Seattle Variable Tolling Study

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Executive Summary

The Seattle Variable Tolling Study responds to the Seattle Climate Action Plan's direction to investigate variable tolling as a strategy to reduce greenhouse gas emissions. Specifically, the study:

- ***Defines variable tolling and its benefits***
- ***Establishes Seattle's tolling interests***
- ***Creates a checklist to assess how different tolling concepts would meet the City's interests***
- ***Evaluates regional tolling concepts***

Within the Puget Sound region, transportation is the major source contributor to greenhouse gases. In accordance with the Kyoto protocols, the 2006 Seattle Climate Action Plan identified a series of strategies to reduce greenhouse gas (GHG) emissions to seven percent below 1990 levels by 2012.

Cars and trucks contribute more than 40% of Seattle's GHG emissions and are the largest single source of climate pollution. Choices about travel frequency, distance, and mode have a direct impact on the levels of GHG that enter the air – and are among the targets of the City's Climate Action Plan.

The 2006 Seattle Climate Action Plan's Green Ribbon Commission directed the Seattle Department of Transportation to assess how tolling can:

- ***Reduce greenhouse gas emissions***
- ***Generate revenue to fund transit and other transportation choices***
- ***Improve the throughput of people and goods on roadways***
- ***Provide reliable travel times, especially for transit and freight***

The Climate Action Plan directed Seattle to work with regional partners to analyze and develop road tolling scenarios and report findings by the end of 2008.

Variable tolling: **Also called *road pricing, congestion pricing* or *value pricing*, variable tolling is a market-based strategy to manage congestion by charging higher prices when conditions are congested and lower prices at less congested times and locations. The intent is to reduce peak period vehicle trips, associated congestion, and emissions.**

Supply and demand serves as the underlying economic principal of variable tolling. Road space is rationed just like any other utility (gas, water, electricity, etc.) by price, which has proven successful because it:

- Shifts trips from peak demand to less congested time periods
- Creates a modal shift to public transportation, cycling or walking
- Incentivizes a single occupant to consider ride sharing, carpooling, or "trip chaining" to reduce vehicle miles traveled (VMT)
- Encourages alternatives such as telecommuting and teleconferencing

Variable Tolling is a Flexible Tool

- ***Tolls may vary on a fixed schedule or may be dynamic – changing with existing congestion levels***
- ***Variable tolling can be implemented on existing roadways as a demand management strategy to avoid the perceived need to add capacity***
- ***Some highways have a combination of un-priced lanes and tolled lanes. This gives motorists a choice between driving in congestion or paying a toll for an uncongested trip***

Variable tolling projects in use or being considered in the United States include high occupancy toll (HOT) lanes, express lanes, roadway tolls, cordon pricing, area-wide pricing, truck-only tolling, parking charges, emission charges, and VMT charges.

Major international cities use congestion charging to achieve specific policies, such as emissions reduction, congestion reduction, and taxation for transportation improvement. Some European jurisdictions have recently structured tolls to charge less for vehicles with lower emissions while others have included emission classes as a pricing component in distance charges.

Variable tolling can generate needed revenue for transportation

To provide the level of transit service needed to accommodate projected growth in Seattle's urban villages, new revenue sources will be needed. The Seattle Transit plan calls for an additional $50 million per year in annual operating revenues for transit, as well as capital improvements for speed and reliability. Recently approved voter levies such as Seattle's Bridging the Gap measure and the Sound Transit ballot measure have generated new funding sources for street cars, light rail service and express bus service. However, Seattle still has a gap of over $40 million per year in annual transit operating needs that King County Metro and Sound Transit have limited options to fulfill. Existing sales tax authority has been exhausted.

Tolling revenues could provide a source of potential revenue for transit service. Tolling revenues accrue on an ongoing annual basis, consistent with the funding needs of ongoing transit service. They also provide a secure revenue stream to prudently borrow against in order to finance larger transport needs. Dedicated transit subsidies from tolling could also: (1) offset the impacts of tolling to low-income groups; (2) help achieve regional climate change goals through the provision of expanded, faster or more reliable transit service; and (3) reduce traffic diversion impacts onto local arterials.

SEATTLE'S TOLLING INTERESTS

This study and ongoing reviews of other regional projects have served as an impetus for clarifying the City of Seattle's interest in the use of variable tolling and congestion pricing plans.
To reduce GHG emissions and slow climate change, tolling plans should:

- ***Generate revenue for transit.*** Transit operations should be considered part of operating the facility, as toll revenue could provide a steady and sustainable revenue source for subsidizing transit, and transit can provide a reliable alternative to driving on the facility. Transit also increases the person capacity of the roadway. Toll revenue should also be used to provide maintenance and operations of the tolled facility.

- ***Set variable tolls for different times of day.*** With variable tolls, it is generally more expensive to drive during peak morning rush-hour than Saturday at midnight. Variable tolls can be dynamic and adjust to congestion levels. Tolls can also be predictably variable, so users know the price when making the decision to drive or use transit.
- ***Improve transit and freight reliability.*** By reducing traffic volumes and congestion, tolls can produce better bus reliability, which improves the relative competitiveness of buses compared to cars as a mode choice. Reduced congestion and freight access to tolled lanes reduces costs for freight as a gateway to national and international suppliers and markets
- ***Emphasize and maximize the throughput of people and goods versus the throughput of vehicles.*** When designing tolling systems, prioritize movement of transit and freight over SOVs. Provide dedicated lanes for transit when tolls are fixed rate; meter drive-alone access to HOT lanes to maintain transit, HOV and freight mobility; and set tolls to maintain reliable transit times and be higher than comparable transit fares.
- ***Be implemented systematically.*** Broader tolling across a linked network to maximize efficiencies and reduce inequitable impacts to communities - minimize diversion from tolled to un-tolled facilities.

In addition to those key elements that will reduce greenhouse gas emissions, tolling plans should:

- ***Be equitable and just***. Tolling plans should provide users with a reasonable alternative to paying the toll. Reasonable alternatives may include improved transit service and increased transit reliability; they may also include toll discounts for certain disproportionately disadvantaged users.
- ***Maintain or improve the economic vitality of downtown Seattle, the region, the port and the state.*** Variable tolling worldwide has shown improved GDP in charge areas. Reduced congestion can encourage increased investment and increased land values in city centers.

ELEMENTS OF PRICING CONCEPTS THAT MEET SEATTLE'S INTERESTS

Seattle's Tolling Interests	Tolling plans with the following elements should be considered:
Reduce GHG emissions	▪ **Toll rates set to incentivize mode change to non-drive alone, for example tolls higher than the transit fare; or at the level of marginal social cost** ▪ Toll differentials set for less fuel efficient vehicles to encourage shift to lower GHG emission vehicles ▪ Toll revenue used for transit and TDM programs ▪ Variable tolling used to shift travel demand out of peak hours to better distribute traffic into non-congested time periods ▪ Systematic implementation of tolling on freeways and potentially arterials ▪ Design an eco point program where toll rates are set by environmental impact
Generate revenue for transit and transportation demand management programs, also for facility	▪ **Inclusion of transit operations as part of the on-going maintenance costs of the facility** ▪ Spend revenue on mode change incentives, parking, cycling, etc. to reduce private car usage and enhance alternatives

operations and maintenance	▪ Variable tolling implemented 24 hours a day/7 days per week to manage demand and raise revenue ▪ Technology used to capture the greatest net-revenue ▪ Adoption of "open" standards and multiple suppliers for technology ▪ Enhanced compliance measures that minimize enforcement costs
Improve efficiency through variable tolls	▪ **Dynamic tolling used to reduce peak hour travel and related congestion and emissions** ▪ Consider tolls to improve efficiency of existing roadway before funding road expansions ▪ Regional, centralized clearing house for all tolling and transportation payments to lower transaction costs and help integrate payments across modes of transportation
Maximize personal mobility and throughput vs. vehicle throughput	▪ **Dedicated transit lanes on tolled facilities, particularly if tolls are set at a fixed rate; to ensure reliable travel times** ▪ Toll rates set above transit fares to minimize diversion from transit ▪ Drive-alone access to HOT lanes is metered to maintain transit mobility ▪ Freight allowed access into toll lanes to ensure reliable travel times ▪ General purpose lanes are converted to tolled lanes when they carry less people than HOV lanes ▪ Integrated multi-modal transfer facilities along major trip patterns ▪ Toll discounts provided for multi-modal transit and HOV trips
Be implemented systematically and regionally	▪ **Tolling plans should be developed and implemented throughout the region to maximize the use of the entire road network– and to minimize diversion from tolled to un-tolled facilities.** ▪ Policies that permit the use of revenues from any one toll or transit facility to fund and secure another in a rolling wave sequence
Be equitable and just	▪ Standard traffic measures and enforcement minimize diversion though neighborhoods ▪ Limited exemptions and discounts provided for emergency vehicles ▪ Discounts for hospital appointments, senior citizens, low income people, people with disabilities and special needs are carefully considered ▪ Revenues used to create a loan program for cleaner vehicles for low income and freight, and to fund transit
Maintain or improve economic vitality	▪ Pricing has improved the GDP in charge areas worldwide. Reduced congestion can encourage increased investment. ▪ Improved and expanded transit services to improve access to jobs and commercial interests in the city center

Opportunities and Constraints to Achieving Seattle's Tolling Interests

Eco Point Program: A Tolling Alternative

- Historically, tolling has assessed access or distance fees for use of a road, bridge, or facility. As a result, tolling is often negatively perceived by the public as a tax.

- EcoPoint, an alternative payment program developed in Hong Kong, is based on the concept of carbon trading. Under the EcoPoint program, users accrue or trade emissions credits to meet travel needs into and out of a tolled area. Fares are set by environmental impact and trips are charged in *eco-points* that users consume or save based on individual travel behavior.
- An EcoPoint program could take many forms. In one concept, eco-points could be purchased and used to pay for journeys by car, bus, light rail, or heavy rail. A journey by a cleaner car would be charged less than a journey by a higher emission vehicle. A bus trip would be charged less than a car.

Revenue Considerations

- In nationwide surveys, over 75% of Americans prefer tolls over other payment forms, such as a gas tax, as a way of financing transportation improvements. A key acceptance factor is that those paying tolls want generated revenue to build, maintain, and sustain new and existing infrastructure. International examples support this public sentiment.
- Uses of toll revenue could include transit, transportation demand programs, and facility operations and maintenance. Other investments could include pricing program equipment and systems, pedestrian and bicycle improvements, highway improvements, (maintenance, safety, and capacity), and intelligent transportation systems (ITS).
- Investments should support city interests, be balanced against revenue projections, and be clearly identified for the public (e.g., number of lanes to be tolled on each freeway, amount and location of additional transit service, priorities and plans for phasing implementation).

Toll Setting Considerations

- Integration of the toll rate structure will be a key factor in public and political support. Recognition of tolls paid should be balanced with others charges such as ferry fares, parking charges, and transit fares.
- To encourage travelers to use more environmentally-friendly transportation modes, variable tolling rates should be evaluated against public transportation fares.

Economic Considerations

- Congestion can negatively impact local economies. The City of Manchester, UK recognizes that unless traffic congestion is managed, the business center will lose over 30,000 future jobs. In response, a congestion pricing project has been proposed to raise over $5.2 billion to support 31 public transportation projects that will create a more sustainable urban and regional center and protect Manchester's economic vitality and future business growth.
- While congestion affects all income classes equally and every income class shares a portion of the burden for the congestion it creates, pricing and tolls may have a larger impact on low-income workers. Promotion of public transportation and greater discounts for these affected workers should be the first option. Low-income worker discounts for private cars may also need to be addressed.

Legal and Administrative Considerations

- Washington State law restricts use of toll revenues to the corridor in which the toll is collected. This law precludes a regional variable tolling strategy or one that would use tolls to fund improvements outside the tolled corridor.
- In Washington, no single organization is responsible for all aspects of tolling or for any one tolled facility. The Washington State Department of Transportation (WSDOT) owns the facilities, the Washington State Transportation Commission (WSTC) sets toll rates, the Washington State Patrol enforces the tolls, and the State Legislature is the only entity with the authority to impose tolls on a facility.
- There is currently no authorization to toll SR 520, I-90, I-5 or I-405. The 2009 legislature will be asked to give WSDOT the authority to toll SR 520 and/or I-90.

Technology Considerations

- The region should actively consider new tolling technology that provides advances in reliability, security, safety and payment systems. It enables more sophisticated pricing and significantly lowers transaction costs, which increases net revenue to invest in mass transit and other amenities. This technology enables advance payment systems directly through the device in the vehicle for more compliance and less enforcement and uses open standards.

NEXT STEPS FOR SEATTLE'S PRICING PROGRAM

As the City of Seattle considers next steps to implement variable tolling and use it to help reduce GHG emissions, key activities will include:

- Incorporating Seattle's tolling interests into City policy on tolling
- Shaping development of regional pricing projects using Seattle's tolling interests
- Addressing legal constraints on the use of toll revenues to a corridor
- Initiating simple and direct communications to the public on the current and future levels of congestion to raise awareness of the problem and describe opportunities for improvements through tolling and through a focus on moving people and goods

Collectively, these steps will help guide the City of Seattle toward policy decisions that will reduce GHG emissions, encourage economic vitality, equitably serve users, and support a sustainable transportation system.

Chapter 1. Introduction

1.1 Study Purpose

In 2007, the City of Seattle adopted a Climate Action Plan. The Plan identified a series of strategies for Seattle to reduce greenhouse gas (GHG) emissions, in accordance with the Kyoto protocols, by 5 percent below 1990 levels between 2008 and 2012. It also identified 18 actions for the City to take, several of which focused on transportation. One of the identified actions with a high potential to reduce GHG emissions was the implementation of congestion pricing or tolling.

The purpose of the Seattle Variable Tolling Study is to provide information for Seattle's decision makers on options to reduce GHG emissions through tolling. This study also aims to further define congestion pricing and its benefits, establish Seattle's tolling interests, create a checklist against which Seattle can assess how different pricing concepts meet those interests, evaluate regional pricing concepts, and identify next steps and future analysis that Seattle can undertake to further explore this tool.

1.2 Why Tolling?

Reduce emissions. Variable tolling provides opportunities for GHG emission reductions through mode shift, reduced travel frequency, and better fuel efficiency due to congestion relief. Mode shift contributes to regional GHG emission reductions by moving passenger trips from less efficient single-occupancy vehicles (SOVs) to more efficient public transit, cycling, or walking. According to Stephanie Corson at the University of South Florida, "a bus with as few as seven passengers is more fuel efficient than the average automobile used for commuting. The fuel efficiency of a fully occupied bus is *six times* greater than that of the average commuter's automobile, while the fuel efficiency of a fully occupied rail car is *15 times* greater than that of the average commuter's automobile."[1]

Variable tolling reduces GHG emissions by encouraging people to combine or consolidate trips, and thus drive less frequently. It also reduces emissions by reducing fuel wasted by vehicles in a congested network. However, as the vehicle fleet changes to more efficient and electric vehicles, this will be a less important means of reducing GHG emissions than reducing vehicle miles traveled (VMT). Lastly, depending on how a region coordinates land use planning with congestion pricing, future GHG emission reductions can accompany denser developments inside tolled areas and provide greater opportunities for public transit.

Generate revenue. Regional transportation infrastructure and services are not keeping pace with population, employment, and travel demand growth. The gap is growing because the current system for transportation financing system does not generate enough revenue to repair and replace aging facilities.

As fuel costs increase, demand for fuel drops. Even with recent reductions in fuel costs, the recession has kept demand at lower levels, meaning revenue generated by federal and state gas taxes has declined sharply over the last several months. As vehicles become more fuel-efficient, demand and revenue will drop further. As a result, the need at both the federal and state levels to cover transportation investment costs have forced state and local agencies to rethink their transportation funding strategies.

[1] Private Transportation vs. Mass Transit: The Environmental Aspects, Stephanie Corson, University of South Florida, http://www.cas.usf.edu/philosophy/mass/index.html.

Revenues from tolling could fund extended bus service. Increased service times on an existing corridor could provide adequate incentive to change mode from a single occupant vehicle to public transportation.

Based on a study conducted for King County in March 2007[2], a regional congestion pricing plan that would charge freeway system users could generate between $1.6 billion and $2.0 billion annually. The net present value of the funds, net of capital and operating costs, would be approximately $24 billion over 20 years. Similarly, PSRC's Destination 2030 tolling concepts forecasted $1.9 billion in additional revenue from freeway system tolling.

In another example, according to the State Comprehensive Tolling Study, Part 2, tolling State Route 520 alone would not generate sufficient revenue to fully fund route 520 corridor improvements. To manage congestion and generate sufficient revenue to finance such improvements would also require tolling the I-90 floating bridge.

Manage congestion. Transportation is essential for any local economy. It provides connectivity and access for jobs and products. Congestion limits both access and connectivity. It causes people to bypass or avoid areas. In contrast, congestion pricing can result in reliable travel time and reduced delay. Congestion pricing also generates revenue and draws attention to public transportation and alternate means to connect and access a CBD.

The effect of tolling on regional business and economic competitiveness must also be considered. To many, congestion is viewed as a "natural" byproduct of economic growth. In reality, beyond economically efficient levels (when traffic flows slowly but still at maximum throughput) it destroys the economic vitality of a city. Pricing is one remedy for addressing congestion.

Congestion charging is emerging in major congested cities worldwide and has not been discontinued in a city where it has started. It has been used to support a variety of policy purposes (demand reduction, GHG emissions reduction, and revenue generation for transportation improvements). Precise charging policies are tailored to support the primary objectives of imposing the charge in each city.

Demand reduction from road user charging is real, but reduces gradually after the first year. London and Stockholm, the cities whose explicit primary goal was to reduce travel demand, experienced 15 to 20 percent reductions in the number of vehicles entering the charging zone. Oslo and Milan do not give comparable numbers, since their goals were not to reduce congestion. Although Singapore's goal was to reduce demand, it does not give comparable numbers, since Area Licensing Project (ALS) was introduced alongside many other demand reduction measures, and Electronic Road Pricing (ERP) was adopted while ALS was functioning. However, Singapore ERP does show that finer tailoring of charges by location and time (instead of a flat charge) allows the overall financial burden on drivers to be reduced, while improving the demand-reducing effect of the charge.

Congestion charging is only one tool among many to relieve congestion, but only in Singapore has congestion been effectively managed to strategically determined targets. In London and Stockholm, there remains severe congestion on many routes outside the charged locations. This indicates that there

[2] King County Executive. *Destination 2030 – Taking an Alternative Route*. March 2007.

is potential to expand pricing in those cities and to evolve towards more disaggregated charges over time. Relative levels of success are dependent on what other measures are implemented in parallel.

Foster economic growth. In early adapters of congestion pricing, business activity in the charging zone increased. While this may be counter-intuitive, London, for example, has shown stronger business activity in the congestion charging area after its introduction than before. Similar evidence exists for Singapore and Stockholm.

Revenues that sponsor modal choice encourages access CBD shops and activities. Without the need for parking and time lost in finding a parking spot, people spend more time engaging with the local businesses. Additionally, getting people out of their cars and walking on main streets after using public transportation provides more opportunity to discover the City and "spot buy," as their dwell time increases. These factors contribute to improving the economy of the CBD.

Another major factor is access to jobs. As congestion grows, commute time grows to a point where workers in a local area start to look elsewhere for job opportunities that are closer to home to improve their quality of life. City employers then have less of a supply of qualified workers, which indirectly impacts profit margins and efficiency, and encourages relocation. By taking measures to reduce congestion, such as providing more transportation alternatives and better connectivity and access, a CBD improves its economy and attractiveness for business. This draws more business and services into the CBD and makes it a more desirous place to live. It also makes the city more efficient in handling transportation needs due to multiple modes offered.

1.3 Tolling Basics

Throughout this study, *congestion pricing* and *variable tolling* are used to represent the same concept—levying a variable fee to drive on roadways, where the fee changes in response to existing or anticipated congestion levels. The fee encourages drivers to reevaluate their road use. Due to cost, some drivers will change their driving habits by carpooling, driving during off-peak hours, using public transit (and other alternatives), or not traveling at all. Public opinion focus groups conducted in the Puget Sound region in 2007[3] indicated that *tolling* was the preferred term. *Variable tolling* is used primarily throughout this study.

In the United States and around the world, several strategies exist for implementing variable tolling. These strategies consider how best to reduce congestion, generate revenue for roadway projects and transit service, and positively impact air quality and the environment. Main options for congestion pricing or tolling include:

- ***Toll Lanes*** – Fees for using one or more lanes on an existing facility (or new lanes that are charged). This also includes high-occupancy toll (HOT) lanes that allow low-occupancy vehicles to utilize excess capacity on new or existing high-occupancy vehicle (HOV) lanes or general purpose (GP) lanes (e.g., I-15 FasTrak® between Kearny Mesa and Rancho Penasquitos, California).[4] HOT lanes can be a one or two lane system. Parallel lanes remain as an uncharged alternative.
- ***Variable Tolls on Specific Facilities*** – Fees placed on existing and new roads, bridges, and tunnels. Fees rise and fall depending on the measured or estimated traffic level based on time of day (e.g.,

[3] Pricing Focus Groups Draft Final Report December 2007; conducted by EnviroIssues for WSDOT, PSRC and King County
[4] SANDAG – "About I-15 FasTrak®" http://www.sandag.org/index.asp?classid=29&fuseaction=home.classhome4

the Port Authority of New York and New Jersey interstate vehicle crossings) in order to maintain a certain level of service.[5]

- ***Cordon Tolls*** – A flat fee levied for entrance to and/or exit from any roads in an urban area (e.g., Stockholm's congestion charge cordon).
- ***Area Tolls*** – Similar to cordon tolls, but include all trips that start inside the designated boundaries and use any public road in addition to those that enter or exit the charging area boundaries (e.g., areas of London within the congestion charge zone).[6]
- ***Zonal Tolls*** – Mini-area charges within a larger area charging boundary. Users incur charges when crossing into any adjacent zone inside the designated charging area or when trips originate outside the charging area into any of the mini-area tolling zones. Zones can be subdivisions of the charging area designated by geographical or political boundaries.
- ***Network Tolls*** – Charging by distance, time, and location for all vehicle movements across part or all of the network. Charges vary according to congestion and vehicle type and can become a replacement for other road use taxes.

A complete list of tolling terminology and options can be found in Appendix A.

1.4 Evolution of Tolling

Traditionally, tolling has been used as a means to pay for a specific transportation project. Over time, this has evolved to using tolls from one or more facilities to support the development of a network of toll facilities. In more recent years, tolling and pricing have been considered to change travel demand, reduce congestion and greenhouse gas emissions, and raise revenue for general transportation projects. Toll revenue may be used to finance:

- Improvements in public transit
- Progressive shift from other forms of taxation for transportation
- Congestion reductions and environmental impacts
- Remedial maintenance and network reconstruction
- Improvement in targeted safety and bottleneck improvements

With advances in technology, tolling and pricing can be used to achieve societal goals in addition to paying for the construction of a specific facility. Variable tolling can be applied to existing congested toll facilities to encourage some travelers to use the roadway during less congested periods, to shift to another mode of transport, or to change routes. Charges may vary based on a fixed schedule or based on traffic volumes observed over a period of time (e.g., the past week, month, quarter).

Charges may also be dynamic, in which base rates continually adjust according to traffic conditions, to maintain free-flowing traffic levels. With dynamic pricing, a maximum rate is published in advance for

[5] Federal Highway Administration, *Highway Community Exchange – Pricing on Toll Facilities – NJ/NY: Variable Tolls on Port Authority Interstate Vehicle Crossings*, http://knowledge.fhwa.dot.gov/cops/hcx.nsf/384aefcefc48229e85256a71004b24e0/ f28934ff571ff3c 685256db10063e81b?OpenDocument

[6] Lauren Smith – "Services and Technologies: Congestion Pricing" *ITS Decision*. http://www.calccit.org/itsdecision/serv_and_tech/Congestion_pricing/congestion_pricing_summary.html

selected time periods, and actual rates vary below the maximum. Based on real-time traffic on the facility, current rate information is available as a driver approaches a priced facility.

Variable tolling may apply on separated lanes within a highway, such as express toll lanes or HOT Lanes, or on entire roadways. Variable pricing is operational in Lee County, Florida (for heavy vehicles); on the Illinois Tollway; on the New Jersey Turnpike; and on interstate vehicle crossings on Port Authority facilities in New Jersey. Variable tolling is being studied with open road tolling in Broward County, Florida; on the express bus/HOT lane in the Lincoln Tunnel (New York and New Jersey); and on the Pennsylvania Turnpike (Philadelphia). Dynamic variable pricing has been implemented on the SR 91 express lanes in Orange County, California, and locally on the HOT Lanes on SR 167, between the I-405 interchange in Renton and 15th Avenue SW in Auburn.

1.5 Report Layout

The remainder of this report addresses the following topics:

- Chapter 2: Tolling Considerations for Seattle
- Chapter 3: Assessment of Regional Tolling Concepts
- Chapter 4: Conclusions and Next Steps
- Appendix A: Pricing and Tolling Terminology and Options
- Appendix B: Legislation and Related Area Tolling Studies
- Appendix C: Seattle's Tolling Interests and Considerations
- Appendix D: Urban Partnership Agreements and Congestion Reduction Demonstration Initiatives
- Appendix E: Domestic and International Road Pricing Examples
- Appendix F: Designing and Evaluating a Tolling System

Chapter 2. Tolling Considerations for Seattle

2.1 Seattle's Tolling Interests

The City of Seattle used the development of this study and review of other regional projects to identify its interests in how congestion pricing and tolling is designed and implemented.

The City of Seattle will consider supporting tolls to reduce GHG emissions. Charging users of the road system has significant potential to address goals to reduce GHG emissions, generate needed revenue for infrastructure maintenance and transit service, and improve congestion on existing roadways. When a toll or roadway price is in place, drivers respond to "price signals" and adjust driving habits accordingly. Some use transit or carpool, others shift their trip to another time of day, and some determine the trip was not needed. Agencies can structure road pricing to lower vehicle miles traveled (VMT) while managing traffic flows more efficiently. Toll revenue can further reduce congestion by funding transportation choices like transit, cycling, and walking.

To reduce GHG emissions and slow climate change, tolling plans should:

Generate revenue for transit. Transit operations should be considered part of operating the facility, as toll revenue could provide a steady and sustainable revenue source for transit, and transit can provide a reliable alternative to driving on the facility. Transit also increases the person capacity of the roadway. Toll revenue should also be used to fund maintenance and operations of the tolled facility.

Set variable tolls for different times of day. With variable tolls, it is generally more expensive to drive during peak morning rush-hour than Saturday at midnight. Variable tolls can be dynamic and adjust to congestion levels. Variable tolling provides opportunities for GHG emission reductions through mode shift, reduced travel frequency, and better fuel efficiency due to congestion relief. Tolls can also be predictably variable, so users know the price when making the decision to drive or use transit.

Improve transit and freight reliability. By reducing traffic volumes and congestion, tolls can improve bus reliability, which enhances the relative competitiveness of buses compared to cars as a mode choice. Reduced congestion and freight access to tolled lanes lowers costs for freight as a gateway to national and international suppliers and markets.

Emphasize and maximize the throughput of people and goods versus the throughput of vehicles. When designing tolling systems, prioritize movement of transit and freight over SOVs. Provide dedicated lanes for transit when tolls are fixed rate; meter drive-alone access to HOT lanes to maintain transit, HOV and freight mobility; and set tolls to maintain reliable transit times, and to be higher than comparable transit fares.

Be implemented systematically. Broader tolling across a linked network to maximize efficiencies and reduce inequitable impacts to communities - minimize diversion from tolled to un-tolled facilities.

In addition to those key elements that will reduce GHG emissions, tolling plans should:

Be equitable and just. Tolling plans should provide users with a reasonable alternative to paying the toll. Reasonable alternatives may include improved transit service and increased transit reliability; they may also include toll discounts for certain disproportionately disadvantaged users and off-peak times of travel.

Maintain or improve the economic vitality of downtown Seattle, the region, the port and the state. Variable tolling worldwide has shown improved GDP in charge areas. Reduced congestion can encourage increased investment and increased land values in city centers.

Table 2-1 includes an overview and explanation of how various options might serve Seattle's interests.

Table 2-1: Seattle's Tolling Interests and Potential Strategies

Seattle's Tolling Interests	Tolling plans with the following elements should be considered:
Reduce GHG emissions	▪ ***Toll rates set to incentivize mode change to non-drive alone, for example tolls higher than the transit fare; or at the level of marginal social cost*** ▪ Toll differentials set for less fuel efficient vehicles to encourage shift to lower GHG emission vehicles ▪ Toll revenue used for transit and TDM programs ▪ Variable tolling used to shift travel demand out of peak hours to better distribute traffic into non-congested time periods ▪ Systematic implementation of tolling on freeways and potentially arterials ▪ Design an eco point program where toll rates are set by environmental impact
Generate revenue for transit and transportation demand management programs, also for facility operations and maintenance	▪ **Inclusion of transit operations as part of the on-going maintenance costs of the facility** ▪ Spend revenue on mode change incentives, parking, cycling, etc. to reduce private car usage and enhance alternatives ▪ Variable tolling implemented 24 hours a day/7 days per week to manage demand and raise revenue ▪ Technology used to capture the greatest net-revenue ▪ Adoption of "open" standards and multiple suppliers for technology ▪ Enhanced compliance measures that minimize enforcement costs
Improve efficiency through variable tolls	▪ **Dynamic tolling used to reduce peak hour travel and related congestion and emissions** ▪ Consider tolls to improve efficiency of existing roadway before funding road expansions ▪ Regional, centralized clearing house for all tolling and transportation payments to lower transaction costs and help integrate payments across modes of transportation
Maximize personal mobility and throughput vs. vehicle throughput	▪ **Dedicated transit lanes on tolled facilities, particularly if tolls are set at a fixed rate; to ensure reliable travel times** ▪ Toll rates set above transit fares to minimize diversion from transit ▪ Drive-alone access to HOT lanes is metered to maintain transit mobility ▪ Freight allowed access into toll lanes to ensure reliable travel times ▪ General purpose lanes are converted to tolled lanes when they carry less people than HOV lanes ▪ Integrated multi-modal transfer facilities along major trip patterns ▪ Toll discounts provided for multi-modal transit and HOV trips

Be implemented systematically and regionally	▪ **Tolling plans should be developed and implemented throughout the region to maximize the use of the entire road network– and to minimize diversion from tolled to un-tolled facilities.** ▪ Policies that permit the use of revenues from any one toll or transit facility to fund and secure another in a rolling wave sequence
Be equitable and just	▪ Standard traffic measures and enforcement minimize diversion though neighborhoods ▪ Limited exemptions and discounts provided for emergency vehicles ▪ Discounts for hospital appointments, senior citizens, low income people, people with disabilities, and people with special needs are carefully considered ▪ Revenues used to create a loan program for cleaner vehicles for low income and freight
Maintain or improve economic vitality	▪ Pricing has improved the GDP in charge areas worldwide. Reduced congestion can encourage increased investment. ▪ Improved and expanded transit services to improve access to jobs and commercial interests in the city center

2.2 Legal Considerations

Given that Seattle supports tolling plans that reduce GHG emissions, a primary legal consideration is the Washington State law that requires tolls to only be applied to the corridor on which they are collected. The interpretation of the term “corridor or facility” should be examined to ensure tolling scenarios meet Seattle’s interests in moving people and reducing GHG emissions.

The definition of “corridor or facility” should be possibly expanded to include the use of revenues collected to support public transportation that services the charging zone. This is currently allowable under state law; however it has yet to be tested how broad the transit service that serves the corridor can be defined. HB 1773, adopted in 2008, states that toll revenues may be expended to “provide for the operations of conveyances of people or goods.” HB 1773 reserves the Legislature the right to toll specific facilities. It prohibits local authorities from imposing tolls on state projects without the Legislature’s authorization, so stakeholder agencies must work together to develop a plan to approach the Legislature for any necessary authorizations.

If Seattle wanted to pursue local pricing scenarios; they may want to broaden the definition of applying toll revenues to a facility. An example might be to use revenues from a “low emission zone” to secure low-interest loans for independent freight operators to upgrade to a defined lower emissions truck. Such a program is not suggested here, but is provided as an example of how revenue generated by a demand management measure could help Seattle meets its GHG emissions objectives.

Decisions about when to initiate pricing and which facilities to price will impact overall revenue projections and pursued strategies. The State has already received authorization from FHWA to toll the I-90 floating bridge. That authorization was needed to toll an existing Interstate facility – making the case to fund needed reconstruction or rehabilitation on an Interstate highway corridor that could not otherwise be adequately maintained or functionally improved without tolls.

2.3 Implementation Considerations

Seattle's primary pricing interest is to reduce GHG emissions through toll collection. As part of any pricing concept, the City would also like to generate revenue for transit, transportation demand programs, and facility operations and maintenance. To fulfill these goals, two phases of implementation must be recognized—first, setting up the pricing system; and second, investing net revenues generated by the pricing system.

Depending on the selected system, implementation will likely be phased. Current deliberations are regarding separate facilities, such as SR520 and I-405; rather than a regional network. Any roadway expansion proposed with tolling will be phased due to high capital costs and the length of time necessary to acquire right of way for particular roadway improvements. Likewise, some public transportation capital investments may require significant construction time, which may also require phasing. Financing decisions, such as the issuance of bonds, may also impact phasing and project implementation timing.

One risk of phased implementation is that toll rates will be set to operate or payback costs for a particular facility. In Australia, they ran into problems in that when toll rates needed to be higher on facilities implemented in later years, the public had a hard time understanding why they would pay one rate on the older facility and a higher rate on the newer facility. One solution to this is to make sure that toll rates are variable and set to manage traffic as well as raise revenue. The toll authority must be set high enough to accommodate future conditions. Another remedy to this problem is to define the corridor more broadly in tolling authorization. If the corridor is defined as including areas where there would be an "environmental or economic impact"; or on "alternative travel routes or the travel shed" than the system can be managed as a whole.

The region must review its transit and transportation demand project priorities, as well as facility maintenance and operating needs, both funded and unfunded, to identify the highest-priority projects for implementation. It is assumed that these project priorities have been previously presented to the public and reflect their interests. Priorities should be determined by evaluating each project against a set of standard criteria measuring the benefits of each. One such benefit is the project's ability to reduce GHG emissions on a cost-benefit basis.

Once priorities are set, capital and operating costs for each project must be developed and factored into the project implementation timetable to include any inflationary cost elements. This priority list can then be compared to net revenues generated by the pricing concept. From here, the region can develop a multi-year implementation program available for public review and comment before plan adoption. An alternative would be to take a financing approach and borrow against future revenues to advance construction of new infrastructure.

As part of this process to prioritize projects, coordination should occur with the Puget Sound Regional Council (PSRC), King County, and Washington State Department of Transportation (WSDOT) to determine how agencies can work together and pool revenues to support project implementation.

2.4 Environmental Considerations

Pressures on Seattle's environment stem from the direct effects of transportation on the environment and communities, as well as indirect effects associated with economic, residential, and open space development.

2.4.1 Examples of Environment-Based Tolling

Charging for externalities of emissions is a relatively new subject in the field of tolling. The first country to do so is Switzerland, which imposes a variable charge on all vehicles over 3.5 tons on a distance basis based on Euro engine emission classes, across all roads. In an urban setting, Milan recently imposed charges by vehicle emission classes where cleaner emission or "green" vehicles are charged less than those with higher emissions. Germany provides another example of the addition of emission charges to the distance or rate charge based on a truck's emission class (Euro 1 to 3 are charged at the higher rates per mile for their emissions, Euro 4 to 5 are charged a lower charge, and Euro 6 to 7 have no additional charge imposed). This charge applies to autobahns and some other major highways.

The above are examples of policy mechanisms that draw attention not only to VMT, but also to the environmental issues of emissions and noise pollution. To date, the results are significant. In Germany, the truck fleet has shifted from a high percentage of Euro 1, 2, and 3 class trucks to the more cleaner Euro 4 and 5 class trucks—thereby, reducing the overall emissions from trucks over 12 tons (the ones liable for the charge).

2.4.2 Eco-Point Program

An alternative to tolling is the Eco-point concept. Based on prior work by Booz & Company in Hong Kong, the idea of carbon trading for individual transportation needs was originally developed in 1998/99. In this concept, individual trips into or out of the tolling area or zone would be charged in "eco-points," in lieu of currency. The driver would purchase eco-points equivalent to dollars and cents. In turn, a user would pay cash or eco-points for the journey by car, bus, tram, light rail, or heavy rail. Each mode of travel would be assessed and fares would be set by environmental impact. A journey by a cleaner car would cost less than a journey by a higher emissions vehicle. A bus trip would cost less (in eco-points, separate from fare) than a car, and a rail trip lower than a bus. More information on the Eco-point concept can be found in Chapter 4.

2.4.3 Environmental Analysis

Environmental impacts of tolling variations should be studied in terms of changes in vehicle usage and VMT in Seattle, King County, and the regional network. In conjunction with VMT reductions, associated emissions and noise should be assessed. Quality-of-life impacts should also be considered in and adjacent to the charge zone, primarily on a judgment basis using traffic modeling inputs. Examples may include a variable charge that pushes delivery vehicles out of peak periods of traffic to off-peak periods, which may negatively impact neighborhoods in the charge zone before or after the charge period.

Tolling strategies should also be measured using output VMT and vehicle hours by type from the PSRC model, and then converted into emission volumes using agreed-upon standard rates. Variations between the relieved study area and fringe areas affected by diverted traffic should be identified, as well as corridor and global benefits and impacts.

Assessing sustainability is closely related. Sustainability crosses all sectors of economic, social, and environmental performance, for which modal split and relative VMT by public transportation are key indicators. In addition, economic and environmental impacts can be disaggregated by (all or some of) district, purpose, and income group to track cross-sector impacts and generate required inputs for consideration in the City of Seattle's approach to tolling.

Table 2-2 presents the direct environmental effects of transportation that are considered relevant to this study.

Table 2-2: Relevant Direct Environmental Effects of Transportation

Objective/Issue	Possible Evaluation Factors
Change in levels of emissions	Change in vehicle emissions by key transportation corridor and overall regional level: • Nitrous Oxide • Particulates • CO_2 • Noise in db
Noise and vibration impacts	Estimates of changes in assessment of noise and vibration impacts on key routes based on traffic volumes and speeds as an indicator
Improving amenities for those who visit, live, and work in the City of Seattle	• Changes in traffic volumes along particular routes that are known to cause community severance issues • General commentary, informed by overall transportation model outputs • Qualitative assessment
Sustainability: • Share of trips by 'active' modes • Share of trips by Public transportation • Reduction in emissions	• Change in number and percentage of trips by cyclists and pedestrians • Change in number and percentage of trips on Public transportation • Change in number and percentage of SOV trips • Predictions of changes in emission levels, local air impacts, particularly in congested conditions
Supports sustainable transportation objectives	Extent of likely shift to sustainable modes of public transportation, walking, or cycling

2.5 Organizational Considerations

In Washington, no single organization is responsible for all aspects of tolling or for any one tolled facility. WSDOT owns the facilities (i.e., highways, bridges, tolling facilities, and equipment), WSTC is responsible for setting tolls, the Washington State Patrol enforces the tolls, and the State Legislature is the only entity with the authority to impose tolls on an eligible facility.

Business functions could be performed directly by an independent agency or contracted in whole or in part to a service provider(s) or other public agency(ies) that already perform similar functions, such as the City of Seattle, King County, or Washington State transportation departments. WSDOT may be a logical partner, as it owns the facilities and tolling equipment.

This involves assessing the degree to which existing public agencies can manage a tolling authority and conduct its business using private sector models to meet customer demands and daily operational needs. Other factors include maximizing opportunities that leverage existing capabilities rather than duplicate them, thereby holding costs down and providing a funding source for start-up activities.

There may be opportunities to consider a new arms-length entity (operating company) that:

- Operates on a commercial basis,
- Focuses on providing efficient operations, innovative customer service (using potentially competing private sector entities to provide such service), and innovative corridor management (with safety, congestion, and road surface quality goals), and
- Has a clear separation of responsibilities from state and local agencies that set policies and performance objectives.

Another important issue is the agency responsible for allocating funds. To optimize the use of such funds, it would also be possible to create a new state/local agency (transportation funding authority) that makes decisions within a transparent set of objectives and appraisal criteria. The agency would monitor and control payments made to the operating company. Its mandate would be to allocate funds to regional projects, according to a wider strategic policy framework, by buying “benefits” for transportation users. It could also allow for prudent borrowing for funding projects rather than funding on a pay-as-you-go basis. Such an approach could alleviate concerns that tolls would be diverted from transportation projects, or directed for political purposes.

The agency could also be structured to leverage innovative financing opportunities, such as through a public-private partnership—again, within the constraints applicable to those approaches under state law. Currently, legislation limits private participation to designing, demonstrating public support for, and completing the planning process required to obtain approval to build facilities from WSDOT and other agencies.

2.6 Technological Considerations

Current technology used for tolling in the Seattle metropolitan region reflects WSDOT’s decision to adopt a DSRC system using microwave communications at 915 MHz. It uses a proprietary transponder system supplied by Transcore. This is a read-only technology that was considered “best fit” in early 2006 when the “*Good to Go!*” electronic tolling system was selected for implementation on the Tacoma-Narrows Bridge.

This technology was intended as a stop-gap measure until later technologies arrived. It was also intended to be “interoperable.” Both of these conditions need to be considered for future expansion of tolling in the region. It is difficult to reverse or remove proprietary technology once it spreads throughout the region. Currently, the number of tags is sufficiently low enough (approximately 250,000 tags) to implement a newer technology. With any future tolling concepts, the number of tags will grow and make it extremely difficult and expensive to replace.

The region should promote interoperability. Rather than the current standardization on a single vendor product, WSDOT and other agencies involved in toll collection should require that tags support at least one open tolling protocol. This would support maintenance of existing tags, but force future tags to be dual mode—one proprietary and one open mode. This would yield several benefits:

- Open procurement and competition from several suppliers, provided they are tested and can interoperate.
- Lower costs for implementing future systems derived from the competition suggested in item 1 above.
- Reliability of service. Competition drives performance as lower performance tags and readers would not be selected. This would improve overall system reliability and build user trust and confidence in the technology.
- Improved operating revenues. Better performance would mean higher read rates, lower transaction costs, and improved revenue collection. An interoperable and competitive system would support revenue collection as a primary objective. Proprietary and sole-source supply chains have proven time and again to lower performance, reduce reliability, and increase operating and maintenance costs.
- Proprietary systems limit technical innovation. Sole-source supply limits and restricts innovative solutions. WSDOT is currently tied to the technical development of a single company. Without competition, their technical innovation and thinking may not evolve over time. WSDOT and the Puget Sound region could be trapped into the current generation of tolling technology when the world is advancing new standards and products.
- The Vehicle Infrastructure Integration (VII) program has produced an open 5.9 GHz technology standard that is now operational and viable. FHWA has considered the use of new 5.9 GHz technologies as a condition for the receipt of federal funding. Discussions with the US Department of Transportation (DOT) for congestion pricing pilot projects indicate high support for use of open standards. As a result, future FHWA money available to the region could be in jeopardy if Washington State does not adopt a positive policy on the use of 5.9 GHz technology.

An additional consideration is that having an open standard would allow parallel development by multiple technology and operational companies. With the current WSDOT proprietary standard, any transportation operator or intelligent transportation systems (ITS) operator wishing to develop or use tags to improve efficiency or operations must contract or license equipment and software from Transcore, the current and only supplier. This limits third-party applications and stifles the use of the technology. An open standard would allow these third parties to either license or develop their own applications, whichever is more cost effective.

2.7 Financial Considerations

Over the next 20 years, the state faces $80 billion in transportation investment needs.[7] The Puget Sound region accounts for half of the total ($40 billion); King County's share is over 37 percent ($30 billion).

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[7] King County Executive. *Destination 2030 – Taking an Alternative Route*. March 2007. The study was done for the King County Executive by TRAC at the Washington State Transportation Center and Booz Allen Hamilton.

An August 13, 2008 US DOT press release announced that since November 2007, "Americans have driven 53.2 billion miles less than they did over the same period a year earlier – topping the 1970s' total decline of 49.3 billion miles." At the time, US DOT Secretary Mary Peters stated, "We can't afford to continue pinning our transportation network's future to the gas tax. Advances in higher fuel-efficiency vehicles and alternative fuels are making the gas tax an even less sustainable support for funding roads, bridges, and transit systems.[8]"

On September 5, 2008, Secretary Peters stated, "As a result, in recent days, it has become increasingly clear that the tab has come due. Put plainly, the Highway Account of the Highway Trust Fund will not have cash available to reimburse State highway expenditures—not at some point in the distant future, but as soon as this month."

Outlays are now expected to exceed receipts by more than $8 billion for fiscal year 2008. In September alone, we expect the Highway Account will take in $2.7 billion but have reimbursement requests totaling $4.4 billion. At current spending rates, we will start the new fiscal year on October 1 with a zero balance in the Trust Fund, and will continue to spend more than we take in."

The US DOT recently released its strategy for reforming federal funding—an approach that encourages states and metropolitan areas to use innovative financing mechanisms such as tolling, public-private partnerships, credit assistance, private activity bonds, and state infrastructure banks to leverage federal resources. With increased focus on innovative financing opportunities, congestion pricing is one emerging strategy that moves away from the dependence on gas taxes and the Highway Trust Fund at the national, state, regional, and local levels.

In Washington, ongoing studies at the state and regional levels are evaluating the potential of pricing strategies to generate revenue for major projects, such as the Alaskan Way Viaduct and the SR 520 floating bridge; smaller, but equally necessary projects; ongoing operating and maintenance costs; and growing demand for additional transit services.

2.7.1 Financing Options

Through its Urban Partnership Agreement, the Puget Sound region is already leveraging federal funds available under the Value Pricing Program to manage congestion through pricing mechanisms. Other options that could be evaluated as part of an overall funding approach include:

Public-private partnerships – Contractual agreements between a public and a private sector entity that enable greater private sector participation in the delivery of transportation projects. These partnerships allow public agencies to tap private sector technical, management, and financial resources to achieve objectives such as greater cost and schedule certainty, supplementing in-house staff, innovative technology applications, specialized expertise, or access to private capital.[9] The public agency relaxes its control of the project and transfers responsibility and risk to the private partner, which receives the opportunity to earn a financial return commensurate with the risk assumed. Tolling can be considered as a staged process and assessed as to how it can be designed for future needs, not just for day one. This means building flexibility into the plans (e.g., designing

[8] US Department of Transportation. "American driving reaches eighth month of steady decline." August 13, 2008. http://www.dot.gov/affairs/fhwa1708.htm
[9] US Federal Highway Administration Public-Private Partnership Web page: http://www.fhwa.dot.gov/ppp/defined.htm#1

the initial stage in the context of a longer-term strategy). In terms of procurement, that might include private sector contractors participating as partners.

State Infrastructure Banks (SIBs) – Revolving infrastructure investment funds for surface transportation that are established and administered by states. In the past, SIBS could be capitalized with Federal-aid highway apportionments and state funds and could offer flexible financial assistance, including loans and credit enhancement. With the US DOT's proposed reforms to the federal role in transportation funding[10], states would be authorized to use up to 100 percent of funds received under the proposed Federal Interest Highway (FIH) Program to capitalize SIB highway accounts. Metropolitan Transportation Boards (created under the proposed Metro Mobility Program) would also be authorized to create Metropolitan Mobility Banks to make loans or provide other forms of credit to public and private entities for eligible urban mobility projects.

Transportation Infrastructure Finance and Innovation Act (TIFIA) – Authorizes the US DOT to provide federal credit assistance (i.e., direct loans, loan guarantees, or lines of credit up to 33 percent of project costs) to major transportation investments of critical national importance. Proposed reforms would broaden the availability of credit assistance by providing repayment flexibility, excluding loan guarantees or lines of credit from Title 23 and Title 49 requirements, allowing repayment from direct facility pricing for up to 50 percent of eligible project costs, and making loan guarantees/lines of credit available to supplement secured loans.

Private activity bonds (PABs) – Tax-exempt bonds that may be issued for privately developed and operated projects. Volume caps currently limit the number of highways, public transportation, and inland freight transfer projects for which PABs are available, and are inconsistent with federal policy to facilitate and encourage private sector investment in highway and freight transfer facilities. Proposed reforms would remove the volume cap and amend the Internal Revenue Code to make PABs more flexible, by authorizing the use of accelerated depreciation, deferral if interest payments to accommodate lower revenue streams during start-up, and PABs to finance private investment in existing infrastructure.

2.8 Diversion Impacts

With the implementation of any priced roadway network exists the possibility that drivers wishing to avoid paying the toll will divert onto other non-tolled roadway facilities—generally, city streets. Additional traffic on city streets can create newly congested areas, increase crashes, and negatively impact transit performance levels and bicycle and pedestrian travel times on the impacted roadways. Diversion can also impact projected revenue collection from priced facilities, and can thus impact overall available revenue for implementing other priority projects. Traffic diversion was one of the concerns expressed in the WSTC's Comprehensive Tolling Study.

Careful selection of the locations for assessing the toll is critical to avoid traffic diversion. For example, placing toll collection locations beyond a major freeway exit to a major destination such as the CBD allows the motorist to exit before paying the toll and divert to the arterial and collector street network. Likewise, it is important to recognize facilities parallel to tolled facilities. Motorists can use non-tolled facilities to travel the same general corridor while avoiding tolls. In such a case, it may be prudent to toll both parallel facilities to reduce diversion.

[10] US Department of Transportation. Refocus, Reform, Renew: A New Transportation Approach for America, 2008.

2.9 Equity

Equity is a major issue when considering tolling. Any pricing initiative will have less proportional effect on upper-middle and higher-income bracket people than on low-middle and low-income bracket people, although those on higher income brackets tend to travel the most. Additional transportation costs must be considered. Program design should minimize impacts on lower-income brackets without creating a reverse discrimination situation for higher brackets.

Variable pricing offers a good starting point to provide the ability of lower income brackets to shift time and arrange their schedules to travel at lower-priced time periods. Strong consideration should be given to ensure that the peak period is designed to be as narrow as possible with adequate shoulder periods before and after the peak to minimize the pricing impacts of the toll.

WSDOT has conducted focus groups with low-income populations for the SR-167 project. The low income participants reported the travel time savings for paying into a HOT lane are worthwhile expenditures.

Another consideration would be the consistency of these time differentials to trip patterns to ensure that shoulder and peak periods are not unified across the region. Unification of time periods for charging may appear logical from a consistency and stakeholder understanding perspective, but unified price shifts will trap drivers as they commute along the various facilities. As they consume time driving to the first destination, time will elapse and progress into the next higher cost period as they proceed. As a result, drivers may pay more and lose the incentive of the variable priced toll facilities. Therefore, a time-shifted, variable toll plan should be investigated to stagger crossover times along multiple facilities to avoid an inequitable situation for low and other income brackets.

There would need to be a high degree of caution before considering any sort of income-based discount. Factors such as average income may need to balance against family income; otherwise, part-time workers in a high-income family would be eligible. In addition, any discount, and how the program will be administered, verified, and enforced so as not to become inequitable in itself, will need to be defined. It is likely to be more beneficial to design the scheme to better target by time and location.

To appropriately set charges, it would be useful to have data on travel patterns of different socio-economic groups by purpose, so that the social impacts of any proposal are adequately assessed and tolling schedules adjusted to balance strategic needs with concerns over social impact as appropriate.

Lastly, special cases must be considered for disabled parking permit holders, and other special needs categories. Minimum discounts and exemptions will be more equitable in the long term, but these categories should be addressed. One consideration may be a monthly allotment of trips as a minimum supply that can be used or set to expire in the following month. For example, an eligible discounted citizen may receive a monthly allotment of five free trips. These would be the first five trips for the month. After this allotment, he/she would pay for any remaining trips that month.

2.10 Public Outreach

Because variable tolling is new to many people, and the concept of tolling is often met with concern, significant public outreach will be necessary to explain how it connects to investment in transportation infrastructure. Previous efforts to fund and develop transportation projects in the Puget Sound region have demonstrated the importance of communication.

A public involvement process should be representative, open, and transparent; it should provide information to the public and stakeholders so that they can make an informed decision; and it should encourage and accommodate public comments.

Achieving political support will depend on understanding public acceptance barriers and making a convincing case for variable tolling. The problem and proposed solution must be stated through open, frequent, and effective communication methods. Global examples exist; however, the best example may be a comparison with London.

If Seattle were to consider a tolling concept similar to London's, it would require a more sophisticated public outreach program. Public transit mode share in London is substantially higher than in Seattle. This means promoting the positive results of pricing, such as reduced congestion, the investment program, and ways to minimize charges by changing time of travel and mode, ridesharing, and consolidating trips. Tolling should not be presented to the public as a stand-alone option. Rather, it should be presented as one policy alternative to meet Seattle's interests. The public can then evaluate tolling in the context of other options to reduce GHG emissions, reduce congestion, raise revenue, etc.

2.11 Complementary Policy Changes

In addition to reducing GHG emissions, one of the City of Seattle interests in tolling is the ability to raise revenue to support transit and transportation priorities. To encourage motorists to change their demand for transportation services, tolling can be coupled with complementary measures such as parking policies. Although one of the PSRC Destination 2030 tolling concepts analyzed area pricing and parking, it was primarily focused on pricing surcharges. However, these surcharges were not analyzed in conjunction with the implementation of other concepts like HOT lanes or freeway network tolling.

On-street parking is often encouraged by downtown merchants who want nearby parking for their customers for short-term retail stops. Parking rates and penalties for violating time limits encourage high turnover of these spaces. This in-and-out parking can also create friction for through traffic on the street, thereby reducing the street's vehicle-carrying capacity. In the same breath, it can also be used to enhance safety by slowing traffic flow as a form of traffic calming.

Off-street parking is intended for employees, visitors, and residents of an urban area. Off-street parking is often privately owned and operated, particularly in residential and office applications. However, many municipalities control large amounts of off-street parking and therefore can control parking rates and perhaps influence demand for parking via pricing strategies. Some cities provide real-time parking availability information for travelers to direct them to available parking quickly to reduce time spent driving on the street system searching for available parking. Seattle is currently developing its own electronic parking guidance system.

Parking payment systems are also changing. The parking system at the Orlando International Airport accepts both the SunPass and E-Pass transponders in use on toll facilities in the state of Florida and billing for parking is handled through those existing accounts. Similar measures could be introduced in Seattle with transponders used for pricing projects.

Parking policies are not just for a CBD. Suburban areas can also have more sophisticated parking policies as a support measure for congestion management. In Westchester County, New York, planners are examining ways to redevelop existing office parks with excess parking into new housing, some of it for moderate income families. According to a May 11, 2008, *New York Times* article "Could Parking Space Become the Next Living Space?" "Richard Hyman, an independent consultant hired by the county for the study, said there were two big reasons he thought the plan would work. To start with, office parks are typically created with more parking than they need to meet standard zoning requirements. Additionally, the complexes are often built in campus-like settings, with room for more construction—in this case, new residential buildings."

The Puget Sound region may consider reviewing policies around existing office parks, particularly in the proposed area charging/parking policy locations, to determine whether impediments exist to allowing existing parking to be converted to housing by office park owners. This could potentially reduce the need for commuting for office park employees who wish to live adjacent to their workplace.

Attractive and safe streets appeal to people who commute by bicycle, by public transportation, or as a pedestrian. Street furniture, public art, bus pull outs, bus shelters, real-time bus arrival information, and good lighting are design aspects that cities can incorporate into street design to encourage alternatives to the SOV. Additionally, street calming techniques such as use of more narrow lanes, on street bicycle lanes such as those being introduced in New York City, and even careful use of on-street angle parking as used in the Tallahassee, Florida CBD, all have the effect of slowing or "calming" traffic in a downtown setting.

Transit pricing can also influence traveler behavior. For example, Seattle's fare-free zones in the downtown area encourage bus use rather than private vehicle use for short trips within the downtown core. In addition, employer-sponsored bus passes, in lieu of providing free or reduced parking, offer another incentive to use transit. Making it easy to transfer from one public transportation mode to the next is also important. However, it is important to ensure that there is no encouragement of mode shift from walking and cycling to public transit and for public transit fare pricing to reflect peak and off-peak demand, so buses do not operate heavily underutilized at off-peak times.

All of these potential measures must be viewed in the larger context of overall objectives that the City is trying to achieve. It is unlikely that any of these as stand-alone measures will achieve the success the City desires, but some or all of such measures in conjunction with a pricing program may further the goal of reducing GHG emissions.

Chapter 3. Assessment of Regional Tolling Concepts

This section describes tolling concepts currently being tested in the region. In assessing them against Seattle's tolling interests, it recommends changes for the City to consider pursuing. To develop Table 3-6, which appears later in this chapter, a number of regional tolling efforts were analyzed to determine how they meet Seattle's tolling interests.

3.1 Regional Tolling Concepts

3.1.1 Puget Sound Regional Council (PSRC) – Destination 2030

Destination 2030 is the update of the transportation element of the Transportation 2040 Regional Plan. As part of Destination 2030, PSRC partnered with WSDOT in 2008 to develop and test five tolling concepts. All concepts were tested against the time horizons of 2015 and 2030; they represent an evolution of tolling from small-scale to larger-scale concepts:

- HOT lanes
- Selected facilities
- Freeway network tolling
- Full network tolling

The exception to the evolution is the area pricing/parking concept that focuses on a geographic area rather than specific roadway facilities.

In 2009, PSRC studied application of these scenarios in 5 Regional Transportation Plan alternatives.

HOT Lanes

HOT lanes use HOV lanes as their foundation. HOT lanes use available vehicle capacity on HOV lanes or general-purpose lanes to accommodate SOV drivers willing to pay a fee to use the HOV lane.

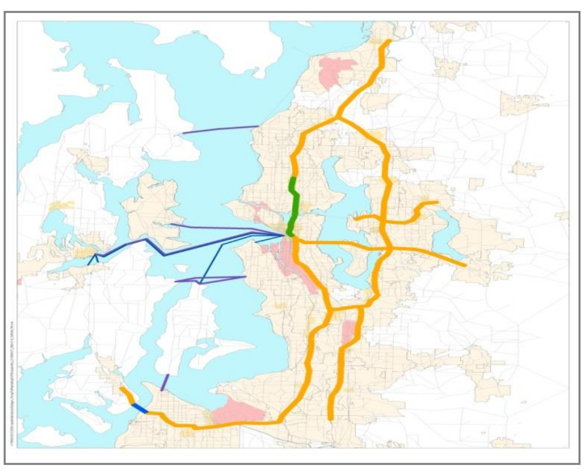


Figure 3-1: HOT Lane Concept

HOT lane pricing can be static or dynamic—one price all day or variable throughout the day based on HOT lane congestion level.

HOT lanes have recently been initiated in the Seattle metropolitan area as a pilot project on the SR-167 facility. According to an August 31, 2008 *Parade Magazine* article "Would You Pay More to Beat Traffic," "in the Seattle area, HOT lane rates hit their maximum of $9 only twice in their first three months of use. The average daily toll is about $1. Most feedback is that people are very happy to have paid the extra money when they're desperate to get home or to work, says Mark Hallenbeck, a traffic expert at the University of Washington." More detailed analysis of the SR167 HOT lanes can be found at http://www.wsdot.wa.gov/Projects/SR167/ValleyFreewayCorridorPlan/hotlanes.htm.

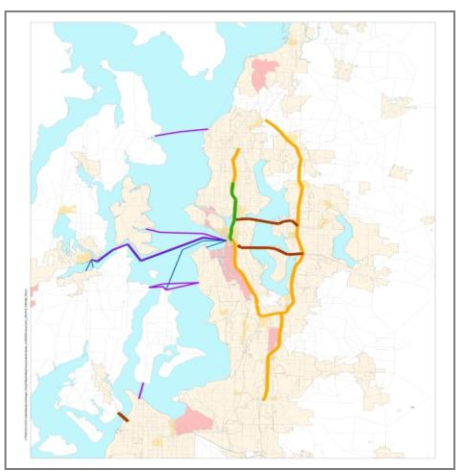
Two HOT lane concepts were discussed in the 2008 PSRC analysis: Concept 1A, a one-lane network as shown in Figure 3-1 with exemptions for 3+ HOVs, vanpools, and transit; and Concept 1B,a two-lane network with exemptions for 2+ HOVs, vanpools, and transit. In both, HOT lanes would operate 24 hours per day/7 days per week and would be dynamically priced, with a goal to obtain adequate transit speeds and reliability.

The two-lane HOT network was not tested as part of the 2008 analysis because it entailed significant facility expansion and left key facilities with only one general-purpose lane if the expansion was not completed. However, a variation of the two-lane HOT network including roadway expansion and HOT-to-HOT connections were studied by PSRC in their 2009 Transportation 2040 Study, Alternative 2.

Selected Facility Tolling

Figure 3-2 presents a concept where toll collection occurs only on selected facilities. The facilities include portions of I-5, SR 167, I-405 HOV converted to HOT, I-5 reversible lanes converted to HOT, and full tolling of the I-90 and SR 520 bridges. In this concept, HOV 3+ and transit are exempt from tolls. Dynamically priced tolls are collected 24 hours per day/7 days per week.

Figure 3-2: Selected Facility Tolling



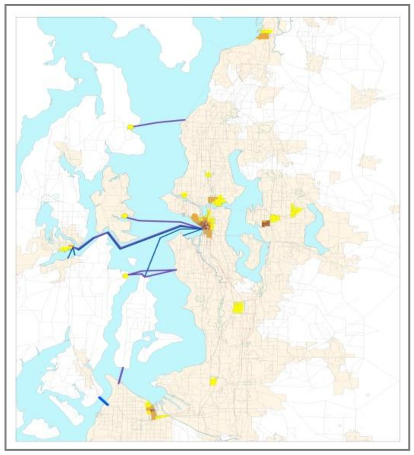
These selected facilities are some of the most congested and heavily traveled roadways in the region's roadway network. This concept focuses on reducing congestion and emissions, increasing vehicle throughput, and generating revenue for infrastructure investments. The objective for lane performance speed would be 45 mph and to obtain adequate transit speeds and reliability.

Area Pricing/Parking Charges

This concept focused on selected "activity centers" that attract large numbers of trips within the four-county region. Originally envisioned as a way of identifying potential "cordon" or "area" pricing areas, it evolved into the analysis of a variable parking surcharge applied to all parking within the zones. The objective of this concept is to minimize the total cost of travel imposed by congestion. Trucks would be exempt from parking charges.

Figure **3-3** shows the zones.

Figure 3-3: Area Pricing/Parking Charges Concept

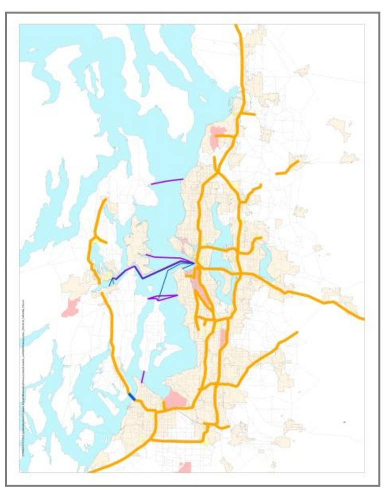


Freeway System Tolling

This concept tolls all existing limited access roadways located within the Urban Growth Area, as illustrated in Figure 3-4. Tolls are applied to all vehicles (except transit) using the freeway. Dynamically priced tolls are collected 24 hours per day/7 days per week.

Objectives include minimizing system-wide user costs and, while minimizing diversion costs, obtaining adequate transit speeds and reliability.

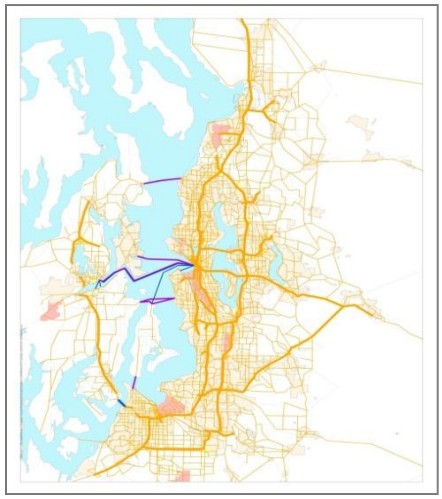
Figure 3-4: Freeway System Tolling



Full System Tolling

This concept assumes tolling on all freeways and major arterials within the Urban Growth Area, as illustrated in Figure 3-5. Tolls are applied to all vehicles using the freeway, except transit vehicles, which travel for free. Tolls are collected 7 days per week most hours per day, with nights free, and are dynamically priced with different rates on the weekend. The intent of this concept is to reduce congestion and travel time costs by optimizing toll rates and generating revenue to support additional infrastructure investment.

Figure 3-5: Full System Tolling Concept



3.1.2 SR-520

WSDOT, the Washington State Transportation Commission, and the PSRC are evaluating scenarios for tolling the SR 520 bridge to provide funds to replace the existing bridge, provide incentives for transit and carpooling, and consider variable tolling as a way to reduce congestion. Four scenarios were initially considered in analysis conducted in summer 2008:

- Start tolling the new 520 bridge in 2016
- Start tolling SR 520 in 2010
- Start tolling the new 520 and the I-90 bridge in 2016
- Start tolling SR 520 in 2010 and the I-90 bridge in 2016.

Scenarios were modeled to estimate changes in travel demand and revenue raised. After the initial modeling assessment, five new scenarios were developed for consideration. A final report from January 2009 is available at http://www.build520.org/choices.htm.

More information on the Urban Partnership agreement and related legislation can be found in Appendix B.

3.2 Seattle Urban Mobility Plan and Central Waterfront Process

The PSRC Model was also used to assess additional scenarios related to a planning effort to replace the Alaskan Way Viaduct.

The Alaskan Way Viaduct is an elevated segment of State Route 99 (SR 99) along downtown Seattle's waterfront; it is also one of two north-south limited-access highways through the city. The Viaduct was damaged in the 2001 Nisqually earthquake and is vulnerable to subsequent earthquake damage, likely requiring closure by the State of Washington in the event of future seismic activities.

The Urban Mobility Plan (UMP) was a response by the City of Seattle to replace the damaged Viaduct, with enhanced transit service and street and highway improvements that move people and goods; it expanded the analysis beyond the vehicle carrying capacity of the SR-99 corridor. The Urban Mobility Plan approach was analyzed through the Tri-Agency (City of Seattle, Washington State and King County) Central Waterfront Process's systems approach.

Tolling Analysis for the Seattle Urban Mobility Plan/Central Waterfront Process

As described in section 3.1.1, PSRC modeled tolling scenarios in 2008 to identify travel behavior impacts on existing roadways. The UMP/Central Waterfront Process analyzed the results of these scenarios to see how they would impact vehicle and transit access to and through downtown Seattle.

The results showed that the full system and freeway system tolling networks (p. 20) would have the potential to contribute to UMP/Central Waterfront traffic reduction and revenue goals. The UMP/Central Waterfront team was dissatisfied with the results of the cordon toll analysis, which, without tolls on I-5 or other area freeways, did not show the potential to perform satisfactorily in reducing traffic or generating toll revenue to pay for other transit service and roadway improvements. The team also concluded that the cordon tested would need to be adjusted to reduce diversion to I-5 and arterial streets to the east of I-5.

The UMP/Central Waterfront Process undertook analysis of another cordon tolling approach, this time including both I-5 and SR 99 and affecting all trips through the central part of Seattle. This cordon analysis assumed that all inbound trips crossing the cordon would be charged a toll. The cordon boundary was from Lake Washington to SR-99, and from the Ship Canal south to Atlantic Street (excluding the Uptown neighborhood). The analysis also assumed tolling on I-90 and SR 520, consistent with concepts for tolling these facilities with the SR 520 Project. Differential tolls were assumed: travel on I-5 would be costlier than SR-99, which would be costlier than surface streets. The I-5 toll was assumed to be $3.00. The analysis showed that this scenario would have the potential to reduce vehicle traffic in Seattle's downtown by 9%; while person travel on transit was increased by 15%.

Recommendations for Future Analysis of Tolling related to the Alaskan Way Viaduct and Center City:

At the conclusion of the UMP/Central Waterfront Process, the tri-agency panel recommended to move forward with a bored tunnel. Many of the transit investments studied in the UMP process were not included in the final package. It is anticipated that tolling the bored tunnel will be studied to raise revenue for the project. Consistent with Seattle's interests in tolling; if the Alaskan Way tunnel were to be tolled, the analysis should include:

- Systematic Tolling: both I-5 and the Alaskan Way tunnel should be tolled to reduce diversion. The analysis that was already done for the UMP/Central Waterfront Process, including a cordon charge; can be taken into consideration to minimize diversion to City streets.

- Funding transit with toll revenues: a portion of net operating revenue should be allocated to funding transit; even if it means a longer payback for construction of the tunnel.

- Variable Tolling: Establish a variable toll rate, either truly variable in response to congestion or predictably variable, to reduce GHG emissions through mode shift, reduced travel frequency, and better fuel efficiency due to congestion relief.

It is anticipated that including these assumptions would result in:

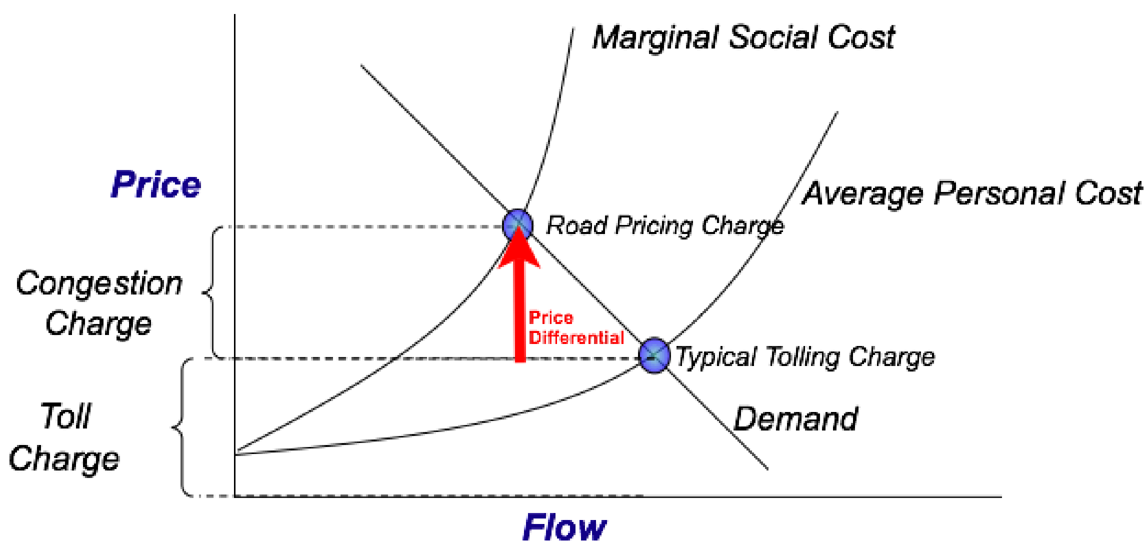
- Less peak period VMT and reduced GHG emissions
- Less auto traffic diversion onto City streets
- Better regional access and mobility

3.3 PSRC Modeling Summary Results

PSRC used a conventional strategic approach to assess various tolling concepts. Previous PSRC work developed elasticity of demand curves from survey work and pilot field trials of tolling charges. This work produced tolling tables and levels that assessed the impacts of various tolling approaches in the region.

These tolling tables reported higher than average personal costs (APCs) and lower than average marginal social costs (MSCs), the cost of an individual trip on other vehicle trips. This is not surprising as most people in surveys state their own time impacts and costs while understating their congestion impact on others. National and international tests and surveys also reflect this pattern. Figure 3-6 illustrates the differences.

Figure 3-6: Differences of MSC and APC on Travel Demand



The impact of tolling rates used by PSRC is that charging by MSC rather than the toll rates assumed would increase revenue, average speeds; and decrease VMT, and vehicle hours of travel (VHT) reported in the table (and reduce MSC itself significantly). MSC would charge higher tolls and suppress more trips to optimize the network or selected facilities for trips of the highest value. Lower value trip individuals would shift to lower-priced time periods, shift modes, consolidate or trip chain, carpool, or simply not make the trip. MSC would therefore increase traffic speeds due to less traffic on the road network. It would also result in a greater reduction of VMT and VHT statistics in the model runs.

Further work to include MSC pricing would improve the results indicated in the following tables. Values shown are indicative, but in considering MSC, would be understated. Taking the data as presented, however, provides a good comparison of various options modeled and provides insights into further analysis.

Table 3-1, Table 3-2, and Table 3-3 provide summary level results from the PSRC tolling concept modeling.

Table 3-1: Destination 2030 Tolling Concepts Modelling Summary Results

Concept	Additional Revenue ($ /year)	Average SOV Toll * per Mile ($)	Average ** Freeway Speed (mph)	Average ** Arterial Speed (mph)	VMT per capita	VHT (millions)
Baseline	0	N/A	40.3	30.9	24.1	3.279
HOT One-Lane	$79 million	0.29	40.3	30.6	24.3	3.309
Area Pricing-Parking Charges	$104 million	N/A	40.3	30.9	24.1	3.277
Selected Facilities	$95 million	0.38	40.6	30.8	24.1	3.280
Freeway System	$1.9 billion	0.39	51.0	29.9	22.7	3.026
Full System	$6.1 billion	0.40	53.1	33.1	21.7	2.747

* In PM peak period
** Daily

Table 3-2: PSRC Tolling Concepts Findings

Concept	Finding
HOT One-Lane	• Improves efficiency of HOV lanes in peak periods
Area Pricing-Parking Management	• Parking management probably best used as a demand management tool in conjunction with other strategies (as studied by PSRC, not true area pricing)
Selected Facilities Tolling	• Opportunity to help finance select investments • Localized speed and reliability improvements

Freeway System Tolling	• Sizable speed and reliability improvement • Creates opportunity for faster transit service • Potential for management of vehicle use (VMT) • Creates some increased need for arterial solutions to minimize diversion • Considerable benefits for trucks
Full System Tolling	• Very significant speed and reliability improvement • Creates larger transit opportunity from faster travel times and higher mode shift • Sizable potential for management of vehicle use (VMT) • Large benefits for trucks • Substantial revenue opportunity (importance of reinvesting the revenues)

Table 3-3: Detailed Tolling Concept Modeling Results

		2006 Base Year	2020 Baseline	2020 Area Charge	2020 Ubiquitous Re-Run	2020 Freeway Only Ramsey	2020 HOT 1	2020 Select Fac - a AWV toll	2020 Select Fac - b no AWV toll	2040 Baseline
VMT	AM	14,921,806	17,016,924	16,978,274	14,370,321	15,821,818	17,080,390	16,957,660	16,996,144	18,913,040
	MD	29,593,178	34,425,772	34,334,136	28,443,636	31,996,372	34,753,820	34,449,872	34,501,972	39,821,984
	PM	19,264,398	22,518,028	22,537,812	19,596,212	20,996,232	22,602,738	22,418,942	22,436,990	25,493,230
	EV	14,029,206	16,630,558	16,618,700	15,634,177	15,843,367	16,686,891	16,655,787	16,659,076	19,359,824
	NT	7,559,408	9,390,058	9,424,551	12,170,340	9,627,369	9,600,822	9,576,582	9,549,259	12,189,087
	Daily	85,367,996	99,981,340	99,893,473	90,214,686	94,285,158	100,724,661	100,058,843	100,143,441	115,777,165
VMT	freeway	36,968,389	42,461,683	42,427,859	32,016,239	34,154,069	43,329,445	42,658,886	42,770,944	46,201,924
	arterial	37,355,014	44,308,435	44,262,092	45,249,058	47,034,106	44,152,136	44,182,844	44,154,702	53,827,627
	connector	11,044,831	13,211,336	13,203,783	12,949,533	13,097,125	13,243,136	13,217,356	13,218,083	15,748,127
	TOTAL	85,368,234	99,981,454	99,893,733	90,214,829	94,285,299	100,724,717	100,059,085	100,143,729	115,777,678
VHT	AM	456,523	545,868	543,405	425,605	492,078	543,341	540,123	542,369	651,684
	MD	884,665	1,068,675	1,064,641	857,739	982,435	1,074,115	1,065,622	1,067,622	1,323,075
	PM	691,546	924,316	928,312	677,432	827,033	945,642	924,469	925,313	1,299,938
	EV	408,810	508,103	507,697	474,263	485,665	511,920	510,740	510,722	652,815
	NT	183,597	232,112	233,241	312,099	239,246	234,600	235,070	234,221	320,782
	Daily	2,625,141	3,279,075	3,277,295	2,747,139	3,026,457	3,309,618	3,276,024	3,280,247	4,248,294
VHT	freeways	841,032	1,054,448	1,053,662	603,118	669,488	1,074,401	1,050,021	1,054,686	1,335,189
	arterials	1,123,182	1,432,719	1,432,214	1,367,518	1,571,988	1,441,402	1,433,769	1,433,271	1,951,948
	connectors	660,930	791,907	791,422	776,506	784,986	793,816	792,238	792,294	961,167
	TOTAL	2,625,143	3,279,074	3,277,298	2,747,141	3,026,462	3,309,618	3,276,028	3,280,250	4,248,304
Delay (veh-hrs)	AM	56,932	84,737	83,403	17,922	49,284	81,999	80,880	82,281	127,312
	MD	77,344	118,634	117,022	18,451	65,014	119,011	115,972	117,022	198,108
	PM	166,129	303,747	307,178	108,917	227,766	323,144	306,269	306,807	580,683
	EV	34,719	60,216	60,070	29,201	44,094	62,784	61,879	61,877	117,520
	NT	3,193	7,032	7,317	10,787	3,698	5,683	6,391	6,197	21,989
	Daily	338,317	574,366	574,991	185,279	389,855	592,621	571,391	574,184	1,045,613
Delay (veh-hrs)	freeways	216,504	336,235	336,041	59,435	89,443	341,796	329,297	331,557	553,003
	arterials	121,816	238,135	238,953	125,844	300,412	250,829	242,097	242,629	492,614
	connectors	0	0	0	0	0	0	0	0	0
	TOTAL		574,369	574,994	185,279	389,856	592,625	571,394	574,186	1,045,617
Avg Speed	AM	32.7	31.2	31.2	33.8	32.2	31.4	31.4	31.3	29.0
	MD	33.5	32.2	32.2	33.2	32.6	32.4	32.3	32.3	30.1
	PM	27.9	24.4	24.3	28.9	25.4	23.9	24.3	24.2	19.6
	EV	34.3	32.7	32.7	33.0	32.6	32.6	32.6	32.6	29.7
	NT	41.2	40.5	40.4	39.0	40.2	40.9	40.7	40.8	38.0
	Daily	32.5	30.5	30.5	32.8	31.2	30.4	30.5	30.5	27.3
Avg Speed	freeways	44.0	40.3	40.3	53.1	51.0	40.3	40.6	40.6	34.6
	arterials	33.3	30.9	30.9	33.1	29.9	30.6	30.8	30.8	27.6
	connectors	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.4
	TOTAL	32.5	30.5	30.5	32.8	31.2	30.4	30.5	30.5	27.3
Person Trips	work/col	2,252,699	2,766,985	2,766,949	2,766,681	2,766,940	2,766,982	2,767,041	2,767,036	3,477,726
l Trips - no schc	non-work	10,675,477	13,163,216	13,163,218	13,163,214	13,163,213	13,163,223	13,163,221	13,163,221	16,850,237
	TOTAL	12,928,176	15,930,201	15,930,168	15,929,895	15,930,153	15,930,206	15,930,262	15,930,257	20,327,964
Mode Shares	SOV	80.2%	78.6%	78.4%	73.3%	77.2%	79.0%	78.7%	78.7%	76.8%
HBW - no colleg	Carpool	7.2%	7.3%	7.3%	9.1%	7.4%	6.9%	7.1%	7.1%	7.4%
	Transit	7.9%	8.6%	8.7%	11.8%	9.8%	8.6%	8.7%	8.7%	9.3%
	- Transit-w	6.5%	7.2%	7.3%	9.6%	7.8%	7.2%	7.3%	7.2%	7.8%
	- Transit-au	1.5%	1.4%	1.4%	2.2%	2.0%	1.4%	1.4%	1.4%	1.5%
	Bike	1.6%	1.8%	1.9%	2.1%	2.0%	1.8%	1.8%	1.8%	2.2%
	Walk	3.1%	3.6%	3.7%	3.7%	3.7%	3.6%	3.6%	3.6%	4.3%
Mode Shares	SOV	45.8%	45.4%	45.3%	44.6%	45.1%	45.5%	45.4%	45.4%	44.7%
(Non Work)	Carpool	44.6%	44.3%	44.4%	44.7%	44.4%	44.2%	44.3%	44.3%	44.1%
	Transit	1.9%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
	Bike	1.0%	1.0%	1.0%	1.1%	1.1%	1.0%	1.0%	1.0%	1.1%
	Walk	6.7%	7.2%	7.2%	7.6%	7.5%	7.2%	7.2%	7.2%	8.1%
Mode Shares	SOV	51.5%	50.9%	50.8%	49.3%	50.4%	51.1%	50.9%	51.0%	50.0%
l Trips - no schc	Carpool	38.4%	38.2%	38.2%	38.8%	38.2%	38.1%	38.1%	38.1%	38.0%
	Transit	2.9%	3.1%	3.1%	3.7%	3.3%	3.1%	3.1%	3.1%	3.3%
	Bike	1.1%	1.2%	1.2%	1.3%	1.2%	1.2%	1.2%	1.2%	1.3%
	Walk	6.1%	6.6%	6.7%	7.0%	6.8%	6.6%	6.6%	6.6%	7.5%

Note: The VHT, delay, and resulting implied speed calculations or the "Modified VDF (1)" runs reflect the modifications to the VDFs.

Notes for Table 3-3 above:

This table is pulled from a PSRC technical report. Definitions of terminology:

1. 2020 Baseline is 2020 projections with no tolling except the Tacoma Narrows Bridge

2. 2020 Area Charge represents the Area Pricing/Parking Charges concept
3. Ubiquitous Re-Run represents the Full System Tolling concept
4. Freeway Only Ramsey represents the Freeway Network Tolling concept
5. HOT 1 represents the 1-lane HOT concept
6. Select Fac a AWV toll represents the tolling of SR 520, I-90, 405 HOT lanes, I-5 HOT lanes, and a toll on the Alaskan Way Viaduct segment
7. Select Fac b no AWV toll represents the Selected Facilities Tolling concept with tolling of SR 520, I-90, 405 HOT lanes, I-5 HOT lanes

3.3.1 Assessment of PSRC Modeling Results

Table 3-3 suggests that one-lane HOT lanes offer the lowest performance option, while full system tolling offers the highest. As one moves down the concept list, freeway system tolling ranks second, while selected facilities tolling ranks third when considering additional revenue generated, average speed, and VMT and VHT reduction parameters. The scale of difference in both freeway system tolling and full system tolling makes them clear considerations for the region. Better results come from increasing the scope of the tolling system.

Some data in Table 3-3 suggests that HOT-1 lanes perform poorly. In comparing the 2020 base data, HOT-1 lanes cause greater delays, and selected facility tolling performs roughly the same. Modeling anomalies may cause these seemingly inexplicable results. Extra capacity indicated by both options appears inconsistent with these results against the same base case. Nonetheless, HOT-1 performance overall appears consistent with other HOT lane performance. It builds support for the need to include 2 HOT lanes in order to improve performance.

Parking charges, or in this case, the surrogate for CBD cordon charging, perform quite well against selected facilities and HOT lane tolling. The degree of difference is surprising in that it would have been expected to have a greater impact than is presented. In global testing, modeling, and implementations, a suppression of 20 to 22 percent of traffic has been found with the charges currently in place in London and Stockholm. These modeling results raise questions as they show better performance in revenue, but poorer performance in trip suppression, VMT, and VHT. This may reflect significant localized benefits that are minimal at a regional level.

The key from this data is that it should now be refined[11]. Refinement should include a combination of HOT lanes, selected facilities tolling, and parking charges. As this was not modeled, it is difficult to extrapolate the net impact of these options integrated into an approach that may increase total trip or end-to-end trip costs. Such a combined increase in the end-to-end trip would create greater diversion, suppression of traffic, and modal switch. These effects would logically provide an overall increase in benefits. Additionally, it would provide a scenario that affects drivers along the entire route to change driving behavior.

It would also impact land use, as higher transportation costs would neutralize longer trips that are now desirable due to lower land and housing costs. This alone would shift behavior to live closer to job markets for easier access. From an environmental policy perspective, this would reduce GHG and support public transportation ridership. While these options individually fall below freeway system

[11] Please note: PSRC did subsequently develop and model alternatives that combined tolling strategies with other capital investments and demand management techniques as part of the Transportation 2040 alternatives analysis. This alternative developing and testing occurred outside the timeline of this study.

tolling and full system tolling, when combined and integrated, they may provide the same or better effects than suggested in the tables above. Again, this should be done in consideration of the MSC of the trips.

Likewise, selected facilities tolling, freeway system tolling, and full system tolling should be studied with parking charges based on indicated performance. Locally, these could work together to provide an effective tolling strategy that shifts a greater number of drivers to more efficient transportation modes. This may also be used as a strategy to charge a lower amount to through trips in the region while charging higher tolls to trips terminating in the CBD. This would increase revenue, reduce demand, and increase speeds for economic benefits to freight and the region as a whole. The CBD would see fewer private car trips and greater use of public transportation and cycling as a result.

3.3.2 Recommended Changes to Current PSRC Tolling Concepts under Study

Based on the previous sections, there are three recommended changes to the concepts presented that may produce better overall results to meet Seattle's tolling interests. These are partially addressed above, but are presented here to clarify suggestions for follow-up modeling and work to be performed. These recommendations should be considered in the overall process.

Recommendation 1

HOT lanes should be evaluated as both one-lane and two-lane tolling. One-lane HOT facilities focus primarily on private car users that pay and get a benefit from travel time savings. Trucks and public transportation vehicles are typically excluded due to safety issues and the need to cross multiple lanes. Dual-lane or two-lane HOT facilities, however, can consider mid-size trucks (5- to 7.5-ton trucks) and public transportation vehicles. While heavy trucks (12 ton and above) are excluded, they will benefit in less traffic due to the shift of mid-size and small commercial vehicles paying to use the toll lane. This will increase revenue (use of variable pricing is assumed) and provide economic benefit to the service and delivery sectors of the economy. Because small and mid-size trucks are used extensively for local service and delivery, two-lane HOT facilities would meet Seattle's goal of improving regional economic conditions. Additionally, public transportation would benefit without negatively impacting private car users that could pass these vehicles in a two-lane facility.

Recommendation 2

Selected facility tolling should be combined with HOT (one and two lanes) tolling and parking charges as a special case for assessment. These three concepts independently provide benefit. When combined, they could provide equal or greater benefits in terms of revenue, time savings, and VMT and VHT reductions. Integrating these three components could provide Seattle with a short-term solution that could be expanded to freeway tolling and ultimately, full system tolling. These measures may work together to produce an overall benefit to both private and public transportation. Additionally, freight movement would benefit to a degree with these combined cases.

Recommendation 3

Selected facility tolling, freeway system tolling, and full system tolling should be modeled and assessed in combination with parking charges. All three of these conditions can logically exist with parking charges. The net result may provide a better synergy to meet Seattle's objectives.

Performance of the PSRC concepts as measured against Seattle's tolling interests is detailed in table 3-6:

Table 3-6: How PSRC Tolling Concepts and SR520 Tolling Study Meet Seattle's Tolling Interests

Table Key: High/Very High, Medium, or Low/Very Low re: how tolling concepts meet Seattle's interests

Seattle Interests	Baseline	SR520 Tolling Analysis	#1A – HOT Lane Network (3+ HOV Exemption) 4-County Region HOV System	#1B – HOT Lane Network	#2 – Selected Facility Tolling – No AWV Toll	Selected Facility Tolling + AWV Toll	Selected Facility Tolling + Downtown Cordon	#3 – Area Pricing/Parking Charges	#4 – Freeway Network Tolling	#5 – Full Network Tolling
Reduce GHG emissions *Set toll rates to encourage mode change to HOV, transit, or more fuel efficient vehicles*	No Impact	**VERY LOW: Modest improvement in fuel consumption**	**LOW: VMT and GHG emissions increase as slight disincentive to carpool with 2+ carpools having to pay, and people traveled further to access the freeway**	**LOW: VMT and GHG emissions increase as slight disincentive to carpool, with 2+ carpools having to pay, and people traveled further to access the freeway**	**MEDIUM: Lower demand on tolled facilities. Good design will reduce emissions. Issue is whether any parallel route congestion offsets this.**	**HIGH: Impact of variable tolling by location, time of day and externalities (e.g. vehicle emissions category of vehicle engine) would result in greater suppression of trips in highest emission categories and provide a business case to shift to higher trip efficiency and more energy efficient vehicles. International evidence supports these findings in Germany and Austria.**	**HIGH: Impact of variable tolling by location, time of day and externalities (e.g. vehicle emissions category of vehicle engine) would result in greater suppression of trips in highest emission categories and provide business case to shift to higher trip efficiency and more energy efficient vehicles. International evidence supports these findings in Germany and Austria.**	**Area pricing: LOW – Some effect on demand will reduce GHG emissions** **Parking charges: VERY LOW – Modest effect on demand, little effect on congestion**	**MEDIUM: Significantly reduce freeway fuel consumption, but partly offset by local network effects**	**HIGH: Greatest VMT and emission reductions. Could approximate a VMT tax to replace gas tax**
Fund transit as part of ongoing maintenance and operations *Transit operations should be considered part of operating the facility, as toll revenue could provide a steady and sustainable revenue source for subsidizing transit, and transit can provide a reliable alternative to driving on the facility. Toll revenue should also be used to provide maintenance and operations of the tolled facility.*	No Impact	**VERY LOW**	**LOW: Revenues very modest**	**LOW: Revenues very modest**	**MEDIUM: Some revenue for transit**	**HIGH: Creates higher revenue generation on selected facilities and the impact of revenue from the AWV toll indicated by PSRC model runs places this in the highly likely category. Shifts to public transportation would generate revenues for public transportation operations to make them more**	**HIGH: Creates higher revenue generation on selected facilities and the impact of revenue from the AWV toll indicated by PSRC runs places this in the highly likely category. Shifts to Public Transport would generate revenues for Public Transport Operations to make them more sustainable operations.**	**LOW-MEDIUM: Potential to raise some revenue**	**MEDIUM-HIGH: Should be considerable revenue potential**	**HIGH: Significant revenue potential**

Seattle Interests	Baseline	SR520 Tolling Analysis	#1A – HOT Lane Network (3+ HOV Exemption) 4-County Region HOV System	#1B – HOT Lane Network	#2 – Selected Facility Tolling – No AWV Toll	Selected Facility Tolling + AWV Toll	Selected Facility Tolling + Downtown Cordon	#3 – Area Pricing/Parking Charges	#4 – Freeway Network Tolling	#5 – Full Network Tolling
						sustainable.				
Systematic implementation *Tolling plans should be developed and implemented throughout the region to maximize the use of the entire road network and balance traffic on all roads – and to minimize diversion from tolled to un-tolled facilities.*	No Impact	**MEDIUM : If I-90 tolled at the same time as SR520**	**MEDIUM: Staged implementation possible but implementation highly disrupts existing traffic and movements. Traffic impacts and off-peak working conditions make this a medium implementation.**	**MEDIUM: Staged implementation possible but implementation highly disrupts existing traffic and movements. Traffic impacts and off-peak working conditions make this a medium rated implementation.**	**HIGH: Staged implementation possible and tolling equipment installation over existing selected facilities is not disruptive to peak hour traffic and can be performed late night thus reducing impact on existing traffic.**	**HIGH: Systematic and progressive approach would be installation of equipment at exits and entrances along with gantry equipment above road surface which would be installed in off-peak periods. Set up of distribution network and tag distribution would rely on existing and new outlets for wide area distribution.**	**HIGH: Systematic and progressive approach would be installation of equipment at exits and entrances along with gantry equipment above road surface which would be installed in off-peak periods. Set up of distribution network and tag distribution would rely on existing and new outlets for wide area distribution.**	**MEDIUM: Depends on scope of parking charges, ownership of parking, boundary effects, and effects on land use.**	**HIGH: Staged implementation possible**	**LOW: Needs other stages first before this can be implemented**
Set variable tolls for different times of day	No Impact	**HIGH**	**MEDIUM: Medium potential to vary toll over length of HOT lane if open for movements into and out of lane. Can be switched to HIGH rating if HOT lane is barrier separated with controlled entrance and exits.**	**MEDIUM: Medium potential to vary toll over length of HOT lane if open for movements into and out of lane. Can be switched to HIGH. If HOT lane is barrier separated with controlled entrance and exits.**	**HIGH: Potential to vary tolls by location, time of day and other factors such as environmental concerns in a given location.**	**HIGH: Tolling charge rates would be set to a fee based on existing known data and objectives to adjust these on a regular basis. Adjustment equation should be set for flexibility to reflect actual impacts, but overall end-to-end trip should equal marginal social cost of trip. Should establish charges for peak and shoulder periods to mitigate dramatic shifts in specific time blocks.**	**HIGH: Tolling charge rates would be set to a fee based on existing known data and objectives to adjust these on a regular basis. Adjustment equation should be set for flexibility to reflect actual impacts, but overall end-to-end trip should equal marginal social cost of trip. Should establish charges for peak and shoulder periods to mitigate dramatic shifts in specific time blocks.**	**LOW: May have some simple changes, but little opportunity to vary tolls by location**	**HIGH: Potential to vary tolls**	**VERY HIGH: Potential to vary tolls as much as is efficient**
Throughput of people and goods vs. vehicles	No Impact	**LOW: Goods throughput improves if**	**LOW: Prohibits heavy freight (light commercial allowed)**	**LOW: Prohibits heavy freight (light commercial allowed)**	**MEDIUM: Much potential to improve**	**MEDIUM: Much potential to improve**	**MEDIUM: Much potential to improve throughput and**	**LOW: May have modest effects on demand, especially**	**MEDIUM-HIGH: Much potential to improve throughput**	**HIGH: Can significantly relieve network wide effects**

Seattle Interests	Baseline	SR520 Tolling Analysis	#1A – HOT Lane Network (3+ HOV Exemption) 4-County Region HOV System	#1B – HOT Lane Network	#2 – Selected Facility Tolling – No AWV Toll	Selected Facility Tolling + AWV Toll	Selected Facility Tolling + Downtown Cordon	#3 – Area Pricing/Parking Charges	#4 – Freeway Network Tolling	#5 – Full Network Tolling
Improve transit and freight reliability		freight allowed in lane in addition to added lanes for East-West crossing.	because PSRC assumed would slow travel time and transit and freight would fill HOT lane, not allowing GP to buy in. However that *may be a reasonable outcome for Seattle's goals. Could be Medium if HOT lane concept expanded to dual lanes for better movement and passing.*	because assumed it would slow travel time and transit and freight would fill HOT lane, not allowing GP to buy in – this may be a reasonable outcome for Seattle's goals.	throughput and reliability for people and goods on tolled facilities, careful design to avoid transferring traffic onto non-tolled routes	throughput and reduce time delays for freight operations. Higher variable tolls may impact industry operating costs which would have to be calculated against operational gains in delivery and shipment reliability. Also offers greater reliability over a greater time period for operational considerations.	reduce time delays for freight operations. Higher variable tolls may impact industry operating costs which would have to be calculated against operational gains in delivery and shipment reliability. Also offers greater reliability over a greater time period for operational considerations.	area charging, but likely to ignore major arterials	and reliability for goods and services, but offset by some local network diversion	
Tolling plans are equitable and just and offer reasonable alternatives including improved transit	No Impact	MEDIUM: Alternatives routes exist but may not be practical in reducing GHG emissions due to longer travel time, variable pricing reflects demand in peak periods which would allow a time shift for lower income groups. However, current plans do not include funding for transit services.	MEDIUM: Alternatives exist but HOT rather than toll lanes arguably discriminate on basis of occupancy, when evidence of HOV effectiveness is low. Alternatives on the facility due to options being free or tolled lanes to driver. No evidence of lower class being disadvantaged in studies and data collected from SH 167 and other HOT lanes in CA, Utah and VA. Demographics o users match free-lanes.	MEDIUM: Alternatives exist but HOT, rather than toll lanes, arguably discriminate on basis of occupancy, when evidence of HOV effectiveness is low. Alternatives on facility due to options being free or tolled lanes to driver. No evidence of lower class being disadvantaged in studies and data collected from SH 167 and other HOT lanes in CA, Utah and VA. Demographics o users match free-lanes.	HIGH: Potential to charge according to actual marginal cost on congested routes but such marginal social cost incorporated may impact low income workers. Variable tolls by time of day will help mitigate this impact by offering a time shift to and lower pricing to drivers from low income brackets.	HIGH: Potential to charge according to actual marginal cost on congested routes but such marginal social cost incorporated may impact low income workers. Variable tolls by time of day will help mitigate this impact by offering a time shift to and lower pricing to drivers from low income brackets.	HIGH: Potential to charge according to actual marginal cost on congested routes but such marginal social cost incorporated may impact low income workers. Variable tolls by time of day will help mitigate this impact by offering a time shift to and lower pricing to drivers from low income brackets.	LOW: Area charging is a blunt tool, but alternatives may exist for others such as private parking as part of a residential or office complex	HIGH: Potential to charge close to marginal cost on individual links	HIGH: Can charge by marginal cost, charging less at off peak and low demand. Transit operations redesigned to provide better alternatives
Maintains economic health of the region	No Impact	LOW: Enhances network utilization, but low net impact because bridge is a	LOW: Enhances network utilization. Modest net impact as time savings are low for users and may impact regional	LOW: Enhances network utilization. Modest net impact as time savings are low for users and may impact regional	MEDIUM: Would relieve main arterial routes, improve travel time, reliability, and vehicle	MEDIUM: Would relieve main arterial routes, improve travel time, reliability, and vehicle	MEDIUM: Would relieve main arterial routes, improve travel time, reliability, and vehicle operating	LOW: Localized impacts, and may be too blunt to target marginal costs effectively. May discourage efficient	MEDIUM: Relieves most strategically important network	HIGH: Reduces externalities of emissions and pollution by managing congestion and vehicle operating costs

Seattle Interests	Baseline	SR520 Tolling Analysis	#1A – HOT Lane Network (3+ HOV Exemption) 4-County Region HOV System	#1B – HOT Lane Network	#2 – Selected Facility Tolling – No AWV Toll	Selected Facility Tolling + AWV Toll	Selected Facility Tolling + Downtown Cordon	#3 – Area Pricing/Parking Charges	#4 – Freeway Network Tolling	#5 – Full Network Tolling
		replacement. Economic benefit in user time savings.	**through trips.**	**through trips.**	**operating costs. Variable tolling by location and time of day would provide greater time shifts to decrease peak travel and provide greater ridership to public transportation, thereby increase economic benefits.**	**operating costs. Variable tolling by location and time of day would provide greater time shifts to decrease peak travel and provide greater ridership to public transportation, thereby increase economic benefits. Increased land value in CBD would improve local GDP.**	**costs. Variable tolling by location and time of day would provide greater time shifts to decrease peak travel and provide greater ridership to public transportation, thereby increase economic benefits. Increased land value in City Center would improve local GDP.**	**usage**		

Chapter 4. Conclusions and Next Steps

4.1 Conclusions

Congestion charging is emerging in major congested cities worldwide and has not been discontinued in a city where it has started. It has been used to support a variety of policy purposes (demand reduction, GHG emissions reduction, and revenue generation for transportation improvements).

This study provided Seattle with a good background on the structure and opportunities for tolling. It helped Seattle establish its tolling interests and identified key elements of tolling to advocate for in regional and state tolling efforts. Below are recommendations for particular elements that Seattle may want to advance in future tolling analyses (at both a regional and municipal level).

4.2 Next Steps

As the City of Seattle considers next steps to implement variable tolling and use it to help reduce GHG emissions, key activities will include:

- Incorporating Seattle's tolling interests into City policy on tolling
- Shaping development of regional pricing projects using Seattle's tolling interests
- Addressing legal constraints on the use of toll revenues to a corridor
- Initiating simple and direct communications to the public on the current and future levels of congestion to raise awareness of the problem and describe opportunities for improvements through tolling and through a focus on moving people and goods

Collectively, these steps will help guide the City of Seattle toward policy decisions that will reduce GHG emissions, encourage economic vitality, equitably serve users, and support a sustainable transportation system.

As described at the end of Chapter 3, moving forward, it may be worthwhile to incorporate the following scenarios into future tolling model analyses:

- HOT lanes with 1-lane and 2-lane options
- Selected facility tolling combined with HOT lanes (1- and 2-lane options)
- Selected facility tolling, freeway system tolling, and full system tolling in combination with parking charges

4.3 Eco-Point: A tolling alternative

Seattle may wish to further develop and study an alternative to tolling; the Eco-point concept. Based on prior work by Booz & Company in Hong Kong, the idea of carbon trading for individual transportation needs was originally developed in 1998/99. In this concept, individual trips into or out of the tolling area or zone would be charged in "eco-points," in lieu of currency. The driver would purchase eco-points equivalent to dollars and cents. In turn, a user would pay cash or eco-points for the journey by car, bus, tram, light rail, or heavy rail. Each mode of travel would be assessed and fares would be set by environmental impact. A journey by a cleaner car would cost less than a journey by a higher emissions vehicle. A bus trip would cost less (in eco-points, separate from fare) than a car, and a rail trip lower than a bus.

Eco-points would be consumed or saved based on individual travel behavior or modal choice. For example, by taking the bus or train to work on Monday to Thursday, eco-point savings would pay for the Friday trip by private car.

In another variation, users would accrue eco-points much like air travel points. Each journey by mode would amass points into an individual's eco-bank. With today's electronic toll collection systems, smart cards, and other computerized payment systems, an eco-bank could be identified with a personal account number that an individual could later use for credit to purchase additional journeys or trade accrued credits to others for cash.

Another variation is that all residents and workers in a tolling area, cordon, or zone would automatically be allocated a limited number of eco-points on a monthly basis. Points can be used to off-set a limited number of trips, for example, five car trips per month into the toll area. Should they commute by bus, eco-points would get them 8 bus trips or 10 rail trips. Biking or walking would result in trading or selling credits to another traveler in need of eco-points. This would encourage efficient travel modes, reward environmentally friendly mode-users, and help mitigate emissions for a more sustainable environment. Eco-points could be purchased or accrued in levels, with higher charges for larger consumers (similar to water and energy pricing). For example, the first 100 eco-points awarded for the month into the users account could be free. The second block of eco-points purchased after consumption of the first free allocation could be at a set price. The third draft of eco-points could escalate to a higher cost and so forth. In this manner, individuals with free or lower-cost points can carry over and aggregate eco-points. Likewise, the eco-point holder, due to their environmentally friendly approach to individual travel, can amass points and sell them to those looking to purchase more eco-points. Thus, the system encourages and monetarily rewards environmentally friendly behavior by those wishing to trade below their next draw of eco-points at higher rates due to previous consumption.

Implementation of such a system could possibly raise less revenue than tolls, but it could also significantly reduce VMT, congestion, and emissions. An option for program management is to create an independent agency that receives a small proportion of the cost of traded permits to fund system administration.

4.3.1 Designing an Eco-Point System for Seattle

The overview of an Eco-Point program is meant to present the concept of individual carbon trading to the discussion about tolling in Seattle. It has merit for the individual as a reward and charging system rather than a pure tolling system.

Administration: The technology used would be similar to the technology and back office needed to run a tolling system. The technology would need to be more ubiquitous, such as cell phone administered billing rather than car transponder systems. Eco-point payment could be integrated into both tolling transponders in cars as well as transit passes. A transit user reloading funding in his/her ORCA transit pass card could also purchase eco-points. One can imagine future transit pass and ticket machines, such as those in the Metro DC subway, evolving to handle eco-point transactions.

While the concept would need to be further defined, it is addressed here to stimulate thought and consideration. If the eco-point system has interest, it can be developed further in a follow-up study.

Future studies could:

- Further explore technology and billing system methods and possible partnerships between agencies.
- Compare the revenue, travel time savings, and GHG reduction generated from tolling to the revenue, travel time savings and GHG reduction generated through an eco point program.
- Analyze distance-based charges with standard consumption for different vehicle emission categories and higher consumption at peak times.

Appendix A: Pricing and Tolling Terminology and Options

Terminology

The following terms and definitions provide descriptions of terminology used in tolling and pricing as well as information on locations where pricing strategies have been applied.

Area-wide Tolls – Per-mile charges on all roads within an area. Charges may vary by level of congestion, vehicle type, location, and time of day.

Automatic License Plate Recognition (ALPR) – Software that enables authorities to match a vehicle license plate with identity information in registration data.

Figure A-1: Example of ALPR Image

Barrier System – A toll system, parking facility, etc. where the customer must come to a partial or full stop at a barrier until the payment has been processed.

Car Sharing – Automated hourly neighborhood car rentals that substitute for car ownership. By sharing a car, individuals eliminate fixed monthly expenses such as loan and insurance costs, and instead incur a variable payment based on usage.

Cash-Outs – Strategies that involve cash payments to deter the use of parking or cars:

Parking cash-outs involve employers offering employees the option of receiving taxable cash in lieu of free or subsidized parking provided by the employer. Employees may deny the cash and keep the tax-free parking subsidy or accept tax-free transit or vanpooling benefits in its place, with any balance in taxable cash. Parking cash-outs have been evaluated locally, in King County, WA.

Car cash-outs involve paying multiple-car households to use one less car for a certain period of time. It helps people review their transportation choices and see how travel by foot, bicycle, transit, and ridesharing is competitive with private automobile use. Car cash-outs have also been implemented in Seattle, WA.

Closed Barrier System – A facility with both mainline toll barriers and ramp toll plazas, placed so that no toll-free movement is permitted (e.g., Sam Houston Tollway in Houston and E-470 in Denver).

Closed System – A system that monitors entrances and exits and calculates tolls based on distance traveled.

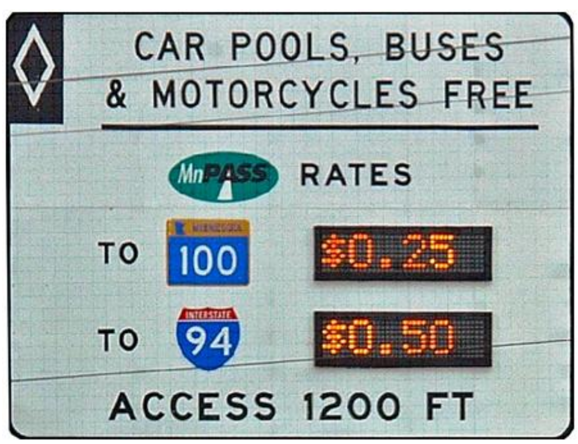
Congestion Pricing – Also called v*ariable tolling, road pricing,* or *value pricing*. Demand- or market-based strategy to manage congestion by charging higher or lower prices based on congestion levels and locations, with the intent of reducing peak-period vehicle trips. Tolls may vary based on a fixed schedule or they may be dynamic. Dynamic rates change with congestion levels at a particular time. Congestion pricing can be implemented when road tolls are implemented to raise revenue or on existing roadways as a demand management strategy to avoid the perceived need to add capacity. Some highways have a combination of un-priced lanes and value-priced lanes, allowing motorists to choose between driving in congestion or paying a toll for an uncongested trip. The latter is a type of *Responsive Pricing*, intended to change consumption patterns. Congestion pricing in use or being considered in the United States include HOT lanes, express lanes, roadway tolls, cordon pricing, area-wide pricing, truck-only tolling, parking charges, emission charges, and VMT charges.

Cordon Tolls – Fees paid by motorists to drive within or into a congested area within a city. In some cases, cordon tolls apply only during peak periods. Cordon tolls can be assessed by requiring vehicles driven within the area to display a pass or by tolling at each entrance to the area. Cordon pricing has been implemented in Singapore and Stockholm. In Norway, cordon pricing has been implemented to generate revenue to fund transportation investment. In Italy, access control has been implemented in 18 cities (including Rome, Florence, Bologna, Siena, Pisa, Torino, Mantua, and Padua; it is being studied in Milan) to manage congestion through a permit system for inner-city zone access, with exemptions for residents, nominated customers of businesses, or users of medical facilities. Cordon tolls are under study in Lee County, FL.

Dynamic Message Sign (DMS) – See Variable Message Sign.

Dynamic Pricing – Tolls that may increase or decrease as necessary to manage demand and ensure that lanes are fully utilized to maintain free-flowing traffic levels.

Figure A-2: MnPass Dynamic Pricing



Electronic Toll Collection (ETC) – The collection of tolls based on the automatic identification and classification of vehicles using electronic systems.

Express Lanes – A naming convention used to differentiate lanes from other types of *ETC* lanes. An *express lane* is an *ETC* lane where vehicles pass the collection point at highway speeds without stopping. Orange County, CA (SR 91) provides one example of express lanes currently in operation. Express lanes are under study in San Diego, CA (I-15 HOT lane extension, vehicle enforcement on I-15 managed lanes); Santa Cruz, CA (Route 1 median lanes); Denver, CO (C-470 express toll lanes); Lee County, FL (priced queue jump lanes); Raleigh/Piedmont, NC (I-40 HOT lanes); Portland, OR (Hwy 217 express toll lanes); Dallas, TX (LBJ Freeway managed lanes); Houston, TX (I-30/Tom Landry Freeway and Katy Freeway managed lanes); and San Antonio, TX (I-35 managed lanes).

Figure A-3: I-15 Express Lanes in San Diego, CA

Fast and Integrated (or Intertwined) Regular (FAIR) Lanes – FAIR lanes involve separating freeway lanes, typically using plastic pylons and striping, into "fast" lanes and "regular" lanes. Fast lanes are electronically tolled express lanes, with tolls set dynamically, in real time, to limit traffic to the free-flowing maximum. Regular lanes are free, but more congested than fast lanes. In regular lanes, drivers with transponders are compensated with credits. Credits can be used as toll payments on days when drivers choose to use the fast lanes, or as payment for transit, paratransit, or parking at commuter park-and-ride lots in the corridor. FAIR lanes, with dynamic ridesharing, are being studied on I-580 and I-680 in Alameda County, CA.

Flat Tolls – Charges fixed at a flat rate, generally to raise revenue, rather than manage demand or congestion.

HOT Lanes – On HOT lanes, low-occupancy vehicles are charged a toll, while HOVs can use the lanes free or at a discounted toll rate. HOT lanes create an additional category of eligibility for people wanting to use HOV lanes. Drivers can either meet the minimum vehicle passenger requirement or they can pay a toll to gain access to the HOV lane. This manages traffic in the HOV lane and maintains an incentive for mode shifting and revenue generation. HOT lanes are operational in San Diego (I-15), Houston (I-10, US 290), Minneapolis (I-394), and Miami-Dade (I-95 lanes are open with toll collection to begin late summer 2008) and are under study in Alameda County, CA (I-880, I-680 SMART carpool lanes), Denver (I-25/US 36), Atlanta (I-75), and the Puget Sound Region (SR 167). In addition, the HOT lane concept can be expanded to convert one or more general-purpose lanes to a HOT lane. The decision to convert must be viewed in the context of overall roadway operation and local objectives that might be achieved by such a conversion. The Federal Highway Administration (FHWA) has recently published guidance to assist decision makers when converting HOV lanes to HOT lanes.

HOV Lanes – Highway lanes typically reserved for vehicles with two or more occupants.

Leakage – Transactions where no revenue is collected, or revenue is not fully collected. (Does not include non-revenue or *violation* transactions where the vehicle is either not permitted to cross the barrier or where a *violation* image is taken.)

Managed Lanes – HOV lanes, HOT lanes, or other types of restricted or special lanes such as truck-only or bus-only lanes.

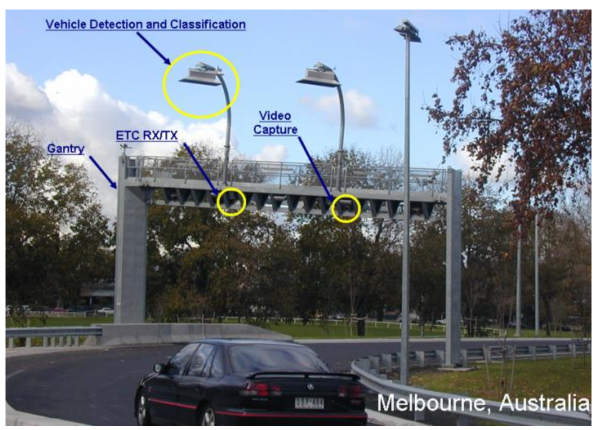
Manual Lane – A toll lane where a toll service attendant is present to accept cash, token, or ticket as payment from a customer.

Mixed-Use Lane – A toll lane where different payment types are accepted (e.g., card-based and electronic toll transactions).

On-Board Unit – Also called an on-board *transponder*. The in-vehicle device component of an ETC system. A receiver or transceiver permitting the *Operator*'s *Roadside Unit* to communicate with, identify, and conduct an electronic toll transaction.

Open Road Tolling (ORT) – An ETC system without toll plazas, where all drivers are charged the toll without stopping, slowing down, or being in a specific lane.

Figure A-4: Open Road Tolling, Melbourne, Australia



Operator – An entity that manages the functions of a tolled facility, parking lot, etc.

Pay-As-You-Drive (PAYD) Automobile Insurance – Converts automobile insurance from a fixed cost to a per-mile cost, providing financial incentive to drive less.

Priced New Express Lanes – Introduction of tolls on added lanes that vary by time of day, may be set dynamically, and are collected at highway speeds using ETC technology.

Pricing – Using tolls to manage traffic demand, with revenue generation being a secondary objective.

Queue Jumps – Roadway facilities that drivers can use to pay a toll to bypass points on the transportation network with severe congestion (i.e., "bottlenecks"). Priced queue jump lanes are under study in Lee County, FL.

Responsive Pricing – Pricing intended to change consumption patterns.

Road Pricing – Also called *congestion pricing* or *value pricing*. A system by which congestion and improved roadways can be managed through different levels of toll rates at peak and non-peak hours, which is also an all encompassing term for all forms of direct road charging.

Roadside Unit (RSU) – The roadside infrastructure component of an ETC system. A receiver or transceiver that identifies the *on-board unit* in vehicles and identifies the account, permitting and electronic toll transaction.

Throughput Volume – Traditionally, the number of vehicles passing through a lane, in one direction, over a defined period of time. When considering throughput, planners may also wish to consider person throughput, which would include the number of persons passing a certain point, including occupants of HOVs and transit vehicles.

Toll – A fee charged by a toll facility operator in an amount set by the operator for the use of the toll facility.

Toll Lane – Restricts traffic flow to facilitate either the automatic or manual collection of tolls.

Toll Plaza – An area with restricted traffic flow where tolls are collected from drivers, either manually or electronically.

Tolling – Charging for the use of a facility, such as a highway, bridge, or tunnel. Traditionally used to support operations and maintenance and to service debt issued to finance the toll facility, with tolls collected at flat rates or based on distance traveled.

Toll Pricing – Strategies that vary toll price by time of day or traffic volume level to manage congestion or use of a facility.

Transportation Demand Management (TDM) – Strategies that increase overall system efficiency by reducing auto trips and vehicle miles traveled by increasing travel options, providing incentives and information to modify individual travel behaviors, or reducing the physical need to travel, thereby encouraging a shift from SOV trips to non-SOV modes, or by shifting auto trips out of peak periods. TDM approaches include pricing and non-pricing strategies:

Non-pricing strategies include ownership restriction, marketing of alternatives, parking restrictions, planning regulations (e.g., limits on parking, location of business/residential parking), travel planning, public transit innovation (e.g., park and ride, integrated ticketing, real-time information systems), teleworking, and urban planning for infrastructure to improve convenience and safety for cycling, walking, and access to public transit.

Pricing strategies include both those that involve tolls and those that do not:

Tolling strategies include usage-based vehicle charges and market pricing of parking facilities, such as the introduction of: 1) tolls on toll-free facilities (e.g., conversion of HOV to HOT lanes, area pricing or cordon tolls, FAIR lanes); and 2) tolls on lanes added to existing highways (e.g., tolls on new general-purpose lanes, tolls on new HOV lanes for vehicles not meeting occupancy requirements, tolls on queue bypass lanes added at intersections on arterial streets) and variable tolls on existing flat-tolled facilities.

Pricing strategies that do not involve tolls include taxes on vehicle ownership (used in Singapore, Hong Kong, and Denmark), taxes on fuel consumption (used worldwide; used to manage congestion in the UK), taxes on parking, subsidies on public transit fares, usage-based vehicle charges (including mileage-based charges for insurance, taxes or leasing fees, and car sharing), and parking or car cash-outs and other parking pricing strategies.

Transponder – The in-vehicle device component of an ETC system. A receiver or transceiver permitting the operator's roadside unit to communicate with, identify, and conduct an electronic toll transaction.

Figure A-5: Transponder for SR 91 Express Lanes

User – Any driver or motorist driving on a toll facility. The user holds the account and on-board unit. The user may use the on-board unit to pay for tolls or services.

Usage-Based Vehicle Charges - Fees for service under which motorists pay for road use based on miles driven on the road system. Usage-based vehicle charges are operational in San Francisco (car sharing) and under study in Atlanta (pricing simulation on the interstate system), Minnesota (statewide variability of fixed auto costs), Oregon (statewide mileage-based road user fees), and in the Puget Sound Regional Council's (PSRC's) global positioning system-based Traffic Choices Study[8].

Value Pricing – Also called congestion pricing, road pricing, or variable tolling. A system by which congestion and improved roadways can be managed through different levels of toll rates at peak and non-peak hours.

Variable Message Sign (VMS) – Also called dynamic message sign (DMS). Changeable message boards located on a facility that display text information on weather and road conditions that may affect traffic conditions and travel times.

8 http://psrc.org/projects/trafficchoices/index.htm

Figure A-6: Variable Message Sign

Variable Tolling – Use of tolls on congested facilities, varied by time of day to encourage some travelers to travel during less congested periods, shift to another mode, or change routes. Charges may vary based on a fixed schedule or on traffic volumes observed over a period of time (e.g., the past week, month, quarter). Charges may also be dynamic and adjust according to traffic conditions, to maintain free-flowing traffic levels. With dynamic pricing, a maximum rate is specified for selected time periods, which alerts drivers in advance. While actual rates vary below the maximum based on real-time traffic on the facility, they are only available as a driver approaches a priced facility. Variable tolling may apply on separated lanes within a highway, such as express toll lanes or HOT Lanes, or on entire roadways. Places where variable pricing is operational include Lee County, FL (for heavy vehicles), the Illinois Tollway, the New Jersey Turnpike, and interstate vehicle crossings on Port Authority facilities in New Jersey. Variable tolling is being studied with open road tolling in Broward County, FL; on the express bus/HOT lane in the Lincoln Tunnel (New York/New Jersey); and on the Pennsylvania Turnpike (Philadelphia). Dynamic variable pricing has been implemented on the SR 91 express lanes in Orange County, CA, and locally on the HOT Lanes on SR 167, between the I-405 interchange in Renton and 15th Avenue SW in Auburn.

Vehicle Miles Traveled (VMT) – The sum of the miles traveled by vehicles in a specified timeframe.

VMT Tolls – A fee for service scheme under which motorists pay based on miles driven on the road system. VMT tolls have been evaluated in Oregon, where they are referred to as mileage fees or road user fees, as a road revenue system alternative to the gasoline tax.

Violation – A record of an unpaid toll that occurs when a customer does not pay the proper amount.

Potential Tolling Options

Several factors define tolling options that can be considered for implementation. Figure A-7 shows the logical options.

Figure A-7: Potential Tolling Options

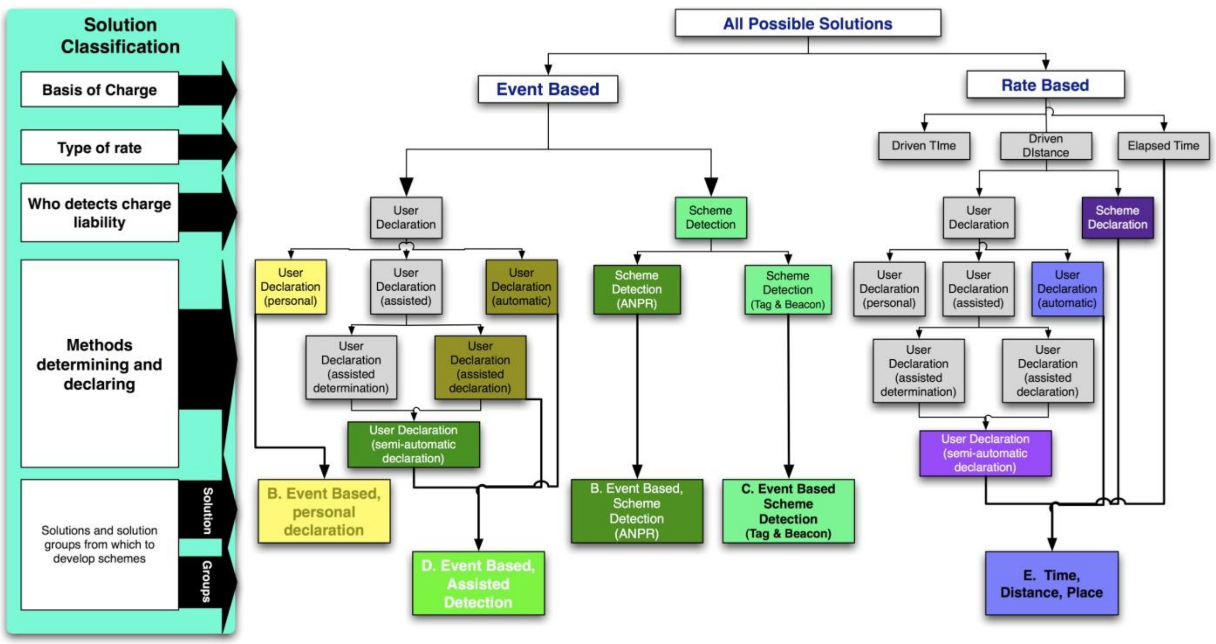
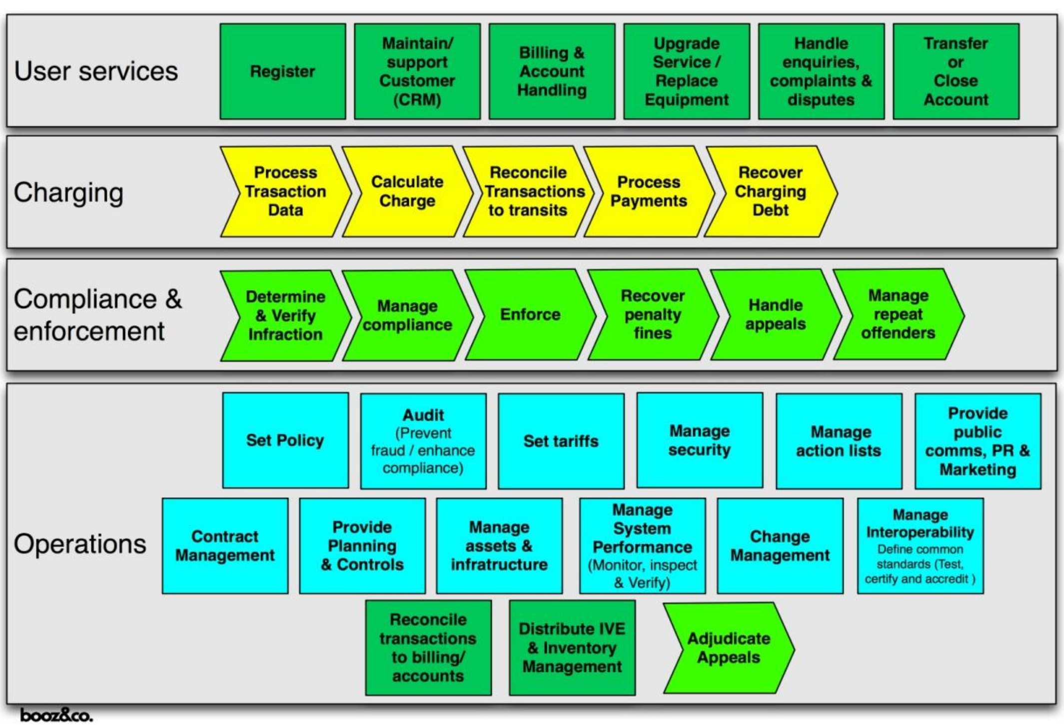


Figure A-8 illustrates the overall functional architecture for a tolling system. Key areas are User Services, Charging, Compliance/Enforcement, and Operations. Under each key area, several sub-functions must be performed or shared to constitute a fully functional system. It provides an example of a tolling functional architecture to be considered when addressing a tolling project, and illustrates the four major functions and their sub-functions.

Figure A-8: Tolling System Functional Architecture



Appendix B: Legislation and Related Area Tolling Studies

Existing Legislation

Legislative programs at both the federal and state levels enable and encourage the use of tolling and pricing strategies to manage demand, allocate costs, improve operation, and generate revenue to reduce congestion and emissions and define alternatives to the gasoline tax.

Federal Legislation

The federal highway and transit reauthorization bill of 2005, SAFETEA-LU, includes several tolling and pricing programs. Of these, five are non-grant programs that provide tolling authority and one (the Value Pricing Program) makes grant funds available:

Value Pricing Program (VPP) – Initially authorized by the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 as the Congestion Pricing Pilot Program. This program was renamed VPP in 1998 by the Transportation Equity Act for the 21st Century (TEA-21) and renewed with the passage of SAFETEA-LU to provide grant funding to encourage implementation and evaluation of value pricing pilot projects to manage congestion on highways through tolling and other pricing mechanisms. VPP has funded over 70 programs to demonstrate:

- *HOV to HOT lane conversions*: HOT lanes create an additional category of eligibility for travelers wanting to use HOV lanes, since drivers can be eligible to use the facility either by meeting minimum passenger requirements or by choosing to pay a toll to gain access (e.g., HOT lanes on SR 167 in the Puget Sound, I-15 in San Diego, I-10 in Houston).
- *Cordon tolls*: Fees paid by motorists to drive in a particular area (e.g., a CBD) and may apply only during peak periods (e.g., being considered in San Francisco).
- Multiple freeway lanes separated into fast and regular lanes, where the fast lanes are electronically and dynamically tolled express lanes. In the unpriced regular lanes, vehicles equipped with transponders are compensated based on tolls in effect at time of travel (e.g., in Alameda County, CA).
- *Pricing on existing lanes*: Convert existing lanes to variable tolling (e.g., variable priced tolls on SR 520 in Seattle).
- *Pricing on new lanes*: Variable tolls on added lanes that may be set dynamically and are collected through ORT (e.g., express lanes and dynamic pricing on SR 91 in Orange County, CA).
- *Pricing on toll facilities*: Variable tolls on congested toll facilities that vary by time of day with the intention of encouraging some travelers to use the roadway during less congested periods (e.g., Illinois Tollway, Florida Turnpike, New Jersey Turnpike, Pennsylvania Turnpike).
- *Usage-based vehicle charges*: Mileage-based user fees or charges for fixed costs such as insurance, taxes, or leasing fees (mileage-based user fees in Oregon, Pay-As-You-Drive insurance in Seattle, variability of fixed auto costs in Minnesota).
- *Cash-out strategies/parking pricing*: Parking cash-outs are offered by employers to employees in lieu of free or subsidized parking; car cash-outs pay households to use fewer cars to help people review their transportation choices and how other modes are competitive (e.g., parking and car cash-outs in King County, WA, San Francisco car share and smart parking initiative).

- *Regional pricing initiatives*: Pricing applications that use technologies to provide drivers with real-time congestion and pricing information on alternative routes, to evaluate the effect of pricing on reducing congestion, altering travel behavior, and encouraging the use of other modes (e.g., regional value pricing evaluations in Virginia, Houston, Dallas).
- *Truck-only toll facilities*: Highway lanes reserved for commercial vehicles, with fees charged when necessary to manage lane performance (e.g., dedicated truck lanes to access the Ports of Los Angeles and Long Beach).

In May 2006, the US DOT announced a multi-mode congestion initiative that includes establishing partnerships with major urban areas to reduce roadway congestion. These Urban Partnerships draw on the experience provided by VPP projects. In fact, VPP funds for 2007 to 2009 have been awarded to five Urban Partnership Agreement (UPA) projects. Seattle's UPA is discussed in Appendix B of this report. The other UPAs are described in Appendix C.

The remaining tolling and pricing programs are non-grant programs that provide authority to toll facilities constructed using federal funds to finance Interstate construction and/or reconstruction, promote efficiency in highway use, reduce traffic congestion, and/or improve air quality:

HOV Facilities – Clarifies aspects of the operation of HOV facilities and provides more exceptions to the vehicle occupancy requirements for HOV facilities. It also authorizes states to create HOT lanes, to convert existing HOV lanes to HOT lanes, and to charge vehicles that do not meet the established HOV lane occupancy requirements if the agency meets criteria for enrolling participants, collecting tolls electronically, managing demand by varying tolls, and enforcing violations. Tolls may be charged on both Interstate and non-Interstate federal facilities.

Express Lanes Demonstration Program – Permits tolling on selected demonstration projects to manage high levels of congestion, reduce emissions in a non-attainment or maintenance air quality area, or finance added Interstate lanes to reduce congestion. Fifteen projects are authorized from 2005 through 2009 to collect a toll from motor vehicles at an eligible toll facility for any highway, bridge, or tunnel, including on the Interstate. If an HOV facility is tolled, variable pricing by time of day or level of traffic must be implemented to manage congestion or improve air quality. Variable pricing is optional for a non-HOV facility. In addition:

- Motor vehicles with fewer than two occupants may be permitted to use HOV lanes as part of a variable toll pricing program.
- Automatic toll collection is required in express lanes.
- Toll revenue may only be used for debt service, reasonable rate of return on private financing, operation and maintenance costs, or any eligible title 23 or 49 project if the facility is being adequately maintained.

Interstate System Reconstruction and Rehabilitation Pilot Program – Allows up to three existing Interstate facilities to be tolled to fund needed reconstruction or rehabilitation on Interstate highway corridors that could not otherwise be adequately maintained or functionally improved without tolls. Interstate maintenance funds may not be used on a facility for which tolls are being collected under this program. Two slots have been reserved for I-81 (Virginia) and I-70 (Missouri). One slot is still available.

Interstate System Construction Toll Pilot Program – Authorizes up to three existing Interstate facilities to impose tolls to fund construction of new Interstate highways. Applicant(s) must demonstrate that financing the construction of the facility using tolls is the most efficient and economical way to advance the project. Non-compete agreements are prohibited—a state may not enter into an agreement with a private party that prevents the state from improving or expanding the capacity of adjacent roads to address conditions resulting from diverted traffic. One of the three slots has been reserved for new construction of I-73 (South Carolina, but available to all of I-73). Two slots remain available.

23 USC 129 Toll Agreements – Provides federal participation in five types of toll activities:

- Initial construction (except on the Interstate System) of toll highways, bridges, and tunnels, including approaches to these facilities
- Reconstructing, resurfacing, restoring, and rehabilitation of any existing toll facility
- Reconstruction or replacement of free bridges or tunnels and conversion to toll facilities
- Reconstruction of a free Federal-aid highway (except on the Interstate system) and conversion to a toll facility
- Preliminary studies to determine feasibility of the above toll construction activities.

If Federal-aid funds are used for construction of or improvements to a toll facility or the approach to a toll facility or *if a state plans to reconstruct and convert a free highway, bridge or tunnel previously constructed with Federal-aid funds to a toll facility, a toll agreement under Section 129(a)(3) must be executed.* The toll agreement must require that all toll revenues are used first for debt service, reasonable return on private investment, and operation and maintenance, including reconstructing, resurfacing, restoring, and rehabilitating work. If the state certifies annually that the toll facility is being adequately maintained, the agreement may also provide for the use of excess toll revenues for highway and transit purposes authorized under Title 23.

The issue of whether a toll facility is to become free when debt is retired or at some other time in the future or whether tolls are to be continued indefinitely is a matter to be determined by the state.

Decisions regarding the amount of tolls charged are made by the toll operator subject to requirements under state and local laws and regulations.

Toll Credit for Non-Federal Share – States are permitted to use certain toll revenue expenditures as a credit toward the non-federal matching share of programs authorized by Title 23 (except emergency relief program) and for transit programs authorized by Chapter 53 of Title 49. The amount of credit is based on actual cash outlays by a toll authority for capital improvements to build, improve, or maintain public highway facilities that carry vehicles involved in interstate commerce; it cannot include expenditures for routine maintenance, debt service, or costs of collecting tolls. Eligible improvement activities may be carried out on facilities that have received Federal-aid funding in the past. Credit can be earned only if a state satisfies the maintenance of effort determination—an assessment of a state's non-federal transportation capital expenditures over a 4-year period.

State Legislation

Since 2005, the Washington State Legislature has passed, and the Governor has signed, several bills pertaining to tolling. The following paragraphs provide a brief summary of each bill.

SB 1541 – Transportation Innovative Partnerships Act (2005)

The Transportation Innovative Partnerships Act enabled WSDOT to enter into partnerships with private entities to develop transportation facilities. It directed the WSTC to conduct a statewide tolling feasibility study to determine which state highways and facilities are candidates for development of public-private partnerships. It also directed WSTC to enact rules for the evaluation and selection of public-private partnership proposals. See SB 6091 below for further information.

HB 1179 – Authorizing a Pilot Project for High Occupancy Toll Lanes (2005)

At the same time that the Innovative Partnerships Act was passed, the Legislature authorized WSDOT to pilot a HOT lane on SR 167, with tolls to be established by WSTC. The bill also enabled variable tolling, requiring that tolls be adjusted during peak hours to maintain HOT lane performance of 45 mph at least 90 percent of the time. HOT lane tolls may be used to finance improvements; enforce toll collection; maintain the facility; and increase transit, carpool, vanpool, and trip reduction services.

SB 6091 – Transportation Funding (2005)

This bill appropriated funding for a comprehensive tolling study. It authorized WSTC to conduct a feasibility study of tolling specific transportation facilities or a network of transportation facilities, including the feasibility of value pricing. The study served as the statewide tolling feasibility study required by SB 1541 and as the tolling study necessary to implement toll facilities in a regional transportation investment district. The resulting report was submitted to WSTC on September 20, 2006, and resulted in eight policy recommendations:

1. The WSTC should use tolling to encourage effective use of the transportation system and to provide a supplementary source of transportation funding; to accelerate the implementation of high-cost, high-need projects; to use price differentials to make the most effective use of the system; to convert HOV lanes to HOV/tolled express lanes to optimize performance; and to build additional capacity as tolled express lanes.
2. Tolling should be used when it can be demonstrated to contribute a significant portion of the cost of a project that cannot be funded solely with existing sources and to optimize system performance.
3. Toll revenue should be used only to improve, preserve, or operate the transportation system.
4. Toll rates, including variable pricing, should be set to optimize system performance, recognizing necessary tradeoffs to generate revenue.
5. Tolls should remain in place to fund additional capacity, capital rehabilitation, maintenance, and operations, and to optimize system performance.
6. WSTC, as the state tolling authority, should set policies and criteria for selecting the parts of the transportation system to be tolled, propose the study of potential toll facilities, recommend toll deployments to the Governor and the Legislature, and set toll rates.
7. WSDOT should be responsible for planning, development, operation, and administration of toll projects and operations.
8. Toll systems in Washington should be simple, unified, and interoperable and avoid attended tollbooths, whenever possible.

HB 1094 – Transportation Budget (2007)

The Legislature directed the WSTC to complete a second phase of the tolling study to provide more detail on possible tolling project candidates and for more detailed modeling of tolling options on specific routes and structures. This study, completed in February 2008, identified 28 potential tolling projects and provided six additional policy recommendations as follows:

1. *Consideration of system impacts* – In authorizing tolling projects, the Legislature should consider system impacts of tolling the entire transportation system and not just focus on a specific highway segment.
2. *Pre-construction tolling* – Tolling complex mega-projects before improvements are completed could have benefits for the public and should be considered (e.g., reduction in overall project cost by avoiding interest charges during construction, smoothing traffic flow, and increasing operating efficiency on existing facilities).
3. *Federal waiver for I-90 tolling* – The state should seek a waiver to allow tolling on I-90.
4. *Duration of toll collection* – Tolls should continue for the life of a facility to ensure adequate funding for maintenance and rehabilitation of the facility and to serve as a traffic management tool to optimize traffic flows.
5. *Public awareness and acceptance* – Public education is needed to enable tolling to be used effectively for financing and traffic management.
6. *Effective engagement of the private sector* – Effective private sector engagement is necessary to leverage incentives for cost-effective delivery of major projects through the use of alternative contract vehicles.

Among the 28 recommended projects, short-term opportunities (within 10 years) include SR 520 and I-90 and I-405 Express Toll Lanes. Long-term projects (beyond 20 years) include comprehensive tolling in the Central Puget Sound region, by time of day, combined with active traffic management and increased transit service, and comprehensive statewide tolling to replace the gasoline tax.

HB 1773 – Imposition of Tolls (2008)

House Bill 1773 provides a framework for collecting tolls in Washington, giving the Legislature the authority to impose tolls on unspecified roads and bridges and making the WSTC responsible for determining toll rates, including variable pricing, and reviewing toll operations.

The legislation provides that tolling will be used as a source of transportation funding and to encourage the effective use of the transportation system. The legislation provides the following policy guidelines for tolling:

- Tolling should be used when it can be demonstrated to contribute a significant portion of the cost of a project that cannot be funded solely with existing resources or optimize the performance of the transportation system. Tolling should not adversely impact other portions of the transportation system by diverting traffic to other routes and should consider relevant social equity, environmental, and economic issues and make progress toward the state’s GHG reduction goals.
- Revenue from tolled facilities may be used only to construct, improve, preserve, maintain, manage, or operate the facility in/on which the tolls are collected. “Eligible toll facilities” are defined as portions of the state highway system specifically identified by the Legislature.

- Toll rates must be set to meet anticipated funding obligations, and to the extent possible, to optimize system performance, recognizing necessary trade-offs to generate revenue.
- Tolls on future toll facilities may remain in place to fund additional capacity, capital rehabilitation, maintenance, management, and operations, and to optimize system performance.

These guidelines are to be used by the WSTC in setting tolls. The Legislature reserved for itself the responsibility to authorize the budget and the finance plan, including specific issues such as the amount of financing required for a facility or corridor, the budget for construction and operations financed by tolling, whether and how variable pricing will be applied, and the timing of tolling. The Legislature is the only entity with the authority to impose tolls on an eligible toll facility, which is defined as sections of the state highway system identified by the Legislature. Local authorities are prohibited from imposing tolls on state projects without the permission of the Legislature.

The legislation charges WSDOT with using and administering toll collection systems that are unified, simple, and interoperable and avoid the use of toll booths, and with setting standards for all toll facilities in the state.

HB 3096 – Financing the SR 520 Bridge Replacement Project (2008)

This legislation creates a tolling implementation committee to work with the public to evaluate tolling the SR 520 bridge and directs the committee to consider tolling technology, traffic diversion, and possible tolling on I-90. The study evaluated various issues related to the SR 520 bridge replacement, including the form tolling may take, traffic diversion, tolling and traffic management technology, and partnership opportunities, and also surveyed the public about the project. The final study report was released in January 2009, and can be found on the WSDOT website at http://www.wsdot.wa.gov/Partners/Build520/choices.htm. WSDOT has since sought and received approval from the legislature to toll the existing SR 520 bridge and its replacement. In May 2009, Governor Gregoire signed ESHB 2211, which authorizes 520 tolling to begin in 2010. (Pre-construction tolling is a requirement of the Lake Washington UPA. To receive federal funds, the US DOT requires approval of a variable tolling policy, legal authority to begin tolling, and implementation of variable tolling on the SR 520 bridge project.)

The legislation further specifies that the SR 520 bridge replacement and HOV project must include six lanes, including two for transit and HOV use and four general-purpose lanes. The project finance plan must recognize funds from designated sources—state and federal ($1.7 billion); tolling revenue, including early tolls that could begin in 2009 ($1.5 to $2 billion); federal UPA funds ($85 million); and private and other governmental sources. It must also recognize savings from early construction of traffic improvements and a single string of pontoons to support the six lanes; pre-construction tolling to reduce total financing costs; and deferral of sales tax paid on construction of the project.

Congestion Relief Initiative – Seattle's Urban Partnership Agreement (UPA)

Figure B-1: USDOT-Designated Final Urban Partners

The National Strategy to Reduce Congestion on America's Transportation Network (the "Congestion Initiative") was initiated by the US DOT to develop aggressive and innovative strategies to reduce congestion and the rate of growth of congestion. Through the Congestion Initiative, the US DOT established UPAs with five cities—Seattle, San Francisco, Minneapolis-St. Paul, Miami, and New York City—to model congestion pricing strategies. The New York City agreement was subsequently withdrawn, and new agreements were developed with Los Angeles, Chicago, and Atlanta through the Congestion Reduction Demonstration (CRD) Initiative. In total, these UPAs are providing $848.1 million in federal funding for comprehensive programs to reduce urban traffic congestion using four complementary and synergistic strategies—tolling, transit, technology, and telecommuting. More information on other UPAS can be found in Appendix C.

Figure B-2: Seattle UPA Project Map

In the Seattle region, the Lake Washington UPA is a collaboration among WSDOT, PSRC, and King County to demonstrate congestion pricing in the Lake Washington Corridor (SR 520, I-90, I-5, and I-405) by tolling SR 520 in advance of construction of a new bridge on SR 520.

SR 520, a major access freeway between Seattle and the eastside, experiences serious congestion between I-5 and I-405, carrying twice as much traffic as it was designed to carry. The SR 520 floating bridge over Lake Washington is vulnerable to earthquakes and windstorms and structurally in need of replacement. While no tolls are currently charged on SR 520, there is agreement among political leaders that bridge replacement is necessary and that toll revenues are required to pay for it. A 2006 WSTC public attitude survey showed 74-percent public support for tolling the SR 520 bridge to pay for its replacement, with tolling more popular than other funding options. To address current congestion, King County, Washington; the PSRC; and WSDOT plan to introduce tolls on SR 520, setting toll rates on the facility at a rate that reduces congestion. Toll rates will be communicated in real time, and revenues from tolling will be used to help finance the bridge replacement and possibly to support transit improvements. The project is to deploy ETC equipment, allowing tolls to be collected at freeway speeds. Tolls will be collected using in-vehicle transponders, with supplemental automatic cameras to read license plates for vehicles not equipped with transponders.

Through the Lake Washington UPA, the US DOT is providing $138.7 million to introduce tolling, transit, and technology strategies to reduce congestion in the Lake Washington Corridor, on SR 520 between I-5 and I-405. Elements of the Lake Washington UPA grant include all four of the target strategies, as summarized in Table B-1.

Table B-1: Seattle (Lake Washington) Urban Partnership Agreement

Project	Source of Funding	Amount of Funding
Tolling (congestion pricing) projects		
Variable pricing on SR 520. The Urban Partner will implement variable pricing (based on the level of demand) on all through lanes of SR-520 between I-5 and I-405 and, to the extent necessary to maintain free flow traffic in the through lanes, on all collectors and distributors for SR 520 between I-5 and I-405. The Urban Partner will provide discounted or free access for vehicles with 3+ occupants.	FHWA's Innovative Bridge Research and Deployment Program	$5.1 million in contract authority funds made available for obligation for FY 2007
	FHWA's Transportation, Community, and System Preservation Program (TCSP)	$24.0 million in contract authority funds made available for obligation for FY 2007
	FHWA's Value Pricing Pilot Program (VPPP)	$10.0 million in contract authority funding shall be made available for obligation from either FY 2007, 2008, or 2009; such funding will be made available no later than FY2009, subject to availability for obligation
	Research and Technology Administration's (RITA's) ITS Operational Testing to Mitigate Congestion (ITS-OTMC) Program	$23.9 million in funds appropriated when needed and available, but in any event no later than the end of FY 2009; funding subject to appropriation
Transit projects		
Enhanced bus service along SR 520. The Urban Partner will expand transit capacity along SR- 20 by adding 90 one-way peak period trips on core and other supporting bus routes operated by King County Metro and Sound Transit. **New transit improvements along SR 520 corridor**. The Urban Partner will construct transit facilities to include stops/stations/terminals, expansion of existing park-n-ride lots, and the provision of real-	FTA's Bus and Bus-Related Facilities Discretionary Grant Program ("Section 5309")	$41.0 million in funds appropriated for FY 2006 or FY 2007

Project	Source of Funding	Amount of Funding
time information signs at transit stations to support the tolling of SR 520.		
Improvements to regional ferry service. The Urban Partner will carry out a number of projects to improve regional ferry boat service, as described in applications filed for funding under FHWA's Ferry Boat Discretionary Program.	FHWA's Ferry Boat Discretionary Program	$27.4 million in contract authority funds made available for obligation for Fiscal Year 2007
Technology projects		
Real-time multi-modal traveler information. The Urban Partner will use ITS technology to provide real-time traveler information (including current toll rates) for SR 520 and the Lake Washington corridor. Dynamic message signage prior to traveler decision points will provide current toll rates and opportunities for re-routing in order to access alternate travel routes (I-90, I-405, I-5). **SR-520 active traffic management.** The Urban Partner will implement technology to provide active traffic management of the Lake Washington Corridor (SR 520, I-90, I-5 and I-405).	RITA's ITS-OTMC Program	$23.1 million in funds appropriated when needed and available, but in any event no later than the end of FY 2009; funding subject to appropriation

Under the Lake Washington Urban Partnership timeline, the SR 520 tolling project plan would be considered by the Legislature in the spring of 2009 and could be launched as early as the fall of 2009.

In addition to setting tolls based upon demand and deploying electronic tolling technologies, the Puget Sound region is committed to using active traffic management techniques that allow incident detection, facilitate the removal of disabled vehicles, and provide travelers with real-time information about traffic conditions, such as through 511 and electronically changeable roadway signage. Variable speed limit signs are being installed to facilitate smoother traffic flow during peak travel periods.

Transit improvements are also deployed to reduce congestion and provide travelers with real alternatives to driving and paying congestion tolls. Twenty 60-foot and twenty-five 40-foot hybrid buses are being purchased; the addition of real-time bus arrival information signs will improve seven stops; and two stops will receive improved passenger shelters and lighting. Park-n-ride facilities are being expanded by replacing a 613-space surface parking lot with an 853-space parking garage and by building a new 386-space parking garage.

The UPA also provides expanded opportunities to travel by ferry and reduce the use of surface transportation modes. Ferry investments are being made to support the Mukilteo multimodal terminal; provide high-speed, ultra-low-wake passenger ferries and other vessels; enhance passenger-only ferry service to and from Vashon Island; bolster the Kingston Express ferry service; support a Pierce County ferry system; and repair the Guemes Island ferry dock.

Using existing local resources, the region has also committed to build on existing commute reduction programs; encourage employer-based programs to reduce rush-hour traffic demands; and expand telecommuting opportunities, flexible work schedules, ride sharing, and TDM by increasing outreach to employers and transportation management associations (TMAs) about alternative transportation options and incentives to use them, and by providing improved traveler information and trip planning services to employees. Marketing of the region's Guaranteed Ride Home program, which serves transit commuters and carpoolers who need to return home in an emergency, will be expanded.

Destination 2040 – Puget Sound Coordinated Pricing Activities

The Regional Congestion Coordinated Pricing Work Team is composed of staff members from PSRC, WSDOT, King County, and the Seattle DOT. In 2008, this team formed with the dual purpose of providing leadership to develop and evaluate pricing scenarios for PSRC's Regional Land Use and Transportation Plan Update (Destination 2030) and ensuring that pricing discussion is coordinated throughout the region and that information is widely disseminated to the public. One of the team's initial activities was to define a series of 12 key questions that cover the spectrum of issues that should be addressed when developing a tolling program or an individual project. The intent of the questions was to allow side-by-side comparison of the tolling concepts and projects to determine which, if any, of the concepts meet the region's objectives to be further defined. The results of investigating the 12 key questions are being used to implement Seattle's UPA with the US DOT for SR 520 and were used to inform the development of recent tolling legislation.

King County Pricing Study Summary

Background

In March 2007, the *Destination 2030 – Taking an Alternate Route* study was completed for King County, Washington. This study was commissioned because regional transportation infrastructure and services are not keeping pace with population, employment, and travel demand growth. This gap is widening because the current transportation finance system—both statewide and within the region—is not generating enough revenue to repair and replace aging facilities or add capacity to meet current and projected demands. Over the next 20 years, the state faces $80 billion in transportation investment needs, with the Puget Sound region accounting for $40 billion of that total. King County's share alone equals $30 billion.

Overall Recommendation

The study recommended charging users of the regional freeway system directly for their use of roads through a Transportation Improvement Fee (TIF). Fees would vary by time of day in proportion to travel volume, and would thereby provide congestion relief during high-demand periods.

Revenue generated by the TIF would be spent to improve travel conditions for corridors within which fees were collected. Transportation improvement revenues could be used to preserve and operate existing facilities, expand transportation capacity, and invest in alternative modes of travel.

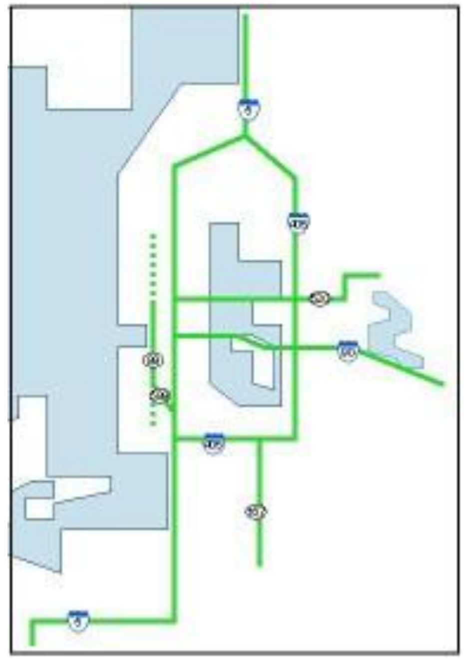
The result would be a travel network with improved mobility, a financially healthier and more environmentally sustainable transportation system, and greater transparency in the use of revenues for the benefit of those paying the fees. Travel decisions would still be left in the hands of the public, but those decisions would be guided by market-based price signals that more accurately reflect the true costs of travel.

Congestion relief would come from three sources:

1. Shifts from SOVs to shared-ride modes (carpools and transit),
2. Shifts of discretionary trips to off-peak periods when the fee would be lower, and
3. Elimination or diversion of some vehicle trips as a result of traveler sensitivity to price.

The improvement fee, in turn, would support multimodal transportation capacity enhancements. Because of the limited scope and timing of this study, travel delay savings were not estimated, but are expected to be substantial based on worldwide experience.

Figure B-3: TIF System Freeways Included in Revenue Estimate



Estimated Revenue

The revenue generated by the TIF would depend on the specific charging schedule selected. It was estimated that a publicly acceptable fee structure would generate between $1.6 billion and $2 billion annually. The TIF net present value (NPV), net of capital and operating expenses, would be approximately $24 billion over 20 years. Figure B-3 depicts freeways in the three-county region included in the revenue estimate.

The base price for use of these freeways would be $1.00 per trip, regardless of trip length. Between 7:00 AM and 7:00 PM, additional charges would be based on time of day and distance traveled. During peak commute periods, charges would range from $2.00 for short freeway trips to $8.00 for a trip passing through the entire region. Given current travel patterns, this means that 64 percent of morning peak-period commuters and 55 percent of evening peak travelers would pay $4.00 or less per trip. Assumptions are that large commercial trucks would be charged at twice the rate of passenger vehicles, whereas transit vehicles and vanpools would not pay the TIF.

Implementation Costs

Initial construction and one-time implementation costs to collect the TIF are estimated to be approximately $80 million. These costs might be substantially reduced through the use of existing WSDOT ramp metering infrastructure (e.g., power, communications, cabinets, signal poles). Annual operating costs are expected to be between 9 and 15 percent of total revenue.

Implementation costs are based on the use of two revenue collection strategies—in-vehicle electronic tag readers (similar to those in use on the Tacoma Narrows Bridge and SR 167 HOT lanes) and automated license plate readers to capture images of license plates of vehicles without electronic tags. Costs assume that electronic tags would be provided at no cost to the owner for all vehicles registered within the three-county region. Other vehicle owners could purchase electronic tags for a nominal fee, if desired. Electronic tags and license plates would be read at freeway entrances and exits included in the TIF system. This would allow computation of distance traveled and the time period during which the trip took place.

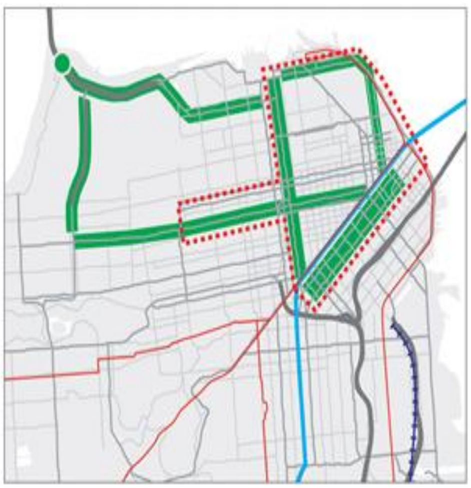
Appendix C: Urban Partnership Agreements (UPAs) and Congestion Reduction Demonstration (CRD) Initiatives

UPAs

San Francisco UPA

On August 8, 2008, the Golden Gate Bridge District directors did not agree to impose a $7 congestion toll on the Golden Gate Bridge as proposed as part of the UPA application. Instead, drivers parking at meters along the route to the bridge will face variable parking fees designed to increase turnover and move long-term parkers to lots and garages.

Figure C-1: San Francisco UPA Project Map



The City of San Francisco's UPA provided for tolling all traffic entering the City from the north, for the express purpose of reducing congestion. The City proposed introducing a variable toll on the already tolled Golden Gate Bridge. Toll rates on the Golden Gate were to be set to keep travel free flowing on Doyle Drive, a congested four-lane, curvy, undivided roadway that serves as the only northern access route for motorists entering the city. Tolling Doyle Drive is also a possibility. If the city does not also toll Doyle Drive, it will need to find other revenue sources to pay for its much needed and expensive reconstruction.

If the City elects to toll Doyle Drive, the US DOT would fund the tolling infrastructure. Vehicle detection on Doyle Drive would be accomplished through either FasTrak transponders or ALPR. Toll rates on Doyle Drive would vary to achieve a 10 to 12-percent reduction of peak-period traffic.

A smart parking system is also part of the San Francisco UPA. This includes variable pricing and guidance in 13 city-controlled garages and on-street parking in three downtown corridors and in the core Civic Center area. Drivers will be required to pay for parking, with prices set such that demand will not exceed capacity. Payment methods in the garages will include FasTrak transponders and TransLink® smart cards. On-street parking pricing will use multiple space meters, with sensors at individual spaces. Payment options will include smart card, credit card, and pay-by-cell-phone. One objective of pricing both garage and on-street parking is to eliminate cruising for on-street parking (a 1997 San Francisco study that showed an average search time for on-street parking of 6.5 minutes, which delayed all traffic.)

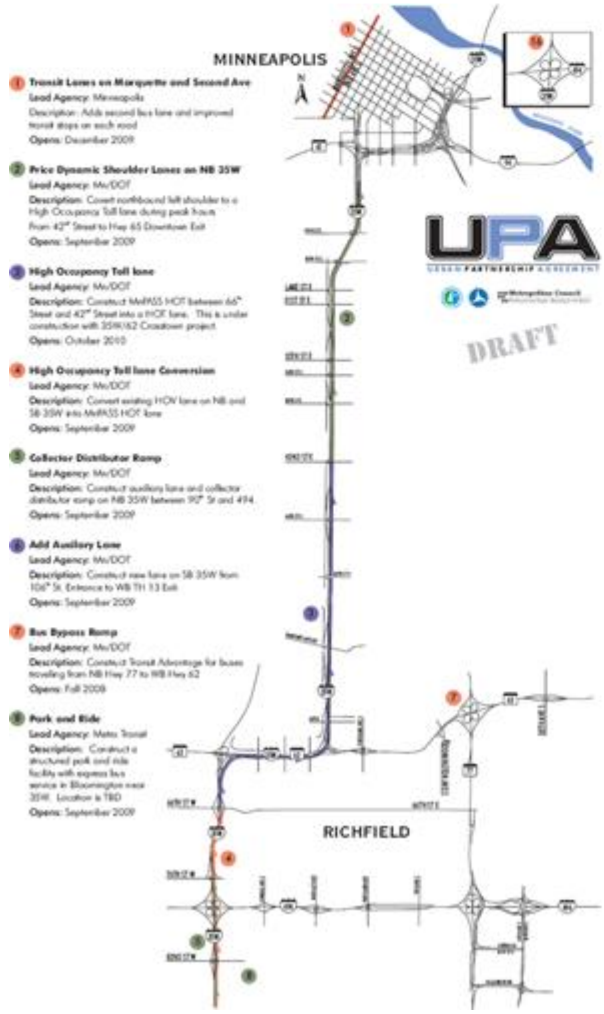
Through the San Francisco UPA, the US DOT will also fund several ITS projects, including an arterial traffic management system that will implement transit signal priority at 500 key intersections, and integrated mobility payment accounts and related infrastructure to support tolling operations and to integrate FasTrak and TransLink® accounts. The regional 511 information system will be upgraded to provide real-time pricing, parking, and transit information.

A number of ferry service improvements will also be carried out. In addition, the program will bolster San Francisco's telecommuting and alternate commute efforts.

Minneapolis-St. Paul UPA

Under this UPA, the Twin Cities metropolitan area will convert narrow bus-only shoulder lanes along the northbound portion of Interstate 35W to wider priced dynamic shoulder lanes (PDSLs), and will move these lanes to the left-most portion of the roadway to minimize conflict with entering vehicles. Buses and HOVs will operate at no charge in the PDSLs with tolled access during peak times to SOVs, with prices set to ensure free-flow travel. PDSLs will enable bus speeds to increase to 50 mph from the current bus-only shoulder lane speeds of 35 mph or less. The longer-term goal is to convert as many miles as possible of the existing 260-mile bus-only shoulder lane network to PDSLs.

Figure C-2: Minneapolis-St. Paul UPA Project Map (Map 1)



PDSLs will link up with new, dynamically priced HOT lanes on Interstate I-35W. The HOT lanes will be extended to create a new 15-mile, dynamically priced managed-lane corridor that connects downtown Minneapolis with communities and major destinations to the south, including the Mall of America, Minneapolis/St. Paul International Airport, and the University of Minnesota.

In the affected corridor, transit will be enhanced and a BRT network will be created.
Enhancements include:

- Additional transit vehicles
- Conversion of the single contra-flow bus lane in downtown Minneapolis to dual lanes (expected to triple bus throughput and reduce bus travel times by an average of 10 minutes for the 665 express buses that serve downtown Minneapolis during the morning commute)
- New bus shelters and amenities
- New BRT stations
- Addition of a bus ramp at an important interchange
- Priority for transit vehicles at signalized intersections
- Electronic next bus signage
- 1,400 park-and-ride spaces and new electronic signage indicating space availability and parking alternatives

Toll revenues will be used in part to provide significant fare discounts for transit riders on trips using the newly priced facilities during peak periods.
The Minnesota Department of Transportation will use advanced technologies to create and manage the PDSLs, including light emitting diode (LED) arrows and in-pavement markings to ensure proper and safe

lane usage, and dynamic lane assignment technology. A system providing direct feedback to bus drivers using shoulder lanes will be extended to cover the new PDSLs. Dynamic message signs will inform drivers about the availability of the lanes for non-bus use, toll rates, travel speeds on the priced versus general-purpose lanes, transit alternatives (e.g., park-n-ride) to driving on the priced lanes, and information about arterial travel alternatives to freeways for drivers trying to avoid priced freeways and to bypass incidents.

The locally-funded telecommuting element of this UPA will expand upon the successful Results-Only Work Environment (ROWE) program. Through ROWE, employers provide employees with the flexibility to telecommute or shift their hours to avoid congested commutes and agree to evaluate employee results, in lieu of requiring physical presence at the worksite at specific times. Approximately 75 percent of Best Buy's 4,500 corporate office employees participate in ROWE and other large employers in the priced corridor will be targeted for participation, with the goal of reducing 500 daily peak-period trips through the corridor.

Figure C-3: Minneapolis-St. Paul UPA Project Map (Map 2)

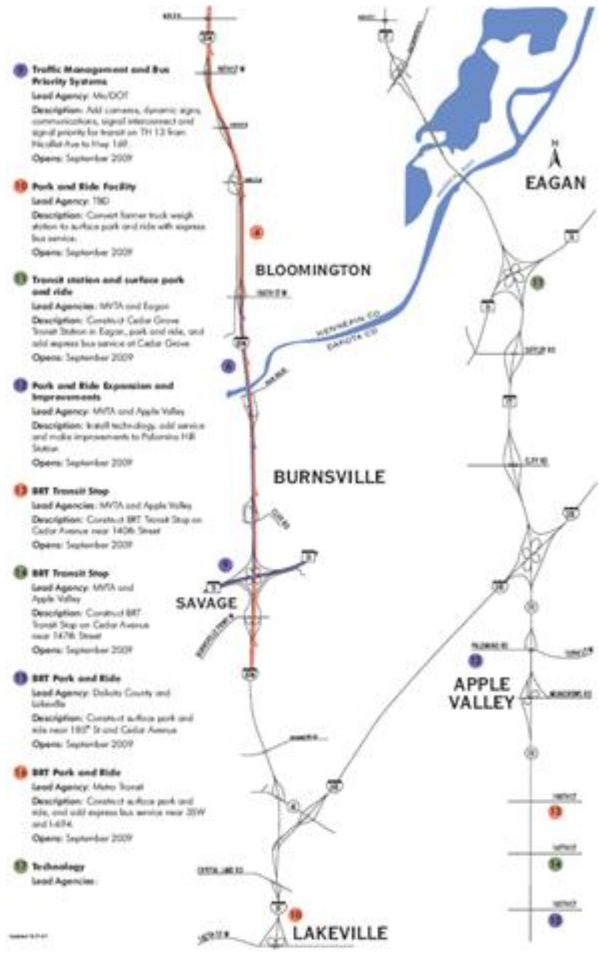


Figure C-4: New York UPA

New York City UPA

On April 7, 2008, the New York State Assembly declined to take a formal vote to provide needed legislative authority to implement the proposed New York City congestion pricing project. The UPA was subsequently withdrawn.

The New York UPA would have made New York City the first U.S. city to implement cordon or area pricing to charge all motorists, with some except-ions, for driving in its congested core. The plan submitted by the Mayor required the approval of a special Traffic Congestion Mitigation Commission, the City Council, and the state Legislature for enactment.

As proposed, the plan was projected to reduce VMT below 86th Street in Manhattan by 6.7 percent. The 3-year pilot would have charged a flat $8 daily fee to passenger vehicles and $21 daily to trucks from 6 AM to 6 PM on weekdays.
Charges would apply for travel on interior surface streets south of 86th Street. Passenger vehicles traveling solely within the congestion zone would receive a 50-percent discount, paying $4 per day; similarly situated trucks would pay $5.50 per day. Charges would not be imposed on drivers who are only using Manhattan's peripheral highways. For drivers using E-ZPass and entering the congestion zone via a tolled bridge or tunnel, toll charges paid on the same day would be rebated to their E-ZPass accounts, eliminating the pricing distortion that leads some motorists to take a more circuitous route into and out of the city to avoid tolled crossings. Toll collection would utilize E-ZPass readers and license plate readers established at entrances to and throughout the congestion-pricing zone.

Following the Traffic Congestion Mitigation Commission's analysis of the Mayor's plan and various alternatives, the Commission approved a modified version, which was projected to lead to a 6.8-percent reduction in VMT below 86th Street and thus remained eligible for UPA funding. The modified congestion-pricing scheme would have applied the charge only to inbound traffic crossing 60th Street. It excluded reverse commutes for drivers returning after 6 PM on weekdays. The plan would not have exempted vehicles using only Manhattan's peripheral highways, but would have exempted trips taking place entirely within the congestion-pricing zone. The modified scheme also added a $1 taxi/livery surcharge for all trips starting or ending in the zone during the congestion pricing hours, increased on-street parking meter rates, created a residential parking permit program, and eliminated the residential parking permit tax exemption within the zone. The modified plan required significantly less charging infrastructure, reducing capital costs from $224 million to $73 million and annual operating costs from $229 million to $62 million, and increasing net revenue to support transit from $420 million to $491 million.

For motorists without E-ZPass tags, an ALPR system with mounted digital cameras to photograph vehicle license plates would be used. All video images of vehicles would be discarded shortly after payment was verified. Drivers would have an option to set up pre-paid accounts, or to pay within 48 hours of the end of the day that the charge is incurred. Those who have not paid within that time period would be fined.

This cordon pricing system, along with the concurrent increases in transit services (e.g., 309 new buses; 3 new bus depots; major ferry service improvements; priority for buses and HOVs on the Manhattan, Williamsburg, and Queensboro Bridges; BRT in five high-traffic corridors; expansion of suburban express bus service and park-n-ride accommodations) and other strategies to speed bus travel (e.g., queue bypass lanes, low-floor buses, left-turn signals) were anticipated to reduce vehicle trips into and within the pricing zone by about 100,000 per day (i.e., 7 percent of the current 1.5 million daily total). Traffic speeds were also anticipated to increase by 7 percent. Expected air quality benefits within the zone included a 9-percent reduction in carbon monoxide, 7-percent reduction in nitrogen oxides, and 12-percent reduction in volatile organic compounds.

Additional strategies included extending real-time traffic signal timing and transit signal priority to all signals, and pedestrian improvements, especially near bus stops and intermodal stations. New York City's CommuterLink regional transportation management association also planned to target employers within the congestion pricing zone to encourage them to increase their employees' use of telecommuting, flex time, carpooling, and transit.

Miami UPA

The Miami-Ft. Lauderdale region is creating a 21-mile managed-lane facility on I-95, between I-395 and I-595, by converting a single HOV lane into two HOT lanes in each direction by narrowing the travel lanes and shoulders. The longer term goal is to provide a network of managed lanes throughout the congested region, by converting flat rate tolls on South Florida's expressways to variable rates based on demand. The managed-lanes network will be used as the backbone of a BRT system subsidized through toll revenues.

Figure C-5: Miami UPA Project Map

Managed Lanes Network Map

Toll rates will change as often as every 3 minutes to maintain free-flowing conditions on the managed lanes at least 90 percent of the time.

The occupancy requirement on HOV lanes was increased from HOV 2+ to HOV 3+ to ensure that the lanes remain free-flowing as HOV demand increases in the future, and to create some excess capacity for priced vehicles. Open access to the HOV lanes will be restricted using delineator posts and only provided at strategic locations, enhancing traffic flow and safety on those lanes. Open road tolling at freeway speeds will use "SunPass" toll transponders and electronic readers and video license plate readers (currently, 63 percent of toll transactions in the region are by SunPass, climbing to 80 percent at certain locations during commute hours). VMS will show the current price for vehicles not meeting the occupancy requirement to use the managed lanes. A camera-based violation enforcement system will be deployed.

In addition to pricing the managed lanes, the Florida DOT is improving traffic conditions in the corridor by installing ramp meters and traffic management cameras coupled with full-service patrols and rescue services.

The I-95 express lanes will be an important part of the BRT service network. For passengers boarding BRT vehicles at the Golden Glades interchange park-and-ride lot and heading the 11 miles south into Miami, bus speeds are anticipated to increase to 50 mph as a result of the corridor improvements, from the current 22 mph. The BRT service network will, in the medium and long term, be far more extensive than just this single corridor. Additional BRT vehicles will be purchased to expand the service and express feeder bus services will be offered. The service network will run on managed expressway lanes and on special-use lanes on three major arterials.

Related improvements will allow transit vehicle priority at 50 signalized intersections, uniquely brand two new express/BRT stations, and construct pedestrian access accommodations at one of the two new stations. In addition, the Chamber of Commerce is leading efforts to encourage telecommuting, flextime, and employer-sponsored ridesharing.

Congestion Reduction Demonstration (CRD) Initiative

In November 2007, the US DOT solicited applications for funding of CRD Initiatives to implement congestion pricing along with complementary transportation solutions, including transit service and innovative technology. Where appropriate, the US DOT may also support jurisdictions with dedicated expertise and/or regulatory flexibility.

Applicants were asked to describe the severity of traffic congestion in the metropolitan area, the community's acknowledgement of the problem, the readiness of the metropolitan area's political leadership to solve the problem, and a solution to congestion that integrates transit, technology, and congestion pricing on highways. Evaluation criteria included the extent to which the proposal would reduce highway congestion; the extent to which the proposal would enable improvements in regional transit service; any incorporation of innovative technology applications; the project's national demonstration value; and the technical feasibility and political probability of the project being implemented by September 2009.

Chicago CRD

In April 2008, the US DOT designated Chicago as a CRD partner under an agreement with the City and the Chicago Transit Authority (CTA) to provide $153.1 million in funds for four new BRT routes along heavily congested corridors in downtown Chicago, which will serve as the first phase of a proposed city-wide arterial BRT network. The $153.1 million is federal funding from several discretionary grant programs, each administered by either the Federal Transit Administration (FTA) or the Research and Innovative Technology Administration (RITA).

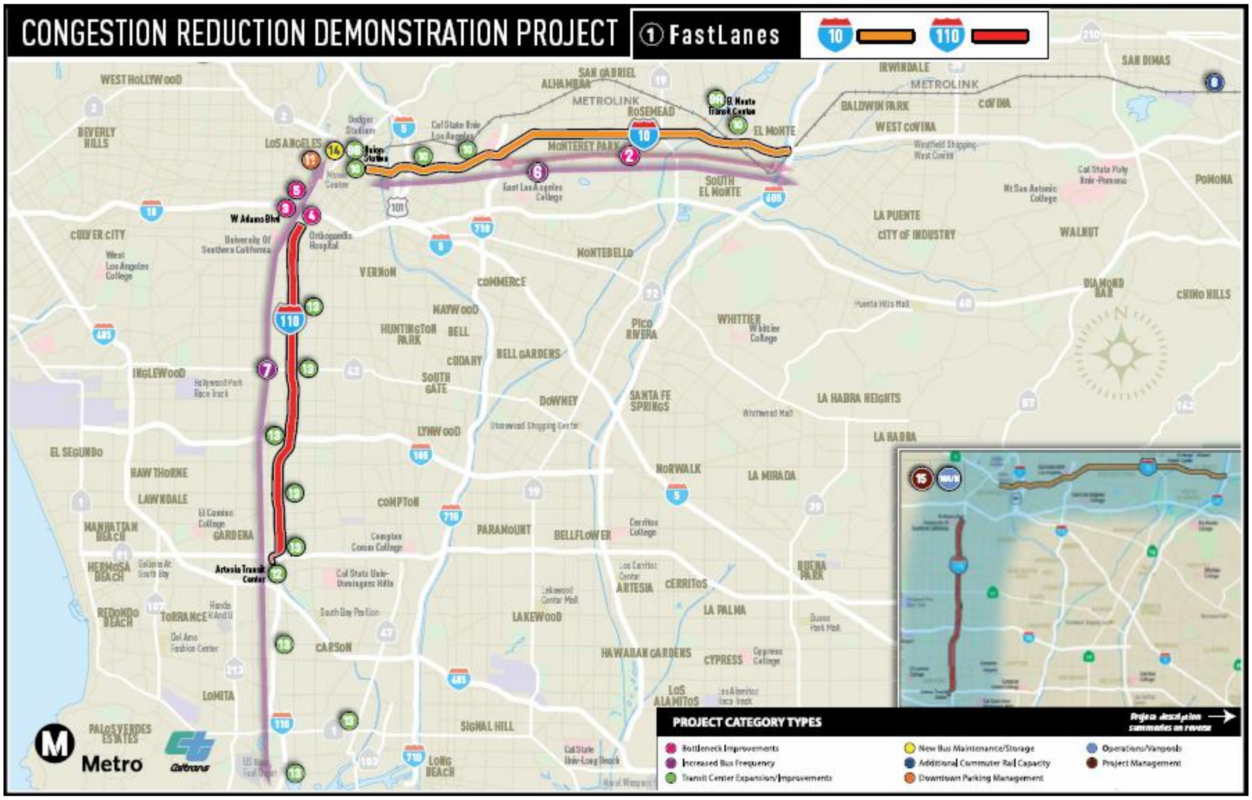
The City will also implement pay-for-use charges on its on-street loading zones, with variable prices to reduce congestion and ensure reasonable availability of commercial loading zone space. Peak-period surcharges will be instituted on off-street non-residential parking, as will variably priced downtown on-street metered parking, to ensure parking availability and reduce traffic associated with drivers cruising to find parking spaces.

Federal funding is contingent, in part, on the City and CTA adopting the necessary legal authorities by December 31, 2008. By the same date, the City must successfully move forward with its plan to privatize the metered parking system and enter into a long-term agreement with a private firm. Further, the City must implement all of the BRT projects, loading zone fees and variable parking pricing by April 30, 2010. The City and the CTA have committed to providing any funding necessary to implement the loading zone fees and the variable parking pricing. The US DOT reserved the right to de-obligate funds for the CRD agreement or to require the return of such funds if these terms are not met.

Los Angeles CRD

Los Angeles was also selected in April 2008 for funding under the CRD Initiative. The agreement among the US DOT, the California Department of Transportation (Caltrans), and the Los Angeles County Metropolitan Transportation Authority (Metro) commits Caltrans and Metro to providing an estimated $131 million in non-federal funding and the US DOT will provide $210.6 million to convert the HOV lanes on I-10 and I-110 to dynamically priced HOT lanes. If funding is available and legal authority is enacted, Caltrans and Metro have also committed to convert the I-210 HOV lanes to HOT lanes. Under the CRD agreement, Los Angeles will enhance it transit service offerings and make reimbursements for congested trips on the HOT lanes. Also under the agreement, the HOT lanes must be in revenue operation by the end of 2010.

Figure C-6: Los Angeles Project Map



To receive funding under the agreement, Caltrans and Metro agreed to:

- Obtain the legal authorities to implement the projects by October 15, 2008 (including the authority to toll the County's freeways)
- Certify the availability of sufficient non-federal funding for the I-10 and I-110 HOV to HOT conversions by September 30, 2008
- Exempt privately operated over-the-road-buses from tolls on the converted facilities if public transportation providers are exempted

Atlanta CRD

In late November 2008, the US DOT announced the award of a $110 million CRD grant to the Atlanta Region Congestion Reduction Partners, which includes the Georgia Department of Transportation, the Georgia Regional Transportation Authority, and the State Road and Tollway Authority. Federal funding will be matched by $37 million in state and local funds.

The grant supports the Atlanta region's long-term goal of implementing an integrated system of congestion-priced lanes, enhanced transit service, and innovative technology. It will fund the conversion, by January 31, 2011, of existing HOV lanes to dynamically-priced HOT lanes on a 14-mile section of I-85 between Old Peachtree Road and I-285. It will also contribute to the completion of an additional 49-mile network of congestion-priced lanes by implementing additional HOV-to-HOT lane conversions along I-85, I-75, and I-20. The grant provides $30 million to help Atlanta purchase new buses and build and expand park-and-ride facilities. The bus service will operate on the new express lanes, providing riders with faster commutes.

Appendix D: Domestic and International Road Pricing Examples

US Road Pricing Project Examples

Most major road pricing projects implemented to date have been outside of the United States. However, there are some examples of variable tolls and HOT lanes projects, many under the FHWA's Value Pricing Pilot Program, as discussed in Appendix A of this report. The four most widely known projects are SR 91 Express Lanes in Orange County, California; I-15 in San Diego; State Route 91 in Orange County; and I-394 in Minneapolis. A short description of each follows.

SR 91 Express Lanes – Orange County, California

The SR 91 Express Lanes were built by a private company in ten miles of the median of SR 91 and began operations in 1995. In 2003, the Orange County Transportation Authority (OCTA) purchased the project. There have been recent discussions about extending the Express Lanes into Riverside County, California, and connecting with I-15.

I-15 – San Diego, California

The I-15 Express Lanes (FasTrak) opened in January 1997 as a 3-year FHWA value pricing demonstration that has been operational since transitioning from HOV-only to HOT express lanes in January 2000. The original facility was an 8-mile, two-lane, reversible HOV facility. With over 10 years of operational experience, the San Diego Association of Governments (SANDAG) will expand the existing reversible facility to four bi-directional HOT lanes with multiple intermediate access locations of over 20 miles in length. The newest 4.5-mile section opened on September 23, 2008. The project objectives are to:

Provide additional highway capacity on what had been a largely underutilized HOV facility.

Provide better management and utilization of the HOV lanes.

Achieve and maintain LOS C or better.

Generate enough revenues to support ongoing operations and maintenance.

Support new express transit service through toll revenues.

Improve highway and transit in the corridor.

Extend the original reversible lane segment to include an additional 12 miles of converted HOV lanes into an HOT corridor.

I-394 Express Lanes – Minneapolis, Minnesota

The I-394 Express Lanes, better known as MnPass, became operational in May 2005 and serves downtown Minneapolis and the western suburbs. Minnesota DOT identified multiple access strategies to accommodate its system configuration, very restricted access for the 3-mile reversible segment, and multiple access points for the 8-mile concurrent flow segment. Besides safety considerations, separate pricing strategies were implemented to manage demand in each section.

The project objectives are to:

- Improve efficiency of I-394 and increase person and vehicle carrying capabilities of the HOV lanes.

- Maintain free-flow speeds for transit and carpools.
- Improve highway and transit operations in the corridor with the revenues generated.
- Use ETC without toll booths.
- Employ dynamic pricing and in-vehicle electronic enforcement

I-25 Express Lane – Denver, Colorado

The I-25 Express Lanes opened in June 2006. Like SANDAG's I-15 Express Lanes, I-25 Express Lanes consist of two segments—a 2-mile reversible segment and a 7-mile barrier-separated HOT lane segment serving downtown Denver. The project objectives are to:

Improve the efficiency and capacity of I-25 HOV/HOT lanes.

Expand the menu of travel options to the motoring public.

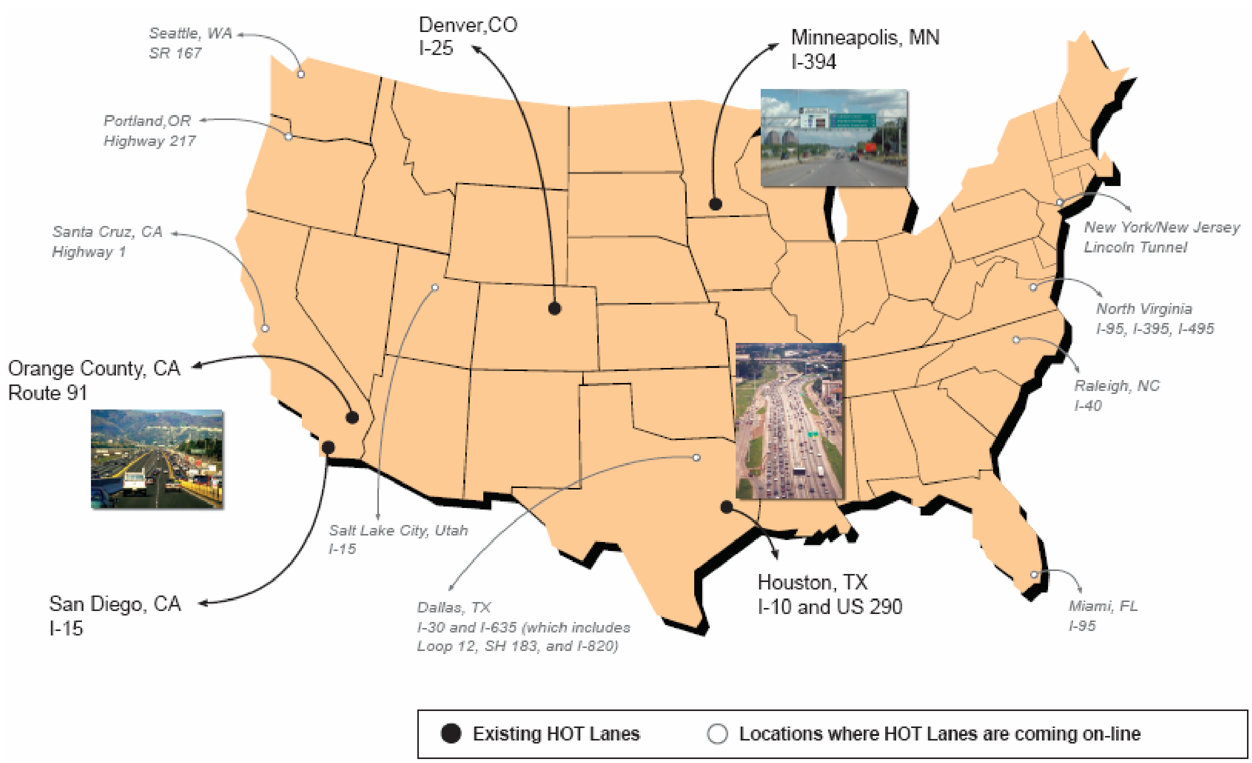
Use the facility as a showcase congestion management tool.

Generate sufficient revenue to cover operating expenses.

Denver also levies tolls on E-470 and the Northwest Parkway. E-470 is a toll highway that runs along the eastern perimeter of the Denver metropolitan area. The 47-mile beltway extends from State Highway C-470 at I-25 in Douglas County south of Denver, runs east and then north through Aurora, passes along the western edge of Denver International Airport, and turns west, terminating at I-25 on the north end of the metropolitan area and connecting to the tolled Northwest Parkway.

Figure D-1 shows a national map of existing HOT lane facilities in the United States, as prepared by the WSDOT.

Figure D-1: Existing HOT Lane Facilities



International Road Pricing Projects Summary

The following tables summarize the five major road-pricing projects in London, Singapore, Oslo, Stockholm, and Milan. Source information was in UK pounds that were converted to US dollars in this report based upon an early September 2008 conversion rate of 1 UK pound = 1.77 US dollars. Some amounts have been rounded for convenience.

Table D-1: International Pricing Examples – Operating Characteristics

	London	Singapore	Oslo	Stockholm	Milan
Geographical Application	Central London and 90% of the eastern side of the Royal Borough of Kensington and Chelsea with a free route through Park Lane running north south through the (almost) center of the zone	Greater CBD (also expressway charges)	Greater CBD/new toll routes	Greater CBD across peninsulas/island	CBD
Type of Project	Area charge	Cordon and specific routes	Cordon and new tolled roads	Cordon	Cordon
Time of Operation	07:00-18:00 Weekdays only excluding weekends and bank holidays	07:30-10:00, 12:00-20:00 weekdays and 12:00-18:00 Saturdays (CBD only)	24/7	06:30-18:30 Monday to Friday	07:30-19:30 Monday to Friday
Start-Up Date	February 2003	1998 electronic (1975 manual)	1990	2006 trial, August 2007 in service	2008
Basis of Charge	Flat. Declaration based	Time, location, vehicle class (space) according to congestion, varies by direction. Detection based	Time, vehicle type (wear/tear), cost of financing road; tag vs. declaration vs. post-pay, Detection and declaration based	Time according to congestion, both directions. Detection based	Vehicle Pollution class. Detection based
Exemptions/Discounts	Buses, taxis and registered private hire vehicles, emergency service vehicles (and some Police and LFPA operational vehicles that meet certain criteria), powered two-wheelers, some local authority operational vehicles such as domestic refuse collection vehicles, social services vehicles and street	Emergency vehicles	Emergency vehicles, buses, fully electric vehicles, drivers with a disability exempt; discounts for 1/6/12-month subscriptions; monthly cap on the amount that can be charged to a vehicle.	Exemptions for emergency vehicles, buses, people with disabilities, military, alternative fuel, motorcycles, foreign, residents of Lidingo Island	Exemptions for mopeds, scooters, motorbikes, people with disabilities. Discounts for multi-day, prepaid value, or annual eco-passes (available to residents only).

	London	Singapore	Oslo	Stockholm	Milan
	cleaning vehicles, port, armed forces, breakdown services. Residents' vehicles are discounted at 90% and are given to all qualifying residents including the entirety of RBKC despite only 90% of the Borough being in the western extension, alternative, bi-fuel, and electric vehicles and, and vehicles of people with disabilities, including those modified for disabled use. $1.77 discount for fleet vehicles ($12.40/day), 9+ seaters and motorized tricycles.				

1 Singapore LTA
2. http://www.lta.gov.sg/motoring_matters/index_motoring_erp.htm"

Table D-2: International Pricing Examples – Policy and Technology Features

	London	Singapore	Oslo	Stockholm	Milan
Through Traffic Alternatives	Ring road around areas (north-south through route)	Some free routes parallel to charged ones	None	Freeway through cordon	None, roads around cordon
Demand Management/ Traffic Impacts	16% reduction in number of vehicles entering the charging zone (2006 vs. 2002, year before the charge was instituted) (Number of chargeable vehicles dropped by 30%; number of non-chargeable vehicles rose by 16%)	20% increase in traffic speed; 10-15% reduction in traffic with respect to Singapore Area Licensing Project (ALS) (which had already suppressed demand significantly).[4]	3-5% reduction in traffic (initial year, much due to recession)	23% reduction in number of vehicles traveling across charging cordon (total during 2006 trial)	New project; stated goal is a 10% reduction in traffic.
Type of Technology	Image capture - Automatic License Plate Recognition (ALPR) for enforcement	Dedicated short-range communications (DSRC) with prepaid smartcard for charging, and image capture (ALPR) for enforcement	DSRC and image capture (ALPR) for charging and enforcement	Image capture (ALPR) (DSRC for Lidingo trip exemption) for charging and enforcement	Image capture (ALPR) for enforcement

Table D-3: International Pricing Examples – Revenues and Penalties

	London	Singapore	Oslo	Stockholm	Milan
Range of Charge (Car)	$14.11 per day	$.33 -3.26 per gantry crossing (passenger), $.65 – 6.45 gantry crossing (very heavy freight)[1]	$4.36 per CBD entry / gantry crossing (passenger), $13.07 (heavy) [2]	$1.48 – 2.97 per trip (entry/exit), maximum $8.93 per day	$14.03 per day
Annual Gross Revenues	$377.3 million (financial year 2006/2007)	$65.3 million (financial year 2006/2007) [6]	$217.5 million (financial year 2006/2007) [7]	August 07-May08: $ 117 million Projected 12-month $140.5million[8]	New Charge — no revenue data available yet
Use of Net Revenue	Improvements to transportation in London including improvements to cycling/pedestrian infrastructure, and to the strategic road network	State revenue, offset vehicle ownership taxes	Finance new roads, public transportation	Improvements to roads	"Sustainable traffic and a sustainable environment" (mostly public transportation improvements)
Penalty Fines	Driving in the charging zone without payment by midnight of following day: with payment within 14 days $212.69- $106.38 early payment discount); with payment 15-28 days $212; with payment 29-42 days $319.15; with payment 43-63 days $327.95. After 63 days sent to Bailiff. Vehicles with 3+ outstanding violations subject to immobilization. Immobilization fee is $124.09; removal fee is 354.54. Vehicle storage	Fine for low balance on smartcard with payment within 14 days: actual Electronic Road Pricing (ERP) fee + $6.54. Fine for not having an On-board unit (OBU) is $45.72. Failure to pay after 28 days may see vehicle owners sent to Court.	Post-payment via invoice in Image Based Transaction (IBT) is acceptable without penalty. If invoice and first reminder are ignored, an additional fee of $452.49 is added to the invoice. Failure to pay results in debt collection activity.	If travel is not declared and paid within 14 days, a service fee of $10.36 is added to the day and the bill is invoiced at the end of the month. If invoice and first reminder are ignored, an additional fee of $74.46 is added to the invoice. Beyond that point, it becomes a tax liability and is treated as a tax evasion offense.	Basic violation: $98.42 to $387.41 [9]

	London	Singapore	Oslo	Stockholm	Milan
	costs $70.91 a day				
Number Of Penalties	100,000 Penalty Charge Notices (PCNs) per month in 2006. Normalization data not given, but this is roughly 4% of all vehicles entering the charging zone during charging hours.	5 per 1,000 transactions (0.5%)	5.8% of daily users are subject to a late penalty charge.	6% of vehicle-days traveled incur the service fee	New Project — no data available

3 *Transport for London Congestion Charging Impacts Monitoring Fifth Annual Report June 2007, http://wwiv.tfl.gov.uk/assets/downloads/fifth-annual-impacts-monitoring-report-2007-07-07.pdf*
4 *J Y K Luk, "Electronic Road Pricing in Singapore ", Road & Transport Research, 8(4), December 2006, p.2.*
5 http://www.imprint-eu.org/public/Presentations/IMPRINT5_Tretvik.pdf
6 *6httij:/fimm\!esmgapore.coiii/wpf/porial/hil:/p/kcxni*
7. *Fjellinjen AS (Norwegian Congestion Tax LLC) 2006 Annual Report. Available at: https://www.fjellinjen.no/omjoss/Om_£ellinjen/852/Fjellinjen-2006.pdf/en*
8. *Forecasted based on initial months revenue*
9. *As reported by Milan Authority*
10. *From APG Menons Presentation Evaluation of Singapore's Electronic Road Pricing (ERP) System (1998 - present), given at International Symposium on Road Pricing 2003.*

Singapore

First Generation: Area Licensing Project, 1975-1998

Singapore's road user-charging project is considered the first congestion-charging project in the world. The project began as a manual system of paper licenses known as the Area Licensing Project (ALS). ALS was introduced as part of a package of measures to reduce road usage in the 1970s, including a high annual road tax, high custom duties for imported vehicles, high vehicle registration fees, a strict quota on the number of registered vehicles, and increased and improved public transportation.[12]

There was a 56-percent drop in inbound traffic in 1975, the year after ALS was introduced. However, the traffic demand-reducing effects of Singapore ALS are difficult to distinguish from the other vehicle limiting fees, since all were introduced within a short period. However, because ALS was the only location-specific charge, it is reasonable to assume that much of the traffic decline into the CBD can be attributed to ALS. When the ALS was extended to afternoon hours in 1988, the number of afternoon inbound vehicles into the CBD fell by 35 percent. The Singapore Subway also began operation in 1988, and the demand reduction due to this major improvement in public transportation cannot be separated from the demand reduction due to afternoon ALS.

Second Generation: Electronic Road Pricing (ERP) since 1998

In 1998, the Singapore government updated its congestion-charging system to pioneer the use of electronic tolling technology via DSRC or tag and beacon and enforcement via ALPR in an urban environment.

Singapore ERP is a mixture of cordon and corridor pricing. The cordon is a ring of gantries surrounding the CBD. No bypass option is available for the cordon; there are no roads entering the CBD that are not covered by the gantries. In addition to the cordon, there are several corridors—limited access highways connecting the suburbs with the CBD – with several gantries along each highway. The number of gantries crossed depends on where the vehicle entered. Corridor gantries can be bypassed, but these bypass routes are longer and slower than the corridors for reaching the CBD.

Gantries include transponders that read toll tags that all drivers are required to install in their vehicles if they are to use the ERP system into the CBD. The sole exemption is for emergency vehicles. Toll tag transponders include a smartcard slot. The smartcard contains stored value, from which tolls were deducted (called the CashCard, the smartcard can be topped up at any ATM). Singapore also installed ALPR cameras in each gantry to capture images of each number plate. If a vehicle with no tag or a malfunctioning tag passes a gantry, the number plate could be read to locate and fine the vehicle owner (which may be reversed if the tag is malfunctioning).

Charges to pass the gantries change in 5-minutes increments during peak hours to represent shoulder periods, to spread demand evenly. Charges also vary by gantry, where high-demand gantries are more expensive than low-demand gantries. The Singapore Land Transport Authority updates ERP charges at each gantry every 6 months to maintain minimum speeds with the core objective being to manage congestion.

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[12] Data on Singapore ALS and ERP presented here is taken from Jack Opiola and Gregory B. Christainsen. "Challenges of Road Pricing", 8th Asia-Pacific ITS forum, July 2006.

Due to the more targeted nature of ERP charges, the number of vehicles entering the CBD dropped by 10 to 15 percent while at the same time lowering the charges at most locations compared with ALS (averaging all charges paid by all drivers over a year).[13] The more finely tailored charges are, the greater the effect will be, with less overall financial burden on drivers.

Penalty fines for not having enough value on the smartcard are just $6.54 in addition to the charge due. The penalty for not having a transponder at all is $45.72. The overall rate of penalties is 5 per 1,000 vehicle crossings (0.5 percent). The relatively low fines are likely due to the ease with which the government has of finding and penalizing drivers, as well as the reputed "obedience" of Singaporeans.

The most recent revenue numbers available give annual revenue of $65.3 million for ERP. Although not specified in the source, these numbers were likely for the financial year 2006/2007. In July 2008, a major increase in ERP charges was implemented to reduce increasing congestion in the CBD including the implementation of five new gantries. Since ERP was introduced in 1998, charges have risen only slightly. However, the 2008 charge increases are significant—they have been estimated to raise revenues by 70 percent. The goal of the new charges is to keep congestion at its current level. This fact illustrates that congestion may rise even in the presence of a charge, and having the option to increase charges regularly allows the authority to keep congestion in check.[14]

London

London's congestion-charging system is arguably the most well-known road user charge in the world. It is the congestion charge with the highest annual gross revenues in the world, by a wide margin. Then-mayor Ken Livingstone instituted the congestion charge as part of his first Transport Strategy for London in 2000/2001 that included significantly expanded bus services.

The system went live in 2003, with drivers paying a flat fee of $8.82 to enter the congestion charging zone. The fee rose to $14.11 in 2005. There are few exemptions, but many 100-percent discounts from the charge including buses, licensed taxicabs, registered private hire vehicles, blue badge holders (i.e., drivers with disabilities), and designated "green" vehicles. There is also a 90-percent discount for qualifying residents who live within the area of the charging zone. [15]

London's congestion charge is a declaration-based system enforced by ALPR. Drivers must pay for their trips to Transport for London (TfL) or face penalty charges. Customers can pay for their charges by Internet, phone, or post, or by using Short Message Service (SMS) text messaging (if pre-registered) at many retail outlets in London and nationwide, as well as vending machines throughout the city. Customers must determine that they will travel (or have traveled) on a specific day and pay the fee for that trip, and have until midnight that day to pay it, or face a surcharge.

Fleet vehicles can opt for detection-based charging instead of declaration-based charging and can create a fleet account. Transactions for registered fleet vehicles (the number of crossings made by each fleet each month) are recorded when the vehicle number plates are read, without the need for declaration. TfL deducts a pre-payment from the organization’s bank account based on the charging history of that

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[14] All data in this section on London congestions charging is taken from Transport for London’s “Central London Congestion Charging: Impacts Monitoring: Fifth Annual Report,” July 2007. Available at http://ivww.tfl.gov.uk/assets/downloads/fifth-annual-impacts-monitoring-report-2007-07-07.pdf

[15] Information on the fleet vehicle discount is taken from Transport for London's Congestion Charging Fleet Project Brochure available at http://www.tfl.gov.uk/assets/downloads/CC-FleetProjectBrochure.pdf.

account. The pre-payment for the following month includes an adjustment to cover the difference between the previous months pre-payment and the actual number of vehicle-days used. The charge is direct debited from the bank accounts of the organization. Fleet accounts cost $17.75 per vehicle per year plus $12.43 per vehicle-day in the congestion zone, a $1.77 savings over the standard congestion charge.

London's charge is an area charge, meaning all vehicles traveling within the congestion zone are charged, irrespective of whether they cross the boundary of the congestion zone. This contrasts with other charging projects described in this document, which are cordon charges, charging users only to cross boundary points, but not charging for trips entirely within the boundaries of the charging zone. To enforce the charge, ALPR cameras are located at the boundaries of the charge and in a network of fixed cameras within the zone and on a few mobile enforcement units.

In the first year after the start of the congestion charge, the total number of vehicles entering the central zone dropped 14 percent. This represented a 33-percent reduction in vehicles subject to the charge, but was offset by increases in buses, taxis, and powered two-wheelers (i.e., motorcycles, scooters, mopeds), none of which are subject to the charge.

The charge increased from $8.82 to $14.11 in 2005, and in 2006, there was an overall 16-percent drop in the number of vehicles entering the congestion zone compared to 2003. The increase to $14.11 helped to slightly more than maintain the congestion reduction benefits from the project's introduction.

In the first year of operation, the number of potentially chargeable vehicles fell by 27 percent, while the number of non-chargeable vehicles rose by 18 percent. The exempt/non chargeable vehicles included licensed taxis, buses and 9+ seaters (i.e., passenger vans), and powered two-wheelers. In 2006, the number of potentially chargeable vehicles entering the charging zone fell by 30 percent, while the number of non-chargeable/exempt vehicles rose by 16 percent both in comparison to 2002.

In 2007, total revenue was $476.4 million. Of this, $129.6 million (27 percent of total revenue) was from penalty charges. In 2005, the average number of Penalty Charge Notices (PCNs) per month averaged about 120,000.

Oslo

Oslo's "urban toll ring" began operating in1990, following a similar system introduced in 1986 in the smaller city of Bergen. The Oslo charge is not a congestion charge—its goal was not to reduce congestion, but to finance the new freeway bypassing the city, as well as some public transportation improvements. However, the toll was charged on all trips inbound into the city, giving it the primary characteristics of a (cordon-style) congestion charge, although demand reduction was not the primary goal.

Because of the relatively low level of the toll, it did not reduce demand significantly. In the first year of operation (1990), travel demand (number of vehicles entering the charge zone) fell 3 to 5 percent. The first year of operation coincided with an economic recession, so the actual demand reduction due to the toll may have been just 1 to 2 percent. Demand has risen steadily since then.

The Oslo toll operates using a mixture of image-based and transponder-based transactions. A 20-percent discount on the charge for transponder trips encourages frequent users to obtain transponders. For those using image-based transactions, individual declaration and payment or post-payment by invoice are available—if charges are not declared and paid within 3 days of travel, users receive invoices at the end of the month.

Unlike other systems described herein, the Oslo toll operates 24 hours a day, 7 days a week. There is no attempt to encourage drivers to shift their trips from peak hours to off-peak hours. There is no variation by time of day.

Exempt vehicles include emergency vehicles, buses, fully electric vehicles, and vehicles belonging to people with disabilities. Oslo also offers discounts for drivers who purchase 1-, 6-, and 12-month subscriptions. Finally, there is a monthly cap on the amount that can be charged to any one vehicle.

The Oslo toll generated $217.5 million in revenues in FY2006/2007, while incurring operating costs of $23.1 million. Because all drivers who neither have a tag nor declare their transactions receive a monthly invoice, there are no fines or penalties. However, there is a fine for late payment of the monthly invoice, but figures for the proportion of revenues coming from this fine are not available.[16]

The Oslo toll was set to expire in 2007 because the debt for the transportation investments for which the toll was instituted had been paid in full. However, local politicians opted to extend the toll, and did so without causing political outcry. This shows that the Norwegian public seems to accept payment for road usage to manage congestion as well as pay for transportation investments.[17]

The payment system with either declaration or monthly invoices is relatively new and was instituted with the shift to fully open-road tolling in February of 2008. The Oslo toll had, until February 2008, included manual lanes for payment of the charge by users who did not have a toll tag. The Autopass toll tag available to Oslo residents to pay the toll is notable for its user feedback and interoperability. The tags have a display light to indicate whether a payment was accepted, and a separate light to indicate whether payment was made but the balance on the tag account is low. If no indicator light is seen, the payment did not occur, and the user must pay by declaration or invoice. The tag is interoperable with toll tags in other Norwegian, Swedish, and Danish areas via the EasyGO system.

Stockholm

Stockholm instituted a charging trial in 2006 with the main goal of reducing congestion. Public opinions of congestion charging improved after the trial's success. A referendum on the charge was held; Stockholm residents voted in favor of instituting the charge 53 to 47 percent. However, if all votes in the greater municipal area are counted, the vote was against instituting the charge 52.5 to 47.5 percent. In 2007, the newly elected conservative party decided to make the charge permanent and use charging revenues for road improvements instead of public transportation improvements.[18]

Stockholm's system is primarily one of image-based transactions (DSRC tags are available only to residents of Lidingo Island as described below). ALPR is performed on all vehicles entering or exiting the

[16] Financial information on Oslo's toll ring is taken from the FY06/07 Report ofFjellinjen AS, the company that operates the toll ring. It is available at: https://imvw.fjellinjen.no/om_oss/Om_fjellinjen/S52/Fjellinjen-2006.pdf/en
[17] The renewal of the Oslo toll ring is discussed in Jm-Terje Bekken and Bard Nordheim. "Use of Toll Revenues and Investment in Oslo, "from Investment and the Use of Tax and Toll Revenues in the Transport Sector, Andre de Palma, Charles Robin Lindsey, Robin Lindsey, StefProost. cd. Elsevier, 2007.
[18] The Stockholm congestion charging referendum is discussed in "The Stockholm Congestion Charging Trial" by Professor Stefan Algers available at: transp-or2.epfl.ch/strc/algers_presn.pdf

city.[19] The charge varies by time of day ($1.48, $2.22, or $2.97) in 30-minute increments. The maximum charge per vehicle is capped at $8.96 per day, regardless of the number of times that a vehicle crosses into or out of the charge zone.

To avoid an additional fee, Stockholm residents must pay their trips within 14 days of travel. If they do not, a $10.37 service fee is charged for each day of travel unpaid for 14 days (regardless of the number of cordon crossings per day). Days of travel unpaid for over 14 days are billed to drivers via monthly invoice. Since the system went live in August 2007, about 6 percent of all days of travel went unpaid for 14 days. To help drivers avoid the service fees, the charging authority offers automatic driver notification via e-mail and automatic payment by direct debit.

The Stockholm charge was the first to include an exemption for trips to and from a specific region. Lidingo Island is a primarily residential island for which the only road connection to the Swedish mainland is through the charging zone. Because travelers to and from Lidingo Island have no choice but to travel through the charging zone, trips to and from Lidingo Island that pass through but do not remain in the central city longer than 30 minutes are not charged. Lidingo Island residents have the option of using a DSRC transponder to supplement their image-based transactions, ensuring that their trips will not be charged. Assuming even the very high accuracy of 90 percent for all ALPR reads, there would be around 20 percent of trips to or from Lidingo Island that would be charged in the absence of a DSRC transponder, demonstrating the need for the transponder to accurately implement the discount.

In addition to the exemption for Lidingo Island, the Stockholm charge includes exemptions for emergency vehicles, buses, people with disabilities, military, alternative fuel vehicles, motorcycles, and foreign-registered vehicles. The Stockholm system is notable for its inclusion of a route for through traffic wishing to avoid the charge.

The Stockholm charge has been effective at reducing traffic. During the trial, the number of vehicles crossing the congestion charge cordon dropped 23 percent.

Milan

In 2008, the city of Milan started a new cordon charge, called "EcoPass," in its CBD. The City Council's stated intention with the charge was to improve the environmental impacts of transportation. The charge cannot be considered a strict congestion charge because a large class of vehicles were exempt (all gasoline passenger cars with an emissions rating of Euro 3 or higher and all diesel passenger cars equipped with a particle filter and an emissions rating of Euro 4 or higher). The charge is intended to make some drivers switch to cleaner vehicles; however, the city traffic authority also expects a 10-percent reduction in the overall number of vehicles traveling in the charging zone during the times the charge is operational (7:30 AM to 7:30 PM Monday through Friday). No data are yet available to verify whether this demand reduction has taken place.[20]

The EcoPass is a pure ALPR system. Drivers must declare and pay their charges by midnight of the day following the day of travel. Payments can be made at ATMs and shops around Milan, by phone, or by Internet. Residents of the charging zone can pay for an annual EcoPass, allowing unlimited travel within

[19] Details of the Stockholm Congestion charge are available on the project website:
[20] Details of the Milan EcoPass are taken from the City of Milan's EcoPass brochure available at: http://www.comune.milano.it/dseserver/ecopass/images/ECOPASSbrochnreinglese.pdf

a calendar year for one fee. Annual EcoPass users do not have to declare their trips. The fines for violating the EcoPass are quite steep—fines begin at $98.61 and can be higher depending on the circumstances of the violation.

Conclusions

Congestion charging is emerging in major congested cities worldwide and has not been discontinued in a city where it has started. It has been used to support a variety of policy purposes (demand reduction, GHG emissions reduction, and revenue generation for transportation improvements). Precise charging policies are tailored to support the primary objectives of imposing the charge in each city.

Demand reduction from road user charging is real, but reduces gradually after the first year. London and Stockholm, the cities whose explicit primary goal was to reduce travel demand, experienced 15 to 20 percent reductions in the number of vehicles entering the charging zone. Oslo and Milan do not give comparable numbers, since their goals were not to reduce congestion. Although Singapore's goal was to reduce demand, it does not give comparable numbers, since ALS was introduced alongside many other demand reduction measures, and ERP was adopted while ALS was functioning. However, Singapore ERP does show that finer tailoring of charges by location and time (instead of a flat charge) allows the overall financial burden on drivers to be reduced, while improving the demand-reducing effect of the charge.

Penalty fines vary widely based on whether post-payment is possible and how easy it is for the authority to recover fines. No fines are levied where detection-based post-payment is possible. In Singapore, where centralized vehicle and person registration makes it very hard for people to evade fines, the fines are low. In Milan and London, where there is only a very limited post-payment payment option, penalties are relatively high.

Congestion charging is only one tool among many to relieve congestion, but only in Singapore has congestion been effectively managed to strategically determined targets. In London and Stockholm, there remains severe congestion on many routes outside the charged locations. This indicates that there is potential to expand pricing in those cities and to evolve towards more disaggregated charges over time. Relative levels of success are dependent on what other measures are implemented in parallel. In Norway, success has been achieved by combining tolls with extensive strategic road network improvements.

Appendix E: Considerations for Developing a Seattle Congestion Pricing Program

If, in the future, Seattle should examine establishing a congestion pricing program for the City, many considerations should be taken into account.

A variable tolling program should be viewed as a package of measures that meets Seattle's tolling interests—one of which is raising revenue to invest in transportation infrastructure. It will be important to identify an infrastructure investment package early when deciding whether to implement a variable tolling program in Seattle. Investments must support the City's interests; be balanced against revenue projections; and be conveyed to the public to provide information, receive public input, and develop support for the overall program. The investments can fall into several general categories:

- Tolling program equipment, systems, and associated works
- Public transportation (rail, bus, ferries) and related amenities
- Pedestrian and bicycle infrastructure improvements
- Road improvements, including maintenance, safety, capacity improvements, and ITS

Tolling Program Equipment

Implementation of a variable tolling program will require investment in equipment to provide motorist information, support revenue collection, and enforce toll payments. This includes field and back-office equipment to support program administration. To maximize infrastructure investment revenue, it is important to minimize capital and operating costs of the variable tolling system. Decisions about what technologies to use, for example, impact both capital and operating costs. Thus, overall system design decisions play a critical role.

Public Transportation Investment

The City of Seattle and the Puget Sound region have a significant investment in their existing public transportation system. Travelers are provided with a variety of transit options including bus, rail, and ferries. System owners and operators have expansion plans in place, as well as a vision for growth beyond currently available revenue.

Investment in public transportation is one of Seattle's interests in implementing a variable tolling program. It will be important to understand the needs of public transportation agencies and how revenues from variable tolling might be used to support those investments. Once these investments are made, it will be critical to consider operational, maintenance, and replacement costs. A focus could be on infrastructure, and a transparent and objective funding allocation process could be established to get the best value for money.

In addition to the primary investment in public transportation, there can be investments in amenities such as passenger information systems, bus shelters, benches, and park-and-ride operations. Another investment consideration is the future demand for paratransit as the local population ages.

Pedestrian and Bicycle Infrastructure Improvements

Many people in the region choose to walk or bike as their primary travel mode or as a means to access public transportation services. As these modes support the reduction of GHG emissions, one of the City's primary interests, the City may choose to invest in projects that encourage the number of people making these travel choices. Investments could include sidewalk improvements, construction of on- and off-road bicycle facilities including safe routes to schools, improved lighting for pedestrians, and associated amenities such as bicycle lockers, water fountains, benches, bicycle racks on buses, space on trains and ferries for transporting bicycles, and improved pedestrian crossings and associated pedestrian signals. The City must also consider associated maintenance costs for these facilities.

Highway and Street Improvements

Even with implementation of variable tolling and the associated reduction in VMT and diversion to other transportation modes, the highway system will remain the backbone for intra-city and regional transportation. The current highway system has not kept up with demand, and current revenue sources are not sufficient to maintain and improve the system now and into the future. Highways and city streets should be part of the overall investment plan.

Current long-range plans should be reviewed to determine planned roadway investments most compatible with City interests and other projects that might be preferred to meet the City's goals. For example, will planned roadway investments provide new capacity that might attract drivers away from priced facilities and negatively impact surrounding land uses? What expenditure would generate the best net economic and environmental benefits for the City, balancing reduced delays, improved safety, and better access? Is there deferred maintenance that should be addressed to ensure the security of networks and produce smoother, safer travel? Would the City consider traffic-calming techniques such as narrowed lanes and roundabouts to slow vehicle traffic and potentially reduce diversion from tolled facilities, improve safety, and provide a more desirable environment for bicyclists and pedestrians? What investments could be made in ITS, including service patrols, to improve overall highway operations? Questions such as these should be considered when how to invest variable tolling revenues in highway and street improvements.

Use of Toll Revenue to Meet Seattle's Interests

Currently, the City of Seattle has no specific authorization to impose tolls on area roadways. Other agencies, including WSDOT, PSRC, and King County, have expressed interest in exploring toll options in the region. Many institutional options exist. The City should work with other stakeholder agencies to determine the type of agency best suited to implement tolling on a regional scale. See Section 2.5 for a more detailed discussion of institutional considerations.

To optimize the region's network flow, toll rates should be set below the MSC of different road users at different times and locations (after taking into account behavior change resulting from tolling, and recognizing efficient levels of congestion). Tolling should be variable to consider time, distance, location, and externalities such as GHG emissions. Dimensions of these parameters would match Seattle's interests and assist in funding its needs. Only through the use of tolling for demand management will the region be able to create micro-economic incentives for travelers to:

- Shift travel time
- Shift travel mode
- Consolidate trips
- Investigate alternative means such as telecommuting and alternate/more-efficient delivery
- Decide if the trip is necessary

As part of the externalities to price, a toll should include both pricing and encouragement for vehicles with lower emissions. Variable pricing that reflects vehicle motive power can accomplish this. For example, an older diesel-powered car could be priced higher than a hybrid or even an electric car that would have no price increase because it is the cleanest vehicle to operate. These pricing differentials are only one part of the toll, which should also reflect the amount of road space consumed (vehicle size or classification) and the price for accessing the facility. One last dimension would be a charge for the approximate distance or a surrogate for the distance traveled.

Tolling that uses the above dimensions would also address equity issues as long as exemptions and discounts are considered. These can create a balance for pricing and compensate specific disadvantaged groups such a users with disabilities. When developing discounts or credits, the impact on revenue collection (and the level of subsequent revenue loss) and risk of fraud through misuse of such discounts should be analyzed.

General Tolling Strategies that Meet Seattle's Interests

As described in Chapter 2 of this report, Seattle has identified several areas of interest in analyzing proposals to implement tolling in the City and region. Table E-1 builds on the table listed in Chapter 2, by including other considerations that Seattle might include if it chooses to develop a tolling program.

Table E-1: Summary of Seattle's Tolling Interests and Additional Considerations

Seattle's Tolling Interests	Consider Tolling Plans with the Following Elements	Other Considerations
Reduce GHG emissions	▪ ***Toll rates set to incentivize mode change to non-drive alone, for example tolls higher than the transit fare; or at the level of marginal social cost*** ▪ Toll differentials set for less fuel efficient vehicles to encourage shift to lower GHG emission vehicles ▪ Use toll revenue for transit and TDM programs ▪ Variable tolling used to shift travel demand out of peak hours to better distribute traffic into non-congested time periods ▪ Systematic implementation of tolling on freeways and potentially arterials ▪ Design an eco point program where toll rates are set by environmental impact	▪ Support investments to encourage bicycling and walking (e.g., bike lanes, sidewalks, street lighting, bicycle storage areas). ▪ Review all ferry, rail, bus, and SOV trips in terms of marginal social cost to compare price incentives and disincentives per mode of travel. ▪ Consider an integrated payment system for all modes of transport by either private or banking contactless smart cards. ▪ Create transportation policy that stipulates demand management measures for new infrastructure projects ▪ With regional partners, investigate establishment of a Regional Transportation Authority to provide oversight and governance of all ground transportation modes.

Seattle's Tolling Interests	Consider Tolling Plans with the Following Elements	Other Considerations
Generate revenue for transit and transportation demand management programs	▪ **Inclusion of transit operations as part of the on-going maintenance costs of the facility** ▪ Variable tolling implemented 24 hours day/7 days/week to manage demand and raise revenue ▪ Technology used to capture greatest net-revenue ▪ Adoption of "open" standards and multiple suppliers for technology	▪ Partner with transit operators to define the City's investment in transit from toll revenues. ▪ Invest in transit enhancements (e.g., bus shelters, real-time passenger information systems, bus pull-outs on city streets). ▪ Link parking policies and fees to demand management strategies. ▪ Adopt variable pricing for on- and off-street parking. ▪ Integrate toll roads, toll facilities, HOT lanes, off-street parking facilities and park-and-ride
Generate revenue for facility operations and maintenance	▪ Inclusion of transit operations as part of the on-going maintenance costs of the facility ▪ Predictive Asset Management (PAM) systems for all projects and facilities ▪ Spend revenue on mode change incentives, parking, cycling, and other alternatives to reduce private car usage and enhance alternatives ▪ Enhanced compliance measures that minimize enforcement costs	▪ Include rigorous inspection and audit of Predictive Asset Management (PAM) systems ▪ Establish independent financial audit of all transportation facilities and publish results annually ▪ Fund and establish independent O&M review of all transportation modes and publish annual report
Improve efficiency through variable tolls	▪ **Dynamic tolling used to reduce peak hour travel and related congestion and emissions** ▪ Consider tolls to improve efficiency of existing roadway before funding road expansions ▪ Regional, centralized clearing house for all tolling and transportation payments to lower transaction costs and help integrate payments across modes of transportation ▪ Interface to ferry operations, WSDOT tolling, rail, and Sound Transit	▪ Perform transaction processing audit of all toll and transportation facilities to measure and monitor efficiency ▪ Investigate the use of Independent Service Providers for handling toll and public transit accounts. Maintain several for competition and quality of service ▪ Consider partnering and using bank and contactless credit cards and mobile telephones with Near Field Communications (NFC)
Maximize personal mobility and throughput vs. vehicle throughput	▪ **Dedicated transit lanes on tolled facilities, particularly if tolls are set at a fixed rate; to ensure reliable travel times** ▪ Dedicated transit lanes on tolled facilities, particularly if tolls are set at a fixed rate; to ensure reliable travel times ▪ Toll rates set above transit fares to minimize diversion from transit ▪ Drive-alone access to HOT lanes is metered to maintain transit mobility ▪ Freight allowed access into toll lanes to ensure reliable travel times ▪ General purpose lanes are converted to tolled lanes when they carry less people than HOV lanes ▪ Integrated multi-modal transfer facilities along	▪ Support discounts for multi-modal transfers or "caps" on end-to-end trips rather than segments ▪ Provide real-time transportation information as public service on continuous basis for all modes of transportation to allow users to better choose modes and transfers ▪ Consider discounts for modal changes to minimize transfer times

Seattle's Tolling Interests	Consider Tolling Plans with the Following Elements	Other Considerations
	major trip patterns ▪ Toll discounts provided for multi-modal transit and HOV trips	
Be implemented systematically and regionally	▪ **Broader tolling across a linked network to maximize efficiencies and reduce inequitable impacts to communities** ▪ Policies that permit the use of revenues from any one toll or transit facility to fund and secure another in a rolling wave sequence	▪ Use planned and staged implementation if necessary to reduce initial capital cost investment ▪ Establish benefit/cost evaluation criteria for prioritizing projects ▪ Establish through fiscal "pump priming" a transportation fund to secure private funding to build infrastructure and facilities to augment the public construction program ▪ Establish an independent board of Public/Private members to evaluate Private Bids for facilities
Be equitable and just	▪ Standard traffic measures and enforcement minimize diversion through neighborhoods ▪ Limited exemptions and discounts provided for emergency vehicles ▪ Discounts for hospital appointments , people with disabilities, and people with special needs are carefully considered ▪ Revenues used to create a loan program for cleaner vehicles for low income and freight	▪ Evaluate impacts of tolling and pricing on lower income brackets and programs. ▪ Manage impact in neighborhoods near edge of charging zones with residential parking management. ▪ Use revenues to finance improving gaps in transit infrastructure that are relevant to enhancing access efficiently. ▪ Establish independent funding board to allocate funds generated equitably and efficiently.
Maintain or improve economic vitality	▪ Improved and expanded transit services to improve access to jobs and commercial interests in the CBD ▪ Target congestion where and when it occurs, ensuring pricing does not overcharge, but optimizes traffic flow and access. Pricing has improve the GDP in charge areas worldwide.	▪ Consider special tax credits for employers who promote "transportation plans" that conform to city requirements and programs. ▪ Consider special tax credits for companies inside variable tolling zones. ▪ Encourage transit-oriented development (TOD) to attract new residents and businesses.

Appendix F: Designing and Evaluating a Tolling System

The challenge in creating an evaluation framework for studying tolling is to provide sufficient details, while balancing the amount of information that must be collected to provide the answers. For this reason, the approach taken is to establish a complete list of all possible evaluation factors to be considered. Included are suggestions about quantitative and qualitative indicators that can be used to determine the relative performance of the different scenarios.

Developing and Evaluating Pricing Strategies and Concepts

Tolling models under development should provide forecasts and analyses to assess the performance of congestion pricing strategies and schemes. The models comprise of a reference model (CTS type model) to provide analyses of underlying travel and traffic conditions and a response model to assess the impacts of various strategies and schemes.

The forecasting and evaluation involves four main steps:

1. **Reference Case:** Assessment of travel conditions based on forecasts prepared using the Reference Input Assumptions representing current policies, programs, and plans
2. **Travel Demand Management (TDM) Case:** Assessment of a package of additional TDM measures required to achieve the target level of service in the study area
3. **Strategy Development:** Development and assessment of a range of possible strategies and schemes to achieve target level of service
4. **Strategy Refinement:** Refinement of preferred candidate projects

Congestion charging strategies comprise a number of components including:

- Geographic coverage
- Time period
- Method – cordon, area, distance
- Vehicle type
- Charge – level, unit

The permutations are many; therefore, a step-by-step approach should be adopted to build strategies:

1. Based on reference forecasts for future years to be determined, target and identify congested:
    - Areas
    - Corridors
    - Time periods
    - Contributory factors – vehicle type, network configuration
2. **Assess Vehicle Type Contribution.** Identify the total amount of traffic reduction required to achieve level of service (LOS) target and assess reductions required under different charging approaches by vehicle type:
    - All vehicles
    - Car only

- Cars and taxis
- Cars, taxis, and trucks

  Should also assess the implications of charging internal—external traffic, internal traffic, and through traffic—and whether some categories of buses (e.g., commercial long-distance services) should pay.

3. **Define Generic Strategies.** Based on worldwide experience and technology studies, define strategy generic types:
   - Area
   - Cordon
   - Distance
   - Access zones
   - Strategic road network
   - Combinations of the above with parking and other measures

   Screen the generic types appropriate for congestion charging in the study area.
4. **Test Charge Levels.** Based on simple charge per trip, assess broad charge level to achieve traffic reduction under vehicle type scenarios.
5. **Define Strategies for Testing.** Based on above research, define strategies and reasonable charge ranges and structures. Prepare initial model tests and undertake operational evaluations.
6. **Refine Strategies for Evaluation.** Refined strategies and charging scenarios should undergo full model analysis and transportation performance assessment.
7. **Conduct Comprehensive Evaluation.** Candidate options for the alternative strategies should be subjected to overall evaluation including technology, public acceptability, and institutional and financial features.

Screening Process

A screening analysis of a long list of potential projects should be carried out early on in the study to identify practical candidates for more detailed analysis, while documenting reasons for excluding other possible approaches.

The screening analysis should use the full evaluation framework in a qualitative manner to test the viability of the long list of schemes and approaches. A first step should be to identify the congested areas, time periods, and contributory vehicle types. Based on preliminary schemes, evaluation framework should be devised and applied to screen the long list of potential projects.

International Experience

The Road Charging Options for London (ROCOL) study in the UK, the Manchester Congestion Charging Project**,** and the recently completed Auckland Road Pricing Evaluation Study show that the evaluation of congestion charging strategies must be based first on a clear definition of the overall goals and objectives of the schemes. More information on international tolling can be found in Appendix D.

Evaluation must generate a clear understanding of the broader strategic outcomes to which transportation policy, and in particular a congestion charging scheme, could contribute. These goals and objectives must cover:

Direct objectives of the congestion charging scheme, including traffic reduction, improved accessibility, improved travel times, improved trip reliability and access, mobility, and environmental objectives. These directly attributed objectives also include items such as technical feasibility, cost (both capital and operating), and revenue generation. In some cases, the performance of different schemes will relate to the technologies or charging regimes adopted, and in other cases, to the shape, boundaries, and specific nature of a particular variation.

Indirect or broader outcomes to which transportation policies in general can contribute, or upon which they can impact. This can include wider environmental outcomes, economic development outcomes, community outcomes, and the like. These objectives are often more difficult to measure, but are particularly important in terms of acceptance of a congestion charging scheme outside the local transportation officials and stakeholders. Broader outcomes should be key determinants of public acceptance of any of the schemes.

Pre-Implementation Outreach on Tolling in the Puget Sound Region

Previous efforts to fund and develop transportation projects in Seattle and the Puget Sound region have demonstrated the importance of communication. This includes a public involvement process that is representative, open, and transparent; provides information to the public and to stakeholders so that they can make an informed decision; and hears and accommodates public and stakeholder comments. Achieving political support for variable tolling will depend on understanding the barriers to public acceptance and through open communications and a clear and well-developed statement of the problem and proposed solution.

The first phase of WSTC's Comprehensive Tolling Study provided input on tolling from elected officials, agency staff, community leaders, and members of the general public in the Puget Sound region. It also included experience with public acceptance in other regions of the United States before and after implementing tolling projects. Their comments provide an indication of the topics that will need to be addressed in outreach and educational efforts to achieve support for tolling in Seattle and the Puget Sound. A key conclusion of the Comprehensive Tolling Study is that the public does not have a good understanding of or appreciation for tolling, and that public outreach and education will be needed if pricing is to be used to manage traffic and finance transportation projects.[10]

Key Outreach Issues

Nationally, experience in other cities reinforces the controversial nature of tolling and congestion pricing, and therefore, the need to build support for such initiatives. Foremost among lessons learned elsewhere is the need to educate the public and bring about a shift in public opinion and understanding of pricing strategies, electronic tolling and associated privacy issues, and concerns about fairness and equity. It will be important to demonstrate the benefits of pricing relative to its costs, by clearly articulating:

- The benefits or improvements system users can expect to see
- The timeframe in which system users can expect to see the benefits

10 Washington State Transportation Commission, *Comprehensive Tolling Study: Final Report*, September 20, 2006.

- How the benefits will be funded
- What funding is being asked from the public
- How toll revenues will be used
- What accountability mechanisms will be instituted to avoid misuse of funds and to review charges periodically.

Real-life experience is highly valued. Information from the region's current experience with tolling and congestion pricing on the Tacoma Narrows Bridge and the SR 167 HOT lanes will be helpful in the education process.

Based on national experience and the findings of the Comprehensive Tolling Study, stakeholders are concerned with specific issues that in turn, create skepticism about road pricing strategies. The issues summarized below should be used in developing the pre-implementation outreach process by leveraging those that are supportive and proactively addressing those that raise barriers.

Public and Stakeholder Comments[21]

- Traffic congestion is a very real concern and tolling is a potentially viable solution for system management.
- Fairness: It is important to consider the needs of particular groups (e.g., carpoolers, low-income drivers, commercial vehicles/trucks).
- Tolling as a state policy:
    - Taxes, not tolls, should fund transportation
    - How tolls will be set, how long tolls will be maintained, how toll revenue will be used
- Issues related to tolling are complex and not well communicated to the general public. The public and stakeholders need to understand:
    - How electronic tolling and its various applications work
    - How Good To Go (i.e., electronic tolling program in Washington State) will work
    - How tolling benefits users
    - The impact of tolls on traffic management and system efficiency
    - Implications of tolling on privacy.
- Taxes currently collected should be sufficient for transportation system needs.
- What happens to existing taxing if tolling is expanded?
- Willing to accept tolling under specific conditions and for specific projects.
- Tolling may divert too much traffic onto free roads or local streets.
- Trucking community concerns are that tolls would erode their thin profit margins, with no ability to pass the cost onto customers.

[21] Washington State Transportation Commission, *Comprehensive Tolling Study: Final Report*, *Background Paper #11 Public and Stakeholder Outreach*, September 20, 2006.

Community Leaders[22]

- Safety – Transportation has been ignored and some roads and bridges are in dangerous condition.
- Economy – An efficient transportation system is critical to the economy.
- Congestion Relief – Congestion has worsened; travelers are regularly affected by delays.
- Fairness – Tolling should be implemented equitably. It is not fair for captive groups (Kitsap Peninsula/Tacoma Narrows Bridge; Vancouver/Columbia River Bridge) to be burdened with a toll only they must pay.
- Congestion Management – Fair way to add capacity to existing roads; good idea if it can be demonstrated to work in certain environments.
- Tolling is Inevitable – There is no other way to make needed transportation investments. But tolling alone is not enough—a combination of funding sources will be required to meet all needs and to keep tolls from being too high.
- Public Acceptance – Will take time. Continual education process is needed, including demonstration projects (e.g., Tacoma Narrows Bridge; SR 167 HOT lanes) to provide success stories.

Outreach Process

Understanding the concerns of the region's stakeholders is one aspect of a pre-implementation outreach strategy. Another is the process for addressing those concerns while promoting the proposed congestion management plan. If pricing is to be used successfully for traffic management and financing, then considerable public outreach and education are needed. Agencies must provide a common understanding of congestion pricing's goals and purposes.

Effective communication and outreach strategies are essential to ensuring that stakeholders understand congestion pricing and how their issues or concerns are addressed. The outreach process should be a two-way street, providing information to stakeholders as it seeks to receive and respond to input from them. Both the message and the method of delivery are keys to effective outreach. The following points are based on lessons learned in managing other programs through to implementation:

An **outreach plan** should define a coordinated, comprehensive, and effective program, including a variety of means of disseminating and obtaining information.

Information and education materials should be compelling. They should be simultaneously eye-catching and informative, with a visual identity that includes project branding for easy recognition of all communications and project materials (e.g., agendas, Web site, brochures, information items, news releases, take-ones, FAQs).

Understanding the **nature and scope of stakeholders' interests and concerns** is critical. It is particularly important to prepare carefully, tailor messages to each audience, and answer all questions. Communications should reflect the needs of diverse stakeholders, such as businesses, trades people, commuters, environmental interests, freight operators, social service organizations, elected officials, etc.

[22] Washington State Transportation Commission, *Comprehensive Tolling Study: Final Report*, *Background Paper #2 – Ascertainment Interviews: Opinion of Washington's Community Leaders,* September 20, 2006.

An integrated approach to communications management should include an **inventory of the region's stakeholders**, including those representing major agencies (e.g., WSDOT, WSTC, PSRC, King County, City of Seattle, and other jurisdictions within King County), media, and non-profit and advocacy organizations (e.g., AAA, Chambers of Commerce, Puget Sound Business Journal), as well as its business, political, and thought leaders, and members of the general public.

In London and Minnesota, the successful implementation of congestion-pricing initiatives is arguably attributable to having a top-level **project champion**—in those cases, the Mayor of London and the Governor of Minnesota. Their support set the tone for the project and engendered support for it. A similar champion in this region can help attract interest and drive the program through to implementation.

Media support is an essential part of the communication and outreach strategy. A **media plan** should include messaging, editorial board meetings, op-ed pieces, press releases, media briefings, talk shows, and ready access to spokespersons.

Meeting schedules and locations should provide accessibility for the entire region, at convenient times and in conveniently accessible locations to reach the most people.

Outreach should include a **variety of communication formats and languages** to appeal to different stakeholders, including project Web sites, media campaigns, videos, print materials, television, and radio, including talk shows. State-of-the-art communication tools (e.g., interactive Web portals) for public information, education, input, and dialogue, including Web-based surveys and virtual workshops, can be very effective for providing information and getting input. More traditional activities are also needed to reach the full range of stakeholders. This could include face-to-face field outreach and community meetings.

Project updates should be provided on a regular basis to keep people informed of current status and next steps, and to keep them involved in moving the program forward.

Market research should also take a variety of forms to reach different market segments through focus groups, interviews, and surveys, potentially including Web-based, mail, telephone, and intercept surveys.

The outreach plan needs to help project planners correctly identify and mitigate major concerns so the project can move into development, construction, and implementation.

Key Areas for Analysis and Evaluation Factors

Building from the previous work in the region, tolling on the Tacoma Narrows Bridge, HOT Lanes on SR 167, and the City of Seattle's tolling interests, the following should form part of the evaluation framework:

1. Transportation performance indicators including:
    - Travel impact (e.g., travel time, cost)
    - Operational performance – level of service
    - Mobility and accessibility impacts
    - Network and service utilization
    - Impact on public bus and rail transportation
    - Transportation economics

2. Sustainability indicators including:
    - Economic and business impacts
    - Environmental impacts – especially changes in VMT and GHG emissions
    - Social impacts – areas, modes, stakeholders
    - Integration of land use and transportation
3. Implementation factors including:
    - Technical feasibility and enforcement
    - Privacy issues
    - Financial – costs, revenues and viability
    - Legislative requirements
    - Institutional requirements
    - Public acceptance and support
4. Technology indicators including:
    - Interoperability
    - Ease of use
    - Security
    - Reliability
    - Open standards.

Transportation Performance Indicators

Travel Impacts

The evaluation process requires an understanding of the potential changes in transportation diversity and shifts in travel time, distance, destination, and mode. Trip diversion (to other modes or routes) and trip suppression (or retiming of trips) should be assessed. Projections of future traffic demand patterns and elasticities should be developed based on responses of the PSRC and Seattle model to the various inputs including surveys, socio-economic and demographic characteristics, and land-use trends.

This should produce several traffic-related outputs that provide the ability to assess the traffic responses of different scheme variations and the different pricing schemes that exist therein. In this context, the possible evaluation factors are listed in Table F-1.

Table F-1: Possible Evaluation Factors for Traffic

Objective/Issue	Possible Evaluation Factors
Understanding changes in levels of traffic by: • location/route • vehicle type (private, commercial, public transportation) • journey purpose • change in trip timing	Changes in overall traffic volumes on key routes Numbers of trips suppressed Numbers of trips retimed Changes in trip by mode

Objective/Issue	Possible Evaluation Factors
	Other trip changes Changes in person/miles traveled Change in total VMT
Freight Vehicles	Numbers of trips retimed Change in VMT

Operational Performance – Level of Service

The key objective is to relieve congestion and therefore achieve a target level of service. This should be measured in the charging area and adjacent affected areas.

Table F-2: Possible Evaluation Factors for Operational Performance

Objective/Issue	Possible Evaluation Factors
Traffic congestion relief	Average speed by vehicle/road type Volume/capacity ratios; junction reserve capacity analysis
Travel time and reliability improvements	Total travel time savings Percentage of the network that is not congested General time saving assessment – minutes saved for average trip Change in travel times for commuters (public transportation and private) to key economic centers

Mobility and Accessibility Impacts

Congestion pricing and mobility accessibility are related to the ease by which travelers can use the transportation system and to congestion pricing education, employment, leisure, and social services. Time and delay dimensions are important, as are costs. Table F-3 presents suggested evaluation factors.

Table F-3: Possible Evaluation Factors for Congestion Pricing and Mobility

Objective/Issue	Possible Evaluation Factors
Mobility and Congestion Pricing improvements	General accessibility – change in aggregate generalized costs for vehicle, public transportation of the study area zones to population, employment, and school places (generalized cost combines all quantifiable costs including travel time, operating costs, parking fees, waiting time, walking time) Sector-to-sector travel times by car Sector-to-sector travel times by passenger transportation Sector-to-sector travel times by freight vehicles

Network and Service Utilization

A fundamental objective of congestion charging is to make the most efficient usage of all transportation resources. Therefore, while containing traffic volumes, the intention is to ensure that road, bus, and rail facilities are not underused.

Table F-4: Possible Evaluation Factors for Network Efficiency and Safety

Objective/Issue	Possible Evaluation Factors
Utilization level of transportation facilities	Percentage of road network at different utilization levels (e.g., V/C ratios) Percentage of rail and bus systems at different utilization levels (e.g., V/C on links or cordons) Average cost per vehicle mile for car, bus, trucks Average cost per passenger mile for bus, rail
Traffic accidents and injuries	Change in number and severity of accidents by: • User group • Road type • Mode
Road maintenance costs	Change in vehicle/mile by: • Vehicle type • Road type

Impacts on Public Transportation and Rail

Seattle has a good ferry, light rail, and road-based public transportation system and can offer a high-quality and high-capacity alternative to private cars and taxis in and to the CBD. Road-based public transportation users are likely beneficiaries of demand management. The parameters in Table F-5 can act as indicators.

Table F-5: Possible Evaluation Factors for Public Transportation and Rail

Objective/Issue	Possible Evaluation Factors
Improved public transportation travel	• Average journey time • Average bus speed • Average vehicle capacity (crowding)
Shift to public transportation broken down by: • journey purpose • time of day • origin/destination	• % change in passenger transportation patronage (rail, bus) • Number and % of commuting trips by passenger transportation • Change in passenger miles traveled
Overall net impact on users of public transportation	• General commentary on overall net impact to users of public transportation • Reliability improvement assessment – qualitative rating scale • Estimates of additional facilities and services required

Transportation Economics

The conventional application of transportation economic evaluation should provide a key input to the evaluation process. The approach should be consistent with that of the PSRC modeling, as far as technical procedures permit. Note that the economic evaluation to a degree overlaps with other evaluation indicators and care should be taken to prevent double-counting.

Table F-6: Possible Evaluation Factors for Transportation Economics

Objective/Issue	Possible Evaluation Factors
Economic Evaluation • Estimate transportation benefits and costs of demand management strategies and schemes • Disaggregate analysis to track social distribution of benefits and costs (as part of sustainability and social impact analyses)	• Travel time savings • Vehicle operating cost savings • Capital costs • Maintenance costs • Accident costs • Environmental costs • EIRR (Economic Internal Rate of Return) • NPV (Net Present Value)

Sustainability Indicators

The study should provide input data to the City process set up by Seattle to measure the contribution of policies and programs to sustainable development. In transportation terms, the key global parameters refer to the extent to which strategies encourage shifts to public transportation and reduce road-based travel. As well as meeting this requirement, the evaluation framework provides for analysis of more disaggregate indicators of sustainability under economic, environmental, and social headings.

Economic and Business Impacts

The impacts of congestion pricing on business should be studied and evaluated at a largely qualitative level in the context of the scheme designs. The study should consider the general impact on the Seattle CBD as a financial, retail, and tourist center and its attractiveness and value. This should be an essentially qualitative view contrasting local economic costs (e.g., possible impact on retail) and international value (e.g., Seattle and the Puget Sound region as a sustainable business place).

Table F-7: Possible Evaluation Factors for Economic and Business Impacts

Objective/Issue	Possible Evaluation Factors
Direct impacts on household sector Impacts on retail trade	General commentary on household consumption impacts, and expected retail impacts, informed by quantitative analysis.
Increased commercial productivity levels, business activity, and investments	General commentary on commercial productivity impacts (e.g., effect on business travel costs arising from incurring demand management versus reduced trip time and costs, relative to total business costs) informed by quantitative analysis
Consistency with, and contribution towards, Seattle tolling interests	Assessment, based on quantitative economic outputs, combined with anticipated land use and business impacts
Travel between key economic centers	Changes in travel times between key economic centers, or along key routes for road passenger transportation

Environmental Impacts

Environmental impacts of tolling variations should be studied in terms of the general change in vehicle usage on the Puget Sound roadway network and the associated emissions and noise. In addition, quality-of-life impacts should be considered in and adjacent to the charge zone, primarily in a judgment-based way, based on traffic modeling inputs. Examples may include a variable charge pushing delivery vehicles out of peak periods of traffic to off-peak periods, which may negatively impact neighborhoods in the charge zone during early hours before the charge or late hours after the charge period.

The environmental impact of any strategy should be measured using output VMT and vehicle hours by type from the PSRC model and converting these into emission volumes using agreed-upon standard rates. Variations between the relieved study area and fringe areas affected by diverted traffic should be identified as well as corridor and global benefits and impacts.

Table F-8 presents direct environmental effects of land transportation that are considered relevant to this study.

Table F-8: Possible Evaluation Factors for Environmental Effects

Objective/Issue	Possible Evaluation Factors
Change in levels of emissions	Change in vehicle emissions by key transportation corridor and overall regional level: • Nitrous Oxide • Particulates • CO2 • Noise in decibels (db)
Noise and vibration impacts	Broad estimates of changes in assessment of noise impacts on key routes based on traffic volumes as an indicator
Improving amenities for those who visit, live, and work in the City of Seattle	Changes in traffic volumes along particular routes that are known to cause community severance issues General commentary, informed by overall transportation model outputs

Social Impacts

The social impacts should be addressed in terms of sustainability and as described in this report under implementation factors regarding public acceptability. The distribution within the community of the benefits and costs of the strategies should be tracked using quantified data from the PSRC and Seattle model and in qualitative terms with regard to quality-of-life and lifestyle issues.

Table F-9: Possible Evaluation Factors for Social Impacts

Objective/Issue	Possible Evaluation Factors
Raise mobility for all sectors of community	Transportation analysis and economic benefits/costs disaggregated by: • Area • Traveler group • Purpose
Provide adequate and affordable transportation	Assess distribution of costs of scheme by social group
Address adverse impacts on stakeholders and social groups	Complementary measures

Integration of Land-Use and Transportation Planning

Assessing consistency with land-use and growth policies should be a qualitative exercise, based on quantitative data inputs wherever possible. The primary basis of the analysis should be existing information on land-use trends, outputs from the modeling, and qualitative judgment on the extent to which different scheme variations would integrate with the planned land-use developments.

The analysis should necessarily take a long-term view of likely land-use changes under the different project variations. The Seattle model outputs should provide an indication of the extent to which the different variations will affect the underlying drivers of land-use change (through modification to patterns of accessibility). It should not provide a definitive view of the longer-term picture. Changes to accessibility should interact with other changes in the demand for, and supply of, land-use activities.

Table F-10: Possible Evaluation Factors

Objective/Issue	Possible Evaluation Factors
Support of planning and urban development objectives in Study Area	Compatibility with planned development and redevelopment Transportation capacity and connectivity
General land use implications	General commentary based on the general transportation patterns delivered by demand management variations

Implementation Factors

Technical Feasibility and Implementation Issues

Assessments should be made of the technical feasibility and implementation issues for tolling strategies and projects. For each project variation, there should be a range of possible technical solutions, each presenting a different cost/effectiveness tradeoff. Evaluation factors in this area should focus on the complexity of the technology required to implement each option, risks and costs of that technology, potential timeframe to implementation, and general feasibility issues. Analysis should draw in particular on the SR167 and SR520 projects and recent national and international experience to provide comparative distinctions between the schemes in terms of design and implementation issues, including enforcement and establishment of operating factors.

Enforcement of tolling is essential to ensure both its integrity and the ability to impact road user behavior. Enforcement costs vary by system type and technology. The technology stream should evaluate the different technologies and make recommendations on the best fit for the Puget Sound environment. This means that technology may not differentiate between the types of format adopted (e.g., distance, area), but may impact the complexity of the boundaries to be drawn or the charging system, to be adopted. Where these characteristics change relative to the performance of different scheme options, they must also be captured in the evaluation framework.

Capital and operating costs associated with the technology choices for different scheme variations should also be captured in the broader evaluation framework.

In terms of assessing feasibility, it is necessary to examine the extent to which the scheme is achievable, able to be implemented (in a technical sense), and adjusted to meet changing needs, and overall, whether it appears “sensible” at a subjective level. Technical assessments should address the administrative systems involved in issuing licenses or permits, issues (at a high level) relating to the introduction of the tolling systems, enforcement mechanisms, and how much flexibility can be built into the systems.

Table F-11 presents possible evaluation factors.

Table F-11: Possible Evaluation Factors for Technical Feasibility/Implementation

Objective/Issue	Possible Evaluation Factors
Implementation within a reasonable time horizon using proven technology	Estimated timeframe for implementation Number of other international schemes in operation using comparable (i.e., proven) technology Assessment as to administrative feasibility Assessment of physical / technical feasibility including estimated timeframes
Technical risks	Qualitative assessment scale of risk management
Administrative and financial risks have been identified and are regarded as manageable	Assessment of the likely ease of enforcement Likely violation rate and rate of violator capture
Capacity to vary charges by user type and/or time of day	Yes/No, based on system designs
Responsiveness of the system to deal with special cases (people/businesses)	Assessment of ability to be flexible for potential special cases (e.g., where a discount might apply)
Minimized aesthetic impact	General commentary on nature of roadside equipment
Capable of area reduction or extension to a wider area or migration to a more advanced system	General commentary on long run flexibility based on technical descriptions

Financial Costs and Revenues

Closely linked with the technology assessment, international research should be used to provide cost estimates for different technology choices. Key issues influencing cost could include moves to 5.9GHz technology, specific communications technology advances, more recent worldwide information, user behavior (e.g., in terms of compliance, payment options, and frequency) and a thorough assessment of costs based on actual implementations. The approach should include describing high-level scheme architecture such as proposed effective technologies; providing capital cost (firm estimates) and ongoing operating costs (broad estimates only) derived from operational framework; and assessing potential revenue leakage risk, including enforcement risk and revenues based on international experience.

Financial assessment should analyze the revenue (e.g., fees, fines) generating the potential of each option and the NPV over an agreed-upon evaluation period based on forecasts for future years and any necessary extrapolation years taking into account implementation and operating costs. Financial outcomes of the project should be sensitive to the charging tariffs. As charge tariffs are increased, traffic volumes available for charging fall as drivers either switch to other modes of transportation or choose not to travel.

Table F-12: Possible Evaluation Factors for Financial Costs and Revenues

Objective/Issue	Possible Evaluation Factors
Revenues raised	Total revenue raised Likelihood to generate positive net revenues (after deducting costs to collect)
Cost to implement – both before and after consideration of mitigation measures	Total cost of establishment and replacement
Financial performance	NPV taking into account both establishment costs and net revenues over a period FIRR (Financial Internal Rate of Return) Depreciation rates on assets
Operating costs	Operating costs per vehicle charged, per chargeable transaction
Business case extent to which costs and revenues are regarded as predictable and achieve acceptable FIRR	Qualitative risk assessment of revenue and cost risks and uncertainties

Privacy Issues

Privacy issues are invariably high on the agenda of the general public and decision-makers when the technology approaches associated with road pricing are considered. The approach should consider two dimensions to evaluating schemes in terms of privacy issues—technical compliance with privacy requirements and the public's perception of privacy implications associated with technology choices for the schemes. As such, Table F-13 presents the proposed evaluation factors.

Table F-13: Possible Evaluation Factors for Privacy Issues

Objective/Issue	Possible Evaluation Factors
Capable of implementation in compliance with Freedom of Information Laws	General commentary – assessment of technical description against Freedom of Information Laws requirements
Public perception of privacy implications / issues	Assessment of system proposed against assumed public position

Social Equity and Lifestyle

Social equity is another important acceptability issue that should be addressed in the strategy and scheme design. This analysis is from a more specific public acceptability perspective compared to the broader analysis under the sustainability assessment.

Boundary conditions of a scheme may divide communities or cause adverse impacts to schools and university students who must cross or enter the zone each day. Likewise, due to individual transportation and work patterns, key social services such as hospitals and clinics within zone boundaries may adversely impact lower income healthcare as observed in London. By comparison, an electronic gateway (or access control) system, such as the one in Florence, Italy, may provide a more acceptable solution that offers a broad range of "social" exemptions or discounts.

The equity distribution of impacts across areas and groups within society should also be recorded. Reporting should cover impacts on the ability to access jobs, education, health care, public facilities, goods, and other services. In particular, information from the operation of the London scheme should be provided. Additionally, the detailed assessment of possible implications for social acceptability and access to education, employment, health, and leisure activities should be reviewed for application in the Seattle environment. In this context, Table F-14 lists possible factors for assessing social impacts.

Table F-14: Possible Evaluation Factors for Social Equity and Lifestyle

Objective/Issue	Possible Evaluation Factors
Boundary effects	Numbers of trips affected by toll charges relating to specific facilities of interest (e.g., education, healthcare) Ability of lower-income, frequent users to avoid the charge by bypassing the toll zone Commentary on incidence of payers (i.e., income, demographic groups)
Overall impact on daily/weekly travel patterns and therefore household activity: • Socio-economic groups • Residential locations • Journey purposes	Qualitative overview of the impact on travel distribution patterns drawing on quantitative analysis
Consequences for urban form and interrelationships between key socio-economic activities	Time effects between employment centers and residential areas with relatively higher unemployment, in the city and region Net transportation cost impact on travel between employment centers and residential areas with high unemployment Qualitative assessment, drawing at a high level on transportation modeling outputs, as to the impacts on travel between residential areas and areas with strong concentrations of community / leisure facilities

Legislation and Administration

The potential legislation required to enable a toll project(s) and its overall administrative simplicity should be reviewed. It is unlikely that legislation will be a factor between scheme variations, so it should not be developed until the preferred tolling project is analyzed in more detail. Administrative simplicity should, however, potentially differ between scheme variations, and may be considered in early rounds of the evaluation.

Table F-15: Possible Evaluation Factors for Legislation and Administration

Objective/Issue	Possible Evaluation Factors
Administrative simplicity	Complexity of the system required, particularly focusing on billing and enforcement arrangements Likelihood of misunderstandings by the traveling public

Public Acceptability

In assessing the feasibility and desirability of each option, it is necessary to assess not only the effectiveness of each option in achieving desired outcomes, but also the incidence of impacts, as tolling will impose costs on some and provide benefits to others.

The impacts on different groups (businesses and households, different types of trip makers, households with different socio-economic, demographic, and income characteristics) must be distinguished. Additional attention should be paid to impacts by geographical area, to identify who pays and who are the beneficiaries and the affected.

The study should include preparation of a public consultation strategy or supporting attitudinal markets/social research. Market-based research should provide an indication of the likely level of public support disaggregated to cover key stakeholders such as:

- **Clear beneficiaries** – Road-based public transportation operators, public emergency services, recipients of funding from net revenues, and the traveling public
- **Possible beneficiaries** – Freight operators, taxi operators, businesses assuming time benefits outweigh costs
- **Possible negative effects** – For example, businesses dependent on private lower-income motorists likely to be affected by congestion pricing schemes.

Table F-16 presents some qualitative measures building from quantitative information provided by the transportation, modeling, and social impact analyses.

Table F-16: Possible Evaluation Factors for Public Acceptability

Objective/Issue	Possible Evaluation Factors
Public acceptability	Judgments on levels of impacts on key stakeholder groups, disaggregated by clear beneficiaries, possible beneficiaries and possible users, and consequently their likely level of public support Identification of possible measures to address

Technology Evaluation Criteria

Technical Feasibility

The key technological barrier to road pricing in the past has been identifying and charging vehicles for road use without stopping them. Three main technologies are used to identify and record chargeable events—image capture of license plates (ALPR), DSRC between a tag attached to the vehicle and a roadside gantry or beacon, and vehicle positioning systems (e.g., GPS or the forthcoming Galileo or Russian GLONOSS) with onboard digital map and mobile cellular data communications.

Some contend that cellular technology can also be used with third-generation wireless technology (3G) since the footprint of the cells are smaller than with the Global System for Mobile communications (GSM). Tests have not proven this to be the case as of yet. The testing of alternate technologies in London has indicated issues with cellular technology for road pricing. A newer technology is that of pico-cells or nanotechnology—in effect, very small processors and very short-range cells. Newcastle University has tested this technology, and while it holds some promise, it may be years before such techniques are commercially available. In summary, Table F-17 presents the tradeoffs between these options.

Table F-17: Comparison of Technologies for Identifying and Charging Vehicles

Technology	Advantages	Disadvantages
Image capture/ANPR	No on board equipment	Inflexible, unsuitable for multiple cordons or time variations. 20-30% rate of detection error
DSRC	Very high detection accuracy. Low cost on board unit. Flexible for multiple cordons or time varied charges.	Expensive roadside infrastructure Needs installation of tags
GPS/digital/mobile data	Highest flexibility. Most suitable for network wide charging. Less roadside infrastructure than DSRC.	More expensive on board equipment. Needs accurate digital map and regular on board unit updating. Enforcement to be proven. Unproven in urban environment.
Cellular (mobile telephone technology)	Reuse of existing infrastructure Suitable to urban centres Low capital costs	Cell coverage is still a problem for boundary conditions. Control is handled by the major network operators. Coverage and blind spots may occur.
Pico or Nano Cell technology	Low cost components. Flexible cells and zones	Not commercially available as yet. Networking of pico cells to central station Unproven enforcement.

The criteria for the technical evaluation of the various options should be assessed according to the following criteria:

Existing urban schemes are ALPR or DSRC-based and have proven themselves to be effective and reliable, with few technical implementation problems. An operational GPS urban scheme does not currently exist. It is clear, however, that technology used in Singapore, Stockholm, Italy, and Norway for electronic free-flow tolling (DSRC) is superior in terms of reliability and flexibility, compared to manual tolling and ALPR technology used in London. With reliability rates of over 99.5 percent, and the ability to charge according to different points and time of day (which is expensive and very difficult with ALPR technology), DSRC provides a significant advantage. Transport for London is now testing the technology for implementation within the next 5 years.

In all schemes, effective enforcement is critical, and ALPR technology is used to capture vehicles without DSRC tags or, in the case of London, without accounts. The reliability of data in the motor vehicle registry database and ready accessibility to it for enforcement purposes is critical in all cases. It is notable that the Stockholm scheme has an exemption for non-Swedish registered vehicles, simply because of the difficulty of enforcement.

Interoperability

The question of interoperability concerns the availability of a standard payment mechanism that can be used (in this case) at a number of independent toll facilities. Thus, because the U.S. lacks a national standard, cash is an example of an interoperable payment mechanism. Manual toll collection systems are effectively interoperable in the sense that a motorist can tender the same form of payment.

In the same way, any future ALPR-based tolling systems would be broadly interoperable, because license plates are issued to a defined standard. The qualification to this statement has to do with two main factors. First, there is the matter of foreign-registered vehicles, which bear plates in different sizes, formats, fonts, and colors from Washington State plates. Second, sufficient variability exists in the manufacturing of Washington State license plates (both in the choice of font and in the positioning of symbols and fixings) to cause optical character recognition (OCR) software to produce errors.

A working definition of interoperability would therefore be “the ability of systems to exchange services.” With ETC, this can have different interpretations. At minimum, it means that a motorist can use his tag in two different systems. Ultimately and ideally, it denotes “the ability to use all fee collection systems with a single DSRC tag or onboard unit (OBU) and a single contract.” WSDOT defines this service based on the principle of "one contract per customer, one box per vehicle.”

Interoperability in the complete sense used above requires interoperation on three levels—technical, procedural, and contractual.

In reality, the situation regarding interoperability of ETC systems based on the use of transponders is not yet fully resolved. However, work is well advanced, and essential standards are now in place governing the interoperability of ETC systems based on DSRC.

The following describe the levels of interoperability:

Technical: Interoperability on this level means that the technical interfaces are harmonized. DSRC provides standards that define the communication software. Technical interoperability is provided by the hardware and firmware of ETC equipment. A number of DSRC provisional standards (prEN) have been in place for several years. Full technical interoperability was not achieved since the provisional standards allowed for variability and for several options in the actual implementation. With the final standards (EN), the allowed variations have been narrowed down and technical interoperability is achieved.

Procedural: Whereas technical interoperability is a relatively simple (though hard-fought) matter and can largely be left to industry to define its own standards, procedural interoperability is a difficult topic and a matter to be agreed upon by the operators of the ETC systems involved. Procedural interoperability is achieved through agreement among operators and is mostly provided for by the ETC equipment application software. This level of interoperability implies harmonization on the processes of fee collection, such as:

- Fee collection concept (pay per passage, pay per distance on a motorway, pay for all distance in an area)
- Classification parameters (tariffs vary by number of axles, length of the vehicle, gross laden weight, emission codes, trailer presence, etc.)
- Security concept.

These topics are at the heart of the individual operator's business model, making it difficult to achieve the required degree of convergence in this area. Differences will remain as various fee collection systems do not share the same aims and legal background (e.g., private concession operators collecting revenue to refinance infrastructure versus public authority operators collecting tax-like fees for the use of all roads in a country versus a city collecting a peak-period congestion charge).

The difficulty with procedural interoperability is that it becomes a matter of defining not the "lowest common denominator" but the widest set of factors that must be present to ensure completely free roaming. This may mean costly provisions by one operator for the benefit of another. Although the home system of a user may require only a minimal set of classification parameters, interoperable user equipment must be prepared to carry parameters required by all other operators involved in interoperability.

Another topic is aligning the security approaches. Large interoperable (probably nation-wide) schemes provide a more lucrative target for organized fraud than small local systems. Preventing this requires well-designed security measures in the ETC systems. For the sake of interoperability, it also necessitates an exchange of security information, like sharing secret keys—something operators are very reluctant to do, since they potentially lose control over their own security domain.

Contractual: Operators that want to become interoperable also have to enter contractual relationships. They need to agree on questions like:

- Who carries the risk of non-paying roaming users?
- Who enforces roaming users?
- What proof is required that a user has actually used a foreign ETC system?
- Which means of payment are acceptable?

Such contracts are notoriously difficult to achieve, since there is little benefit for an operator—commercially, interoperability does not yet pay. The number of roaming users is usually quite small compared to the costs and constraints that interoperability carries.

Payment Systems, Out-of-state Vehicles, and Exemptions

Tolled facilities are required to use free-flow interoperable tolling systems that avoid the use of toll booths and are consistent with WSDOT's standards for toll collection systems. WSDOT's electronic tolling system, *Good To Go*, is in use on the Tacoma Narrows Bridge and the SR 167 HOT lanes. *Good To Go* is an automated, ETC system that allows variable and dynamic pricing. Tolls are collected using a transponder in the vehicle that communicates with roadside antennae. There is no need for manual toll booths—and no interruption to traffic flow for toll collection.

Good To Go customers have pre-paid electronic toll accounts that are debited for each use. Violators who use the express lanes without paying are fined. A camera photographs the license plate and a citation is mailed to the address of record. Toll infractions are issued to anyone who does not pay. The fine for a HOT lane infraction is $124. The fine for a *Good To Go* lane infraction on the Tacoma Narrows Bridge is $52.

A pre-paid *Good To Go* account may be replenished automatically, when the balance drops below the minimum balance ($8.00), by linking the account to a credit or debit card. When an account drops below the minimum balance, funds are automatically transferred from the credit or debit account. The minimum add-value is $30. Accounts may also be replenished manually, for a minimum of $30. Manual transactions may be made using a credit card, debit card, check, cash, or money order.

Good To Go accounts may be opened on-line. Accounts opened on-line are automatically linked to credit cards for replenishment. Value may be added to an account automatically or by mail, over the phone, or in person at a customer service center.

In other areas, efforts are being made to make it easier to obtain a transponder. In the Northeast, E-ZPass "On the Go" makes it possible to purchase a transponder for $25 from a participating retailer. $15 of the $25 pre-paid balance is available immediately; the remaining $10 is accessible when the transponder is registered and the account secured with a credit card.

Efforts are also being made to accommodate customers who do not have credit cards or bank accounts, or who are driving rental cars. Puerto Rico's reverse payment concept activates and replenishes a customer's ETC account with cash, credit, and debit, making ETC tags available to everyone. Tags, which are available at over 125 retailers and the toll authority, provide access to electronically tolled lanes for users who would otherwise need to go through cash lanes. Each technology option should be able to be configured to provide for central accounts and post-payment facilities.

In any technology scheme, it is assumed that there would be an absolute requirement for all vehicles entering the charged area to be captured, via ALPR, by the charging scheme. The issue of how to handle out-of-state vehicles is nevertheless important, as there will inevitably be administrative and technical issues associated with how to accomplish this.

The provision of exemptions (e.g.: emergency service vehicles) is in theory practical for whatever technology option is chosen. However, the potential for evasion and/or fraud must be considered carefully.

Local Technology Transfer

This criterion is contained in the study and relates not only to the possible supply of system elements but also to operation and maintenance issues.

Freeway Extension

This criterion should assess the ability of each technology to be used to extend or be used for toll expressways, including the system's suitability for high-speed tolling in free-flow, multi-lane conditions.

Estimated Costs

Using some assumptions and expert input, it is possible to estimate future capital costs of implementing a congestion pricing system and recurrent costs of subsequent operation and maintenance for each technology option. Results should be assessed and modified as necessary to provide realistic cost projections. Components common to both approaches, such as much of the control center costs, should be normalized to provide consistency.

System Accuracy, Reliability, and Limitations

This criterion includes system capabilities to collect the correct toll fees for all vehicle types and under all anticipated traffic conditions. It also includes the accuracy handling exceptional cases such as exempt vehicles and violators. Recorded accuracies for all technologies should be assessed in this instance. These weighted total accuracies should be taken from other independent tests or operational environments such as the German and Austrian MAUT systems that are operational in those countries. Similarly, data from London, Manchester, Singapore, and Stockholm should be collected and used where possible. For newer technology assessments, results from independent tests, such as the London expansion testing, should be available.

Reliability of the transaction process is covered previously. Issues here include ease of installation, resistance to tampering, robustness in operation, and durability. The availability of GPS, GLONOSS, and Galileo signals for the GPS system options should also be considered under this criterion.

As far as possible, all potential limitations of the identified technology options should be identified, particularly those that might restrict efficient and reliable toll operation, or future expansion.

Radio Frequency and Roadside Equipment Issues

Issues here include the efficiency of use of the radio spectrum, the conformity of any required radio frequency to the Federal Communications Commission (FCC), and the potential for interference from other legal equipment using the same or similar frequencies. The most relevant aspect of the technology option is the communication link. Various DSRC candidates should be closely assessed for the available frequency in Seattle.

The visual, environmental, robustness, and safety considerations of any tolling or roadside equipment required will have a significant impact on its acceptability. They are significant factors in determining the recommended technology option. Gantries across three or more lane carriageways are not only very expensive but also visually intrusive.

In addition, it will be important for the continued operation of a tolling system to ensure that replacement and additional equipment, particularly the ongoing supply of OBUs, is available competitively.

Maintenance

The ease of maintenance and readiness of local maintenance support will largely be determined by the arrangements made by the eventual suppliers of a tolling system. However, it is important to assess the difference in maintenance requirements between the various technology options, both for OBUs and for roadside equipment.

Privacy, Anonymity, and Security Against Fraud

All schemes addressed privacy in their planning and implementation. In Norway, privacy concerns helped design the system to retain data for not more than 24 hours. After that time, detailed transaction records are deleted; the system retains only daily summaries for accounting purposes. This puts a burden on the individual to challenge any charges within 24 hours of the event, because they cannot challenge details after that period.

London, on the other hand, has little in the way of privacy other than government statements of data protection. In a recent controversial case, a celebrity refused to provide detailed contact information to the system for her residential discount for fear of that information being disclosed or sold by Transport for London staff managing the system accounts. While safeguards are in place, there are few assurances in the London system. In Singapore, the system relies on smart card charging and records by a trusted third party, the banking institution, to hold details, rather than the system. The Auckland design had several other privacy design issues involving the use of cameras for enforcement and capturing of images.

Security against fraud is an essential item for a tolling system to be viable. There are likely to be many ways in which deliberate fraud or payment evasion might be attempted. These range from failing to fit an OBU, through the deliberate obscuration or falsification of number plates, to counterfeit equipment, which simulates authorized payment transactions. It will be imperative to ensure that any proposed system is not open to systematic and widespread evasion or fraud through the latter type of equipment.

Each technology option could be configured to offer an anonymous capability, as identified in the project strategies as a requirement. All efforts should be taken to protect the privacy of individuals with respect to their personal data.

Integration with Sound Transit, Smart Cards, and ITS

The various technologies assessed should be evaluated for their potential to integrate with the Sound Transit network in the region and the use of the One Regional Card for All (ORCA) card.

As with Sound Transit, there are several worldwide organizations introducing smart card payments on bank credit cards. These include Visa, MasterCard International, and American Express. A dedicated smart card for tolling, either contact or contactless, is also a possibility that should be considered under this criteria.

Integration with ITS is a wide-ranging criterion. There are two main aspects of any tolling system that are important for its potential contribution to and integration with an ITS system for the state. WSDOT is advancing plans for Active Traffic Management and HOT lanes. These offer the potential for monitoring traffic conditions using the toll system and the potential for using the tolling OBU (onboard unit) as an information and/or guidance device.

Notwithstanding the above, it should be noted that most of the tolling integration with ITS is conceptual at this point. To date, no proven records are available for the cost or benefit analysis of this integration. In addition, many of the possible tolling, automatic teller machine (ATM), HOT, and ITS integration components can be recognized as independent systems. This means that they may be implemented in the region before there is a tolling system available.

System Flexibility and Level of Experience

Any tolling project introduced in the Puget Sound region would need to be capable of being modified and extended based on other worldwide experience. As network changes may occur in any design, it would be necessary to review boundaries and modify them to reflect changing circumstances.

In addition, introducing slightly more complex zone systems could reduce any adverse boundary effects of an initial cordon or area approach. It is therefore highly desirable that the selected technology option should allow for the system design to be readily modified and extended.

Level of experience is another criterion and was included in the GPS technology assessment.

Enforcement

All current charging schemes use video enforcement for their systems. In London, the enforcement technology is also the charging technology, but is used as a deterrent to ensure that travelers have paid the daily charge for entering the system. ALPR technology in London is not used separately as a charging technology, per se, but as the enforcement and deterrent mechanism that ensures users payment. The matching of vehicles to number plates is merely an enforcement process.

The visibly successful enforcement of a full network or area tolling system would be a critical issue in establishing the credibility and hence overall success of the system. The ability to conform to a project timescale may be different between the various technology options, so it is important to assess this criterion.