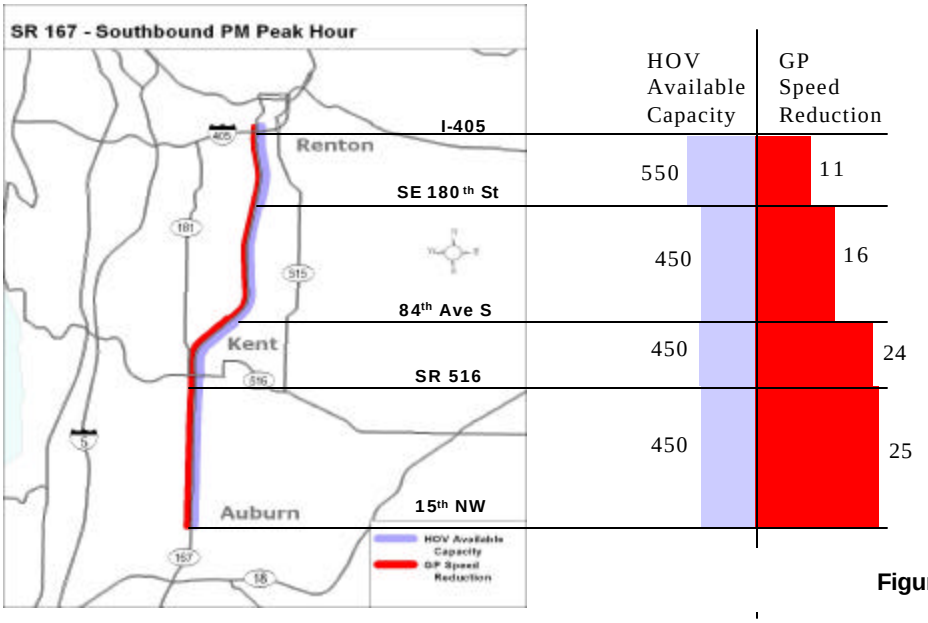


Figure 2

What Do HOT lanes look like and how will motorists use them?

The HOT lanes will have a distinctive look, though familiar to drivers. However, to accommodate HOT lanes, the current roadway will need some modification. The road will be re-striped to provide:

- A 10-foot inside shoulder, wide enough for a broken-down vehicle to pull over safely;
- A 12-foot traffic lane for HOT lane users;
- A continuous four foot buffer separation between the HOT lane and the adjacent general purpose lane;
- An 11-foot and 12-foot general purpose lane; and
- An eight-foot outside shoulder

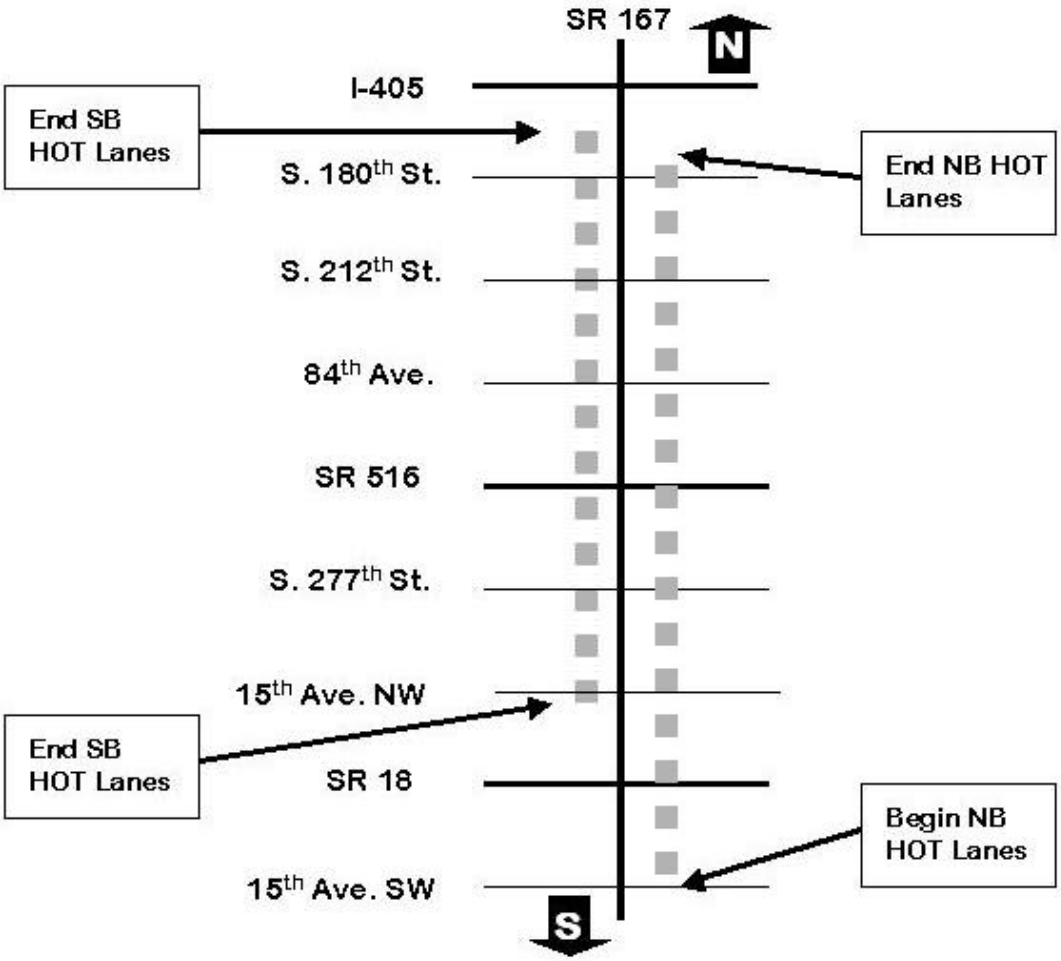


Figure 3

What are existing conditions on SR 167?

Today, SR 167 experiences strong peak direction congestion during both the morning and evening peak periods. SR 167 carries approximately 120,000 vehicles a day. Morning congestion occurs in the northbound direction as SR 167 approaches I-405 in Renton. Afternoon southbound congestion occurs primarily as SR 167 approaches SR 18 in Auburn. During peak periods, neither northbound nor southbound HOV lanes operate to capacity; there is significant space for more vehicles in both.

How will vehicles get in and out of HOT lanes?

Access into the HOT lanes will be different than today's HOV lane access. Today, HOV drivers can enter and leave the lane wherever they want. With the HOT lane concept, motorists will move into and out of the HOT lanes at access points. Under this concept the HOT lane will be buffer separated from the general purpose lane with tubular markers.

The access openings will be 1,000 – 1,500 feet in length. A total of four access points were identified for the northbound HOT lane and three for the southbound HOT lane. Access points will be located between interchanges.

A buffer between the general-purpose lane and HOT lane will increase the comfort level of motorists in the HOT lane, enabling them to move faster than the traffic in the general purpose lanes. HOV violations may be reduced because violators will not be able to jump in and out of the lane.

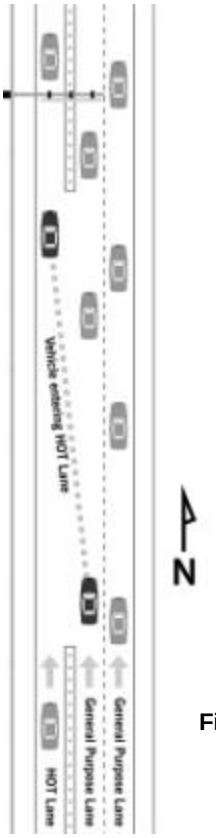


Figure 4: Hot Lane Access Point Example

Design: SR 167 Preliminary Tolling System Concept

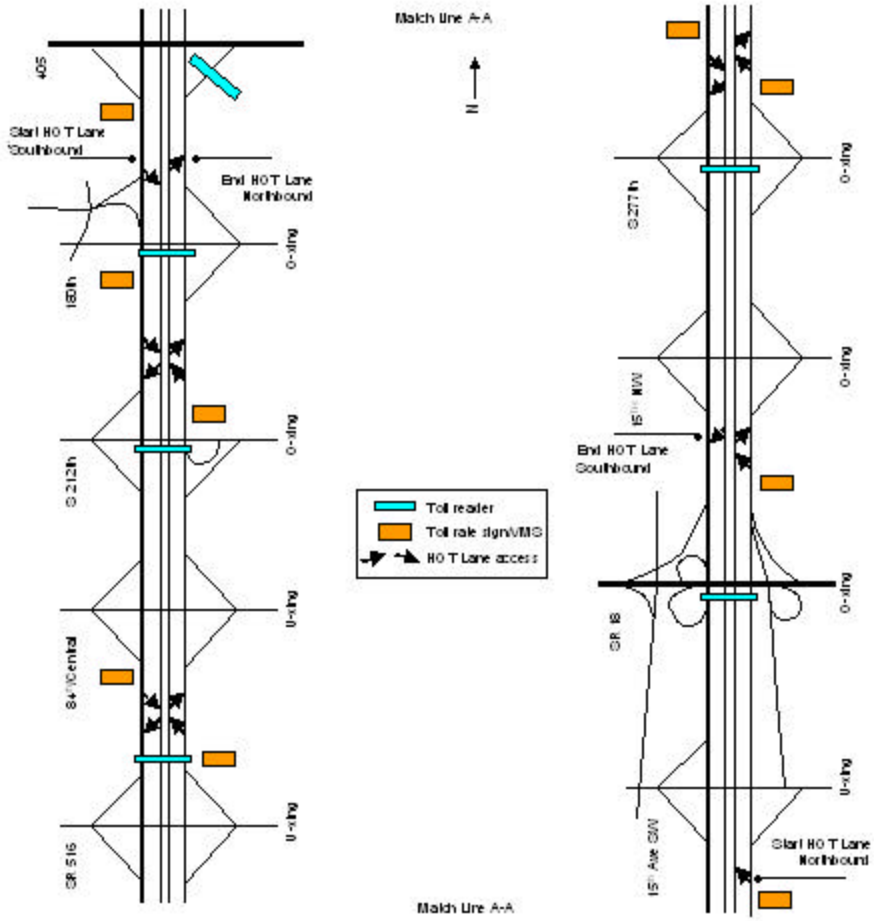


Figure 5

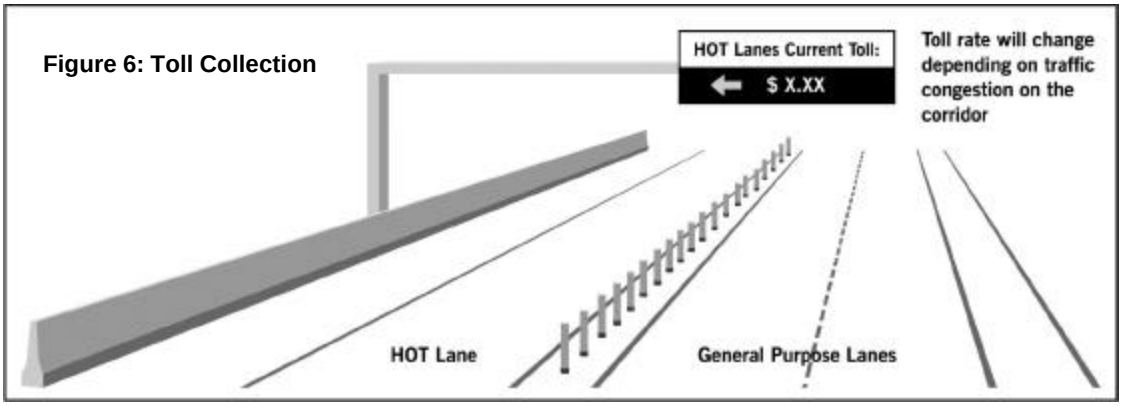
The tolling system for the HOT lanes Pilot was developed to be easily and economically implemented and simple for drivers to use.

Because the pilot project will be the first toll facility of this type in the state, it is anticipated that there will be a learning curve and acceptance period for corridor drivers. This "ramp up" period, which may last a year or more, has been accounted for in the toll revenue estimates.

How does electronic toll collection work?

It is assumed that toll collection on SR 167 will include an electronic toll collection (ETC) system, comprised of vehicle-mounted transponders, over-roadway transponder readers and dynamic toll rate signs throughout the corridor.

Figure 6: Toll Collection



Overhead signs will display toll rates and toll readers. When a toll-paying motorist drives under the reader, the reader "speaks" to a device mounted on the vehicle. The device, about the size of a credit card, is placed in the windshield and identifies the account that will be charged for the use of the HOT lane.

HOT lanes toll rates and toll revenue estimates were developed using a highly specialized tolling analysis model.

Minimum and maximum opening year toll rates are estimated at $.60 and $1.20, respectively, during normal peak period commutes. Toll rates are based on real time traffic volume. The lower the congestion, the lower the toll.

- Minimum and maximum toll rates for 2005 are estimated at $0.60 and $1.20, respectively. Tolls may increase during severe congestion.
- Minimum and maximum toll rate estimates for 2014 are $0.60 and $6.00 respectively.
- Average daily toll rates for 2005, 2010 and 2015 are $0.85, $0.97 and $1.02, respectively.
- Opening year toll revenue is estimated to be about $1.5 million.
- Toll revenue is estimated to increase to approximately $2 million in 2014.

For the Pilot project, HOT lane users will pay a single toll rate or trip fee. Regardless of where they enter and leave the HOT lane, drivers will pay the rate at which they entered the HOT lane for the entire distance of their trip. The concept is known as a "flat rate dynamic tolling".

This strategy was selected for the HOT lanes Pilot project for the following reasons:

- Ease of use
- Cost
- Minimize merging and weaving associated with short trips

Detailed results of the toll rate and revenue analysis are provided in the Appendices.

How will transit use HOT lanes?

Currently there are seven buses using the HOV lane during the peak period in the peak direction, and approximately 150 vanpools use SR167.

Comparable to today's system, transit can use the HOT lane without paying a toll. All movement in and out of the HOT lane will be restricted to designated areas where there are openings in the buffer.

What happens if there's a disabled vehicle?

There are two strategies to address this issue.

- The 10-foot shoulders provide refuge for disabled vehicles to pull out of the HOT lane;
- Enhanced Incident Management Response Service

WSDOT's Incident Response teams are available 24-hours a day, seven days a week to provide traffic control, traffic rerouting, mobile communications, and assistance in incident clearance and clean up on several major routes. Teams help motorists with a flat tire, jump starts, a gallon of gas, and many other types of motorist assistance.

Currently two Incident Response teams split their time between SR 167 and I-405. Tolling revenues from the pilot project could pay for Incident Teams dedicated strictly to SR 167 providing quicker response times for all motorists. The pilot project will increase the level of Incident Response during peak periods.

How do we ensure safe operations?

Safe operation of HOT lanes has been addressed through:

- A 10-foot inside shoulder, wide enough for a vehicle that has broken down to pull over safely;
- A continuous four-foot buffer separation with flexible tubular markers between the HOT lane and the adjacent general purpose lane; and
- Law enforcement to ensure the safe use of the HOT lane.

The tubular markers proposed for use on HOT lanes are approximately three- to four-feet high and less than six inches wide. The plastic tubular markers are fastened to the pavement surface to emphasize lane markings and remind motorists that lane changes are prohibited. Markers are impact resistant and collapsible, do not cause damage to vehicles and therefore can be driven on during emergencies.

WSDOT is proposing several design exceptions to make the HOT lane fit within the available pavement. Additional space for vehicle merging and weaving at the end points of the HOT lanes is recommended to accommodate the additional HOT lane vehicles. Anticipated problem areas for the HOT lanes are where the lanes end. The areas that will be impacted are the end points of the HOT lanes between South 180th Street and I-405 northbound in Renton, and between 15th NW and SR 18 southbound in Auburn. To mitigate the impacts of these bottlenecks, re-striping is recommended to provide additional capacity in these areas.

Cross Section Element	Standard	HOT lane Pilot project design
Lane width	12 feet	11 to 12 feet
Shoulder width (right and left)	10 feet, preferable 2 feet, minimum (dependent on number of lanes, type of operation and sight distance)	6 to 10 feet 2 to 10 feet
Separation/ "Buffer" width (for non-buffer separated operation)	4 feet	4 feet

FHWA Design Standards and HOT lane Pilot project Standards

How will HOT lanes be enforced?

HOT lane enforcement for the pilot project is similar to HOV enforcement today, although the identification of a HOT lane violator is more complicated. The monitoring effort will include viewing a "light" on the toll transponder reader, which will indicate whether a valid toll transponder transaction has taken place. If a valid toll transaction is not observed, a State Patrol officer will determine the vehicle's occupancy. If it does not meet the minimum required vehicle occupancy for HOV's, the officer will stop the vehicle, or radio a downstream officer for enforcement.

An officer will be asked to pull over a vehicle when it does not meet eligibility vehicle occupancy requirements and/or, has not paid the necessary toll. Thus, the enforcement officer must be able to verify both characteristics.

To facilitate this type of enforcement, a minimum inside shoulder the width of 10 feet is required. This is wide enough to allow law enforcement vehicles to monitor HOT lane operations. The HOT lanes pilot project allows vehicles flexibility to alternate between being a solo driver or a 2+ user. If a driver with a valid toll transponder chooses to use the facility while qualifying as an HOV, the transponder can be shielded by placing it in a protective "bag" before entering the toll lane so it does not get charged a toll.

This strategy is employed successfully on existing HOT lanes facilities, including I-15 in San Diego, Calif. WSDOT and the Washington State Patrol will enforce compliance on SR 167 for the duration of the HOT lanes Pilot Project. The photo simulation below depicts a concept for how the HOT lanes on SR 167 would be configured.

Figure 7: SR167 Hot Lane Photo Simulation

What was modeled?

Model networks were developed to simulate 2005 project corridor characteristics with HOV lanes and with the conversion to HOT lanes. The model assumes HOV Stage 3 Project is constructed and completed by 2005. However, due to permitting issues, the Stage 3 HOV Project has been delayed and will not be completed until 2007.

The HOT lane model included the following design modifications to the existing project corridor:

- Incorporate HOV Stage 3 Project elements (northbound HOV extension between 15th NW in Kent and 15th SW in Auburn. HOV ramp by-passes included);
- Modify the northbound SR 167 to northbound I-405 ramp to improve the merge/weave. Initial modeling identified a significant bottleneck at SR-167/I-405 interchange as vehicle from the HOT lane merge into I-405. To address the chokepoint, subsequent modeling – including a minor ramp improvement – significantly improved the operations of the over all HOT lane.

Do HOT lanes increase capacity and overall efficiency?

Converting the HOV lanes to HOT lanes on SR 167 from Kent to Auburn improved traffic flow by moving 13 % more vehicles through the SR 167 corridor while maintaining travel speeds and reliability for buses, carpools and vanpools that use the HOV lanes.

The evaluation was conducted for the peak travel direction during the peak traffic period for the year 2005 with the following results:

SR 167 southbound evening peak hour:

- Total number of vehicles traveling through the SR 167 corridor – all three lanes – increased 13 % with HOT lanes.
- Total number of vehicles traveling in the HOT lane increased 56 %.

SR 167 northbound morning peak hour:

- Total number of vehicles traveling through the SR 167 corridor – all three lanes – increased 12 % with HOT lanes.
- Total number of vehicles traveling in the HOT lane increased 20 %.

Averages for both morning and evening peak hours for the entire corridor:

- The number of vehicles traveling through the corridor increased by 13 % in all lanes and by 39 % in the HOV/HOT lanes.

- Despite the increase in the number of vehicles traveling through the SR 167 corridor, the HOT lanes did not decrease the overall speed of the HOV/HOT lanes.

How do vehicles move with HOT lanes in place?

Implementing HOT lanes will have an average speed change of 0 mph to +10 mph in the corridor general purpose lanes depending on the time of day, direction, and the amount of additional trips that are attracted to the freeway from local roadways. The corridor HOT lanes speeds will not change.

- In the northbound morning peak, the HOT lanes increased the corridor speed in the general purpose lanes between 2 and 10 mph.
- In the southbound afternoon peak, the HOT lanes increased the corridor speed in general purpose lanes between 0 and 10 mph.

What happens to buses and carpools?

Buses and carpools in the HOT lane will have similar travel conditions to what they currently experience in the existing HOV lane. Some changes will occur because of the added buffer strip with limited access points along the HOV lane:

- Currently 5-20% of existing carpools do not use the HOV lanes, mostly those making shorter trips on SR 167. With restricted access, this will not change.
- Tolls on the HOT lanes may encourage new carpools to form. For example:
- San Diego I-15 HOT lanes (see attached spreadsheet)- Since 1997, carpool volumes have increased by 13% annually during the same time that the toll buy-in users have increased by 24% annually. Total HOV vehicles increased by 8,200 daily users from 1997-2003, while buy-in vehicles increased by 5,100 users.

So, even with the ability for SOVs to buy-in, there are more HOVs being formed on I-15 annually than toll vehicles.

Buses on SR 167 are all running express for most of the length. These buses will benefit from the improved reliability and safety of the buffer separation and should be minimally affected by the access points. Transit ridership should stay even or be encouraged.

Safety will improve along much of the HOT lane because the buffer strip reduces vehicle friction. Travel speeds will be similar to the existing HOV lane, but travel time reliability should improve with the buffer strip and more predictable entry and exit points.

Average vehicle occupancy on SR 167 should remain the same once HOT lanes are implemented.

How much will the Pilot project cost?

A preliminary estimate of the costs to convert the SR 167 HOV lanes is approximately $14 million. This cost estimate will be refined as the design proceeds, and includes:

- Construction items, such as pavement grinding and re-paving
- Pavement markings and signage
- Toll collection and ITS equipment and supporting communications
- Design
- Maintenance of traffic during construction
- Construction and design contingencies
- Public involvement and education
- Monitoring of pilot project

Costs not included in the preliminary estimate are listed below. These costs will be developed following the Transportation Commission's decision.

- Operations and maintenance
- Front office/customer service and support costs (shared with Tacoma Narrows Bridge)
- Costs for toll tags (currently assumed to be approximately $30 but cost are coming down with technological improvements)

Wherever possible, it is suggested use of existing structures for mounting toll collection equipment and variable toll rate signs to minimize the implementation costs.

Details of the cost estimate are provided in the Appendix.

Will the HOT lanes pay for themselves?

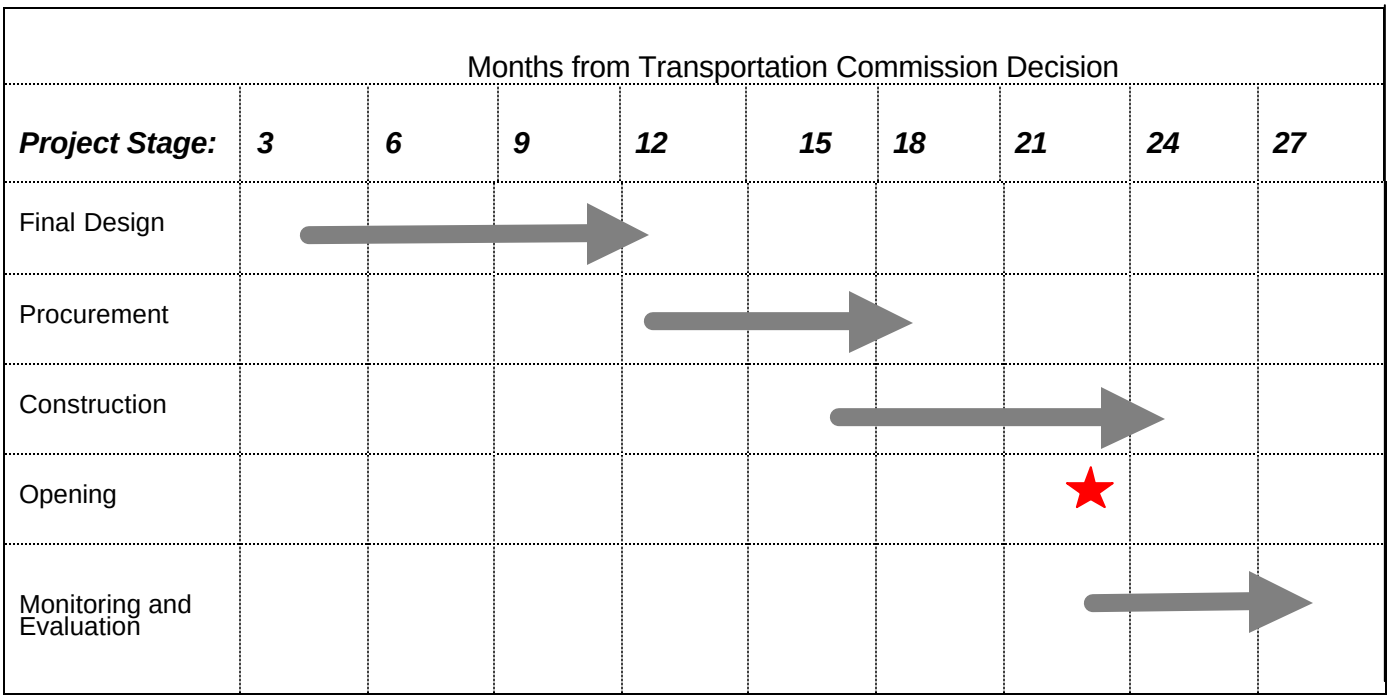
By collecting tolls from solo drivers, the HOT lanes Pilot can pay for its own operations and maintenance. It is estimated that the preliminary capital cost to convert the existing HOV lane could be recovered by net annual toll revenue within 11 to 12 years.

What is the timeframe for the HOT lanes Pilot project?

The HOT lanes Pilot project results will be reported to the Washington State Transportation Commission in November 2003. The Transportation Commission plans to decide on the Pilot project implementation by the end of 2003. Some legislative changes will be required to grant the Transportation Commission authority to implement the Pilot project.

If the Commission decides to pursue the HOT lane pilot project on SR 167, it will take approximately two years to finalize design, construct and install. Following the opening of the HOT lanes, a detailed "Monitoring and Evaluation" period would begin. This period will allow for the collection and assessment of data to determine the overall success of the pilot project and learn valuable lesson for future applications of the HOT lane concept to other parts of the region or state.

Preliminary Pilot project Schedule



Coordination Efforts

Several other tolling efforts are currently underway in the Puget Sound Region: Tacoma Narrows Bridge, Washington State Ferries, and Smart Card. Coordination efforts are underway to ensure "inoperability" between the projects. Coordination efforts include:

- Sharing administrative support
- Compatible technology – all transponders and readers can be used in all of the tolled facilities
- Users of one program could use the services of the other providers and receive one bill – a "transportation bill"
- Public Outreach

Legislative Issues

Legislative changes are needed to implement the HOT lanes project on SR 167. The Transportation Commission needs legislative authority to designate SR 167 as a pilot project, establish a toll structure, and other administrative functions.

Conclusion

There is adequate capacity in the HOV lanes on SR 167 that could be sold to solo drivers willing to pay to use them. WSDOT recommends that the Commission pursue the HOT lane pilot project for SR 167.

As a result of additional use of the converted HOV lane on northbound SR 167 as it approaches I-405, some physical modifications will be required to facilitate traffic at that end. These improvements will improve traffic flow through the SR 167/I-405 interchange.

If approved by the Transportation Commission, the HOT lanes Pilot project will need to be evaluated. Significant before and after traffic analysis and market surveys should be completed. In addition, WSDOT will coordinate with all affected agencies, seek public input and continue exploring funding sources.

What are the next steps?

- Develop a Final Report
- Additional analysis and design
- Legislative changes
- Additional interagency coordination with WSP and transit agencies
- Continue coordination with Tacoma Narrows Bridge and Washington State Ferries for back office coordination
- Continue to explore funding sources for the Pilot project
- Identify a method of project delivery
- Public Outreach
- Develop Tolling Schedule