SR 520 TOLL FEASIBILITY STUDY

prepared for
Washington State
Department of Transportation

prepared by
Parsons Brinckerhoff
PB Consult
with Resource Systems Group

April 2004

FINAL REPORT

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DISCLAIMER

This report was prepared by Parsons Brinckerhoff (PB), in accordance with an agreement with the Washington State Department of Transportation (WSDOT). This report is subject to the terms and conditions of the consulting agreement, and is meant to be read as a whole and in conjunction with this disclaimer.

Information and statements contained this report are based on information provided to PB by, and obtained from, the Washington State Department of Transportation (WSDOT), the Puget Sound Regional Council (PSRC), and other sources. In the preparation of this report and the opinions contained herein, PB makes certain assumptions with respect to such conditions that may exist or events that may occur in the future that are subject to change. These assumptions are made for purposes of modeling various scenarios of the SR-520 Bridge with tolls and to identify potential revenue ranges, and are not intended to reflect any official decisions regarding toll policy or the bridge replacement options. Furthermore, the toll revenue and financial analysis results presented herein are provided for feasibility considerations and to enlighten further policy and planning discussions, and should not be construed as investment-grade projections.

This report does not constitute a recommendation of the Washington State Department of Transportation or that of PB.

EXECUTIVE SUMMARY

This report presents an examination of the revenue potential and traffic impacts of tolling a replacement SR-520 Bridge across Lake Washington.

As the existing bridge and approaches near the end of their design life, a primary objective of this study is to identify how much tolls could contribute toward their replacement, assuming that toll revenues are used to finance a series of bond issues. Preliminary project cost estimates range from $1.5 billion to more than $3 billion in year of expenditure dollars.

In addition, this study seeks to identify and further policy discussions of bridge replacement alternatives, tolling objectives, and project funding.

This effort is distinct from, but complementary to, the SR-520 Bridge Replacement and HOV Project's environmental process. The environmental process is addressing conditions in a 2030 horizon year and is focused on "worst case" impacts. In contrast, this study is primarily targeted at identifying the potential range of toll revenues in 2014, the projected year of opening, and their financial capacity to fund a portion of project construction through the sale of bonds.

The analysis examined two bridge replacement alternatives. The six-lane alternative assumed two tolled general-purpose lanes and one high occupancy vehicle (HOV) lane in each direction, the latter providing toll-free passage for transit vehicles and carpools with three or more occupants (HOV 3+). The four-lane alternative assumed two tolled general-purpose lanes in each direction in the same basic configuration that exists today. In this case, 3+ HOVs were assumed to be tolled like any other vehicle, and only transit vehicles remained toll-free. An eight-lane alternative is also being studied as part of the concurrent environmental process, and a toll feasibility analysis for this alternative is the subject of potential future work.

While this study represents a significant refinement over earlier toll analyses that examined this corridor, it does not constitute an "investment-grade" analysis, and therefore would not generally be suitable for obtaining an investment credit rating and/or issuing bonds.

Finally, please note that the information presented in this executive summary represents the key highlights, and is brief by design. Additional detail can be found in the main report, logically organized within eight chapters and four appendices.

Two Bookend Tolling Objectives Modeled

Two different tolling objectives representing "bookend" pricing policies were analyzed for their toll revenue potential, using somewhat distinct modeling procedures and post -processing methods:

- **Traffic Management** — tolls set by time of day and direction of travel to levels sufficient to minimize congestion and maintain good traffic flow without unnecessarily diverting traffic to other roadways, thereby minimizing overall network travel times; and
- **Maximum Funding** — tolls set by time of day and direction of travel following a more precise time schedule and tailored to maximize toll revenue collections, and thus, project funding.

These two discrete tolling objectives mark the practical boundaries of a time-of-day variable toll schedule. A range of toll values, revenues, and diversion impacts are encompassed by these two tolling objective boundaries. In fact, it is unlikely that the underlying toll schedule for either objective would be implemented precisely as simulated herein. Rather, these two bookends are intended to identify the scope of reasonable possibilities within which an acceptable toll policy would likely be adopted to meet both the financing and transportation needs for improvements in this corridor. It should be noted that toll collection is assumed to be fully electronically automated under both pricing objectives.

In addition, both tolling objectives were modeled using a future transportation network that includes only those improvements fully funded by the 2003 Legislature's five-cent gas tax increase, referred to as the "Nickel Package". An alternative future network, using a more extensive set of improvements corresponding to the Regional Transportation Investment District's list of projects from autumn 2002, was also tested. It was found that these projects, including the I-405 and I-90 improvements, did not have a substantial impact on the SR-520 toll traffic demand or revenues generated.

Survey Research on Bridge User Values of Time

This report provides a more in-depth examination of the impacts of tolling than the series of earlier toll analyses conducted for various projects within the Central Puget Sound region. One notable difference is that the earlier toll analyses generally assumed a uniform value of time as a percentage of the average wage rate. The current work was preceded by a detailed stated-preference survey (SPS) and associated statistical analysis designed to learn more about the values of time and potential willingness-to-pay tolls for bridge users under both pricing objectives. The SPS study estimated the values of time for travelers specifically using the SR-520 facility. The analysis focused on vehicles with one or two occupants — those which would be subject to the assumed toll — and provided values of time by time period, trip purpose and trip frequency (the latter within peak time periods).

The resulting values of time were integrated within the modeling of the Maximum Funding pricing objective and used to derive the dollar value of the toll rate in the post-modeling revenue calculations under the Traffic Management pricing objective. Expressed in today's dollars, the aggregated average value of time for SR-520 bridge users is $14.43 per hour during weekday peak periods, and $12.08 per hour during off-peak and weekend times.

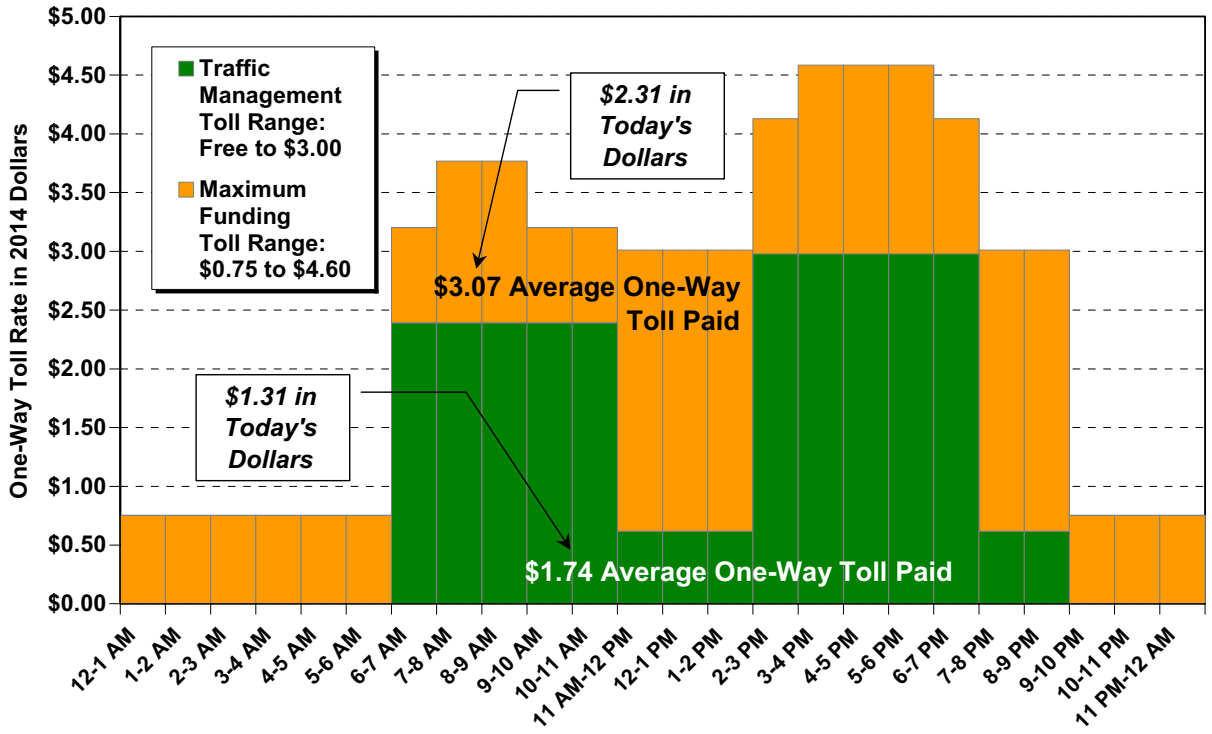
2014 Opening Year Toll Schedules

While the EIS modeling process examines a forecast horizon extending to 2030, this study focuses primarily on the 2014 horizon year as being representative of the time frame in which this project would be completed and operational with tolls.

Figure ES-1 presents the estimated toll rate schedule by time of day for the six-lane alternative under both the Traffic Management and Maximum Funding tolling objectives for 2014 demand conditions. The figure also indicates the daily toll range and average values, with all amounts expressed in 2014 dollars. These future values are about one-third higher than the equivalent toll in today's dollars for 2014 demand conditions. Note that in the Traffic Management case, tolls drop to zero during the night, effectively resulting in a 15-hour toll period, versus all day tolling under the Maximum Funding case.

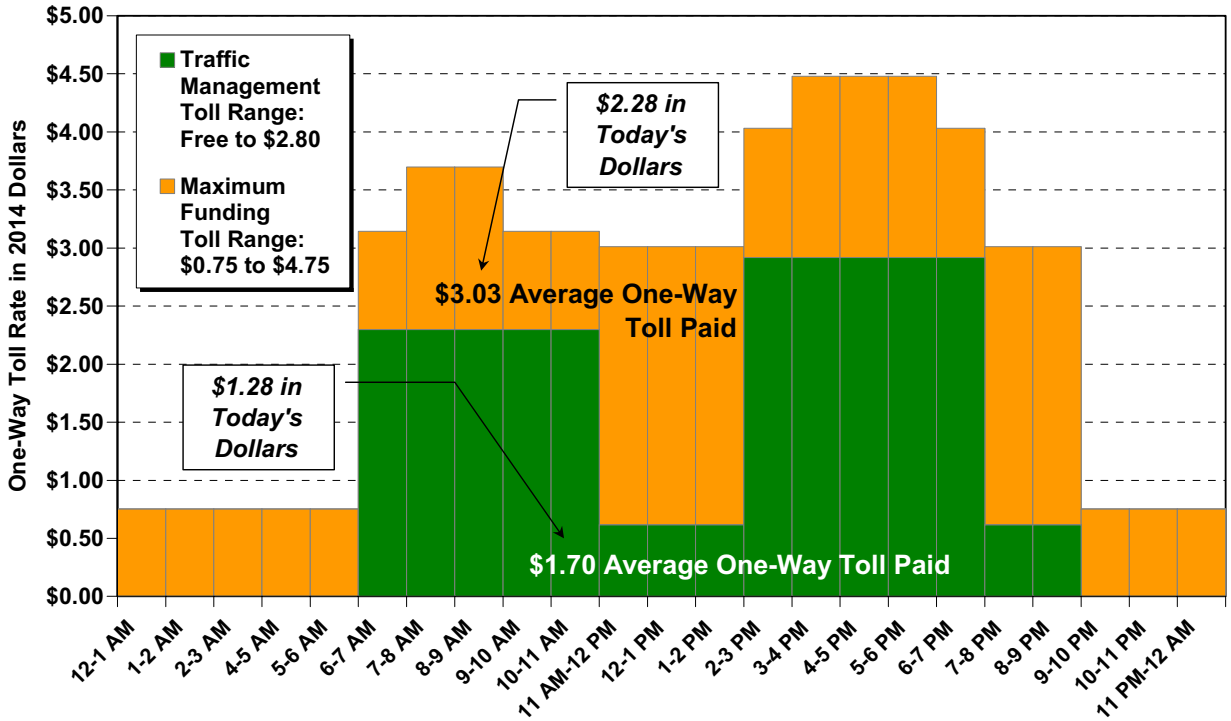
Note that Figure ES-1 does not distinguish toll rates by direction. This is because travel demand on this facility has become — and is expected to remain — balanced between eastbound and westbound travel over the entire day. As a result, the directional differences in estimated toll rates by time of day are likely to be insignificant.

Figure ES-1
Opening Year Toll Schedules by Toll Objective — Six-Lane Alternative (2014 $s)



The toll schedule for the four-lane case is essentially the same, and is presented in Figure ES-2 below.

Figure ES-2
Opening Year Toll Schedules by Toll Objective — Four-Lane Alternative (2014 $s)



A Comparison of Past and Proposed Toll Rates

How does the 35¢ toll that was in place on the existing bridge from its opening in 1963 until 1979 compare with the two bookend, time of day-variable toll schedules analyzed for 2014? In the years since the existing bridge was first tolled, both real wages and travel demand have escalated significantly, generating a likely willingness to pay tolls today that has increased more than general inflation. Even under the assumption of no future increases in real wages, demand growth is expected to result in 2014 tolls that would be higher by more than a factor of inflation over an equivalent situation today.

Nonetheless, considering just past and projected inflation, the 1963 toll rate of 35¢ escalates to about $2.50 in 2014. This falls in-between the average toll rate of $1.74 under the Traffic Management variable toll schedule and the $3.07 average rate under the Maximum Funding schedule. Given the growth in real wages, the evolution of significant traffic congestion on alternative routes, and other factors that have likely increased the potential willingness to pay tolls since 1963, the projected average toll rates of this study are reasonably equivalent to the original bridge's toll in its first year of operation.

Diversion Impacts

The presence of tolls on SR-520, for whichever tolling objective, will result in diversion of traffic from the tolled facility. This includes diversion to alternate routes, for example to I-405 connecting to either SR-522 or I-90 and/or changes in the time of day of travel; shift in travel modes (to HOV 3+ or transit); changes in trip destination to avoid the bridge; combining multiple trips into fewer trips; and trip elimination. The model used in this study does a reasonable job of estimating route diversion, mode shifts and changes in trip destination but is less capable of estimating changes in the time of day of travel, the combining of multiple trips or trip elimination.

In general, diversion rates were higher under the Maximum Funding tolls than under the Traffic Management case, as to be expected. For the six-lane alternative, daily traffic demand on the SR-520 Bridge without tolls is projected to approach 131,000 vehicles by 2014, including transit and 3+ HOVs. Total daily toll diversion of vehicle trips ranges from about 18% in the Traffic Management case to 33% in the Maximum Funding case. Because 3+ HOVs travel toll-free in their own lane under the six-lane alternative, tolling provides an incentive to form carpools, and the overall diversion of person trips is substantially less at 13% and 18%, respectively.

Under the four-lane alternative, 2014 daily traffic demand is projected to be about 125,000 vehicles, with slightly higher diversion rates of nearly 20% in the Traffic Management case and approaching 40% in the Maximum Funding case. With no preferential treatment of 3+ HOVs, there is minimal incentive for additional carpools to form.

During peak periods, especially the PM peak, diversion rates tend to be somewhat lower, and in particular, it was found that route diversion — taking an alternate route to avoid the SR-520 toll — was a less prevalent form of diversion. Route diversion to SR-522 was relatively low and diversion to I-90 almost nonexistent during peak times. Essentially, alternate routes are expected to be already congested to the point that there is little, if any, room for additional vehicles and/or the full alternate route travel time is prohibitively high. At other, off-peak times of day, capacity exists on alternate routes to make route diversion more attractive. Over the course of the day, the increase on traffic on I-90 and SR-522 ranges from 3 to 5%in the Traffic Management case, and from 11 to 15%in the Maximum Funding case, depending on the alternative considered.

Average daily traffic levels on SR-520 under the six-lane alternative with Traffic Management toll schedule would be approximately 107,000 vehicles (including 3+ HOVs), with 94,000 during the 6 AM to 9 PM toll period in 2014. This is roughly equivalent to today's volumes on the existing four-lane bridge. For the Maximum Funding case, 2014 demand is reduced to about 87,000 weekday vehicles, including 3+ HOVs.

Daily traffic levels for the four-lane alternative are 6 to 13% less than the six-lane alternative because the overall level of cross-lake travel is expected to be lower under this alternative.

Financial Capacity of Toll Revenues

A primary question addressed by this study is what level of project investment or expenditure can be financed by issuing toll revenue bonds. To this end, a detailed financial capacity analysis, including assumptions for future market conditions, was conducted using a financial model previously developed for toll facilities.

Gross revenues for the six-lane alternative were estimated for the two bookend tolling objectives, using the modeled traffic demand projections and the toll schedules underlying Figure ES-1. Similar estimates were also produced for the four-lane alternative. In order to assess how much of the project can be supported by tolls, gross revenue deductions need to be identified so that the net toll revenues available for debt service can be estimated. The following items represent deductions from the gross toll collections to yield net revenues:

- A deduction for revenue losses from electronic toll collection (ETC) inefficiencies, errors, violations, and/or subsidized trip allowances;
- A deduction for toll collection operations, customer service administration and enforcement; and
- A deduction for bridge and roadway maintenance.

More detailed information about these cost deductions to gross toll revenues is provided in the main study report.

Toll collection is assumed to commence with project completion on January 1, 2014 (though a sensitivity test was also performed to assess the additional financial capacity from initiating tolling during construction). Using 2014 as a point of reference, a series of additional, time-dependent adjustments were also made to the net revenue projections, including:

- A temporary net revenue reduction for an initial "ramp-up" period during which public understanding and acceptance of the toll facility is still developing; and
- A reduction in the revenue growth rate over time to reflect periodic toll rate increases that are smaller and/or less frequent than the optimal set of toll increases.

This last point is an important one, as revenue growth was capped at 3.0% annually. Whereas the toll modeling assumed that optimal toll increases — those accounting for both inflation and growing demand — are made every year, the financial capacity analysis takes a more conservative stance, recognizing that political events and established policies may constrain toll increases. Periodic toll increases are assumed and required to meet the projected revenue and funding levels. However, there are several combinations of "sub-optimal" toll policies and associated demand levels that would yield the assumed 3.0% rate of annual revenue growth.

Twenty-four financial scenarios were evaluated for the six-lane alternative based upon varying financial assumptions applied to both bookend tolling objectives. The overall range of funds that could be generated is depicted in Figure ES-3, with a minimum amount of $320 million and a maximum of $1.07 billion. Figure ES-3 also indicates some of the criteria required to hit a midrange, $700 million funding target. A similar range for the four-lane alternative generates approximately five to 10 percent less project funds than the six-lane alternative.

Figure ES-3
Toll Revenue Financial Capacity Ranges — Six-Lane Alternative

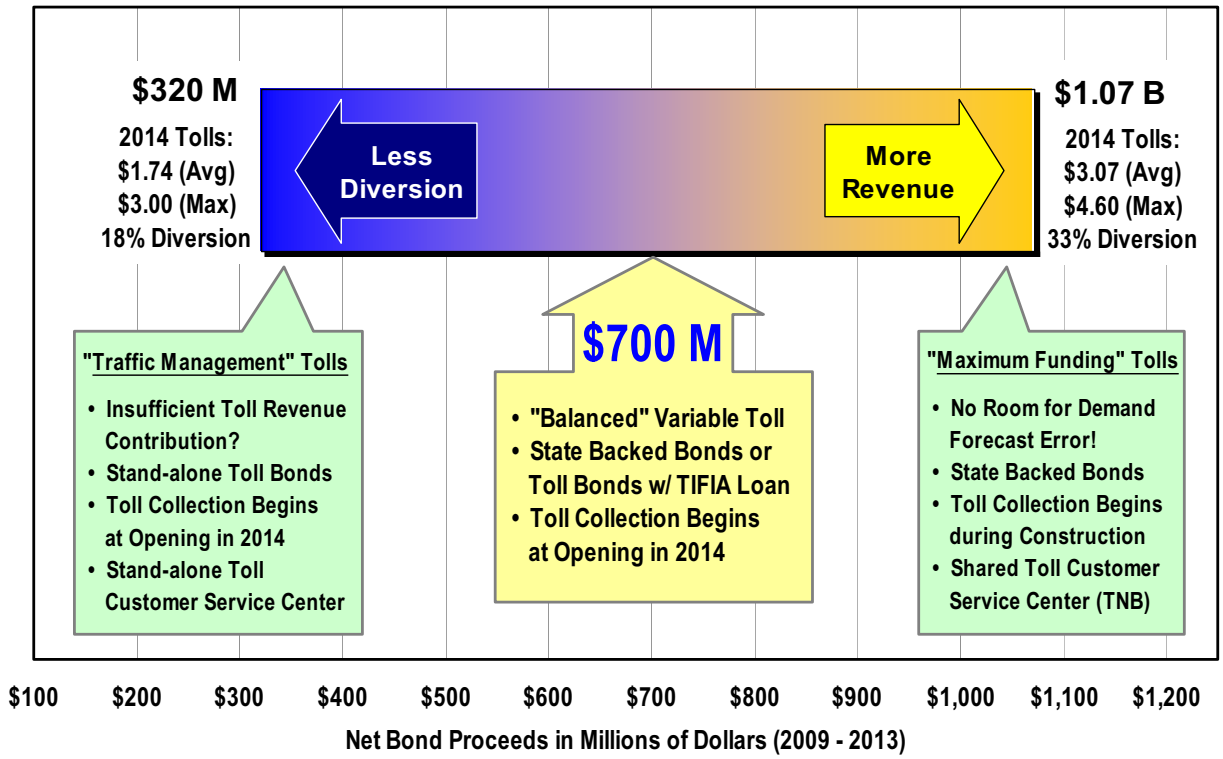


Table ES-1 presents the projected funding capacity from tolling a six-lane facility for 12 of the 24 financial scenarios, those in which tolling commences with the project completion in 2014. These 12 scenarios comprise the evaluation of State-backed bonds, stand-alone toll revenue bonds, and the latter with subordinate debt, under both stand-alone and shared regional operations, for each of the two bookend tolling objectives.

Table ES-1
Summary of Project Funds Generated by Financial Scenario

Tolling Objective	Toll Collection Begins January 1, 2014					
	Stand-Alone Toll Facility (Customer Service Center)			Part of a Regional Toll System (Shared CSC)		
	Stand-Alone Toll Revenue Bonds	Stand-Alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds	Stand-Alone Toll Revenue Bonds	Stand-Alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds
Traffic Management	**$321 M**	**$486 M**	**$521 M**	**$338 M**	**$513 M**	**$549 M**
Maximum Funding	**$554 M**	**$844 M**	**$899 M**	**$571 M**	**$871 M**	**$930 M**

Note: Amounts are net of capitalized interest and represent year of expenditure dollars based upon five years of bond proceeds during construction.

Assuming toll collection begins January 1, 2014, project funding supported by the tolling cases analyzed in this study ranges from approximately $321 to $930 million for the six-lane alternative, depending on the financial scenario. Bond proceeds are generally maximized when the State backs the bonds, the facility shares customer service center operations with the Tacoma Narrows Bridge (or other future regional toll facilities), and the opening year tolling schedule approaches the upper bound that maximizes revenue, and thus, project funding.

Other than the tolling objective assumed, the factor having the largest impact on the financial capacity of toll revenues is whether the bonds issued would be stand-alone toll revenue bonds or otherwise backed by the full faith and credit of the State of Washington (typically via motor fuel tax receipts). State backing could be achieved either with bonds issued directly by the State or possibly via the Regional Transportation Investment District. Such a backing significantly improves the marketability of toll revenue bonds, thereby lowering financing costs and debt service reserve requirements. These, in turn, increase the project funds that can be leveraged by a given net toll revenue stream.

Key Points

This toll feasibility study provides a planning-level examination of the toll traffic demand, toll structure and resulting revenues, and a financial capacity assessment over two "bookend" tolling objectives, for the SR-520 bridge four and six-lane replacement alternatives. However, in all likelihood, the toll setting process would yield a toll schedule and associated traffic and revenue results that fall somewhere in between the Traffic Management and Maximum Funding tolling objectives.

A variety of financial scenarios were tested which yield a broad range of potential project funds that could be generated from toll revenues. Several combinations of financial assumptions and toll operating conditions appear capable of yielding approximately $700 million for the six-lane alternative, and about 5-10% less for the four-lane alternative. Moreover, it appears that this mid-range funding level could be achieved without causing undue adverse impact to other network facilities.

Several forms of toll diversion are a byproduct of managing a roadway with pricing; however, the levels of route diversion to I-90 and SR-522 are expected to be very low during peak travel periods, due to the future congested conditions and associated high time costs for using these alternative routes to cross Lake Washington.

The six-lane alternative results in lower levels of toll diversion than does the four-lane alternative, because the former provide a dedicated toll-free lane for 3+ HOVs and transit. This HOV lane allows tolling to create an incentive for carpooling and transit use. As a result, the diversion of person trips is about one-half the diversion in vehicle trips under the six-lane alternative.

1. INTRODUCTION AND OBJECTIVES

Why this Study?

The forty-year-old SR-520 floating bridge across Lake Washington is approaching the sunset years of its design life, and its floating and approach sections have known storm and seismic vulnerabilities. The *SR-520 Bridge Replacement and HOV Project* is in the process of evaluating replacement options and conducting preliminary design as part of an environmental impact statement (EIS) process. Early cost estimates place the most basic reconstruction of the bridge in excess of $1.5 billion in year of expenditure dollars, and improvements such as a high occupancy vehicle (HOV) lane in each direction bring the estimated cost to over $2 billion. In recognition of the many under-funded major project needs in the central Puget Sound region, tolls are being considered as a potential piece of the funding for improvements in this corridor.

This "planning-grade" toll traffic and revenue feasibility study is primarily targeted at identifying the potential range of revenue streams beginning in the projected year of opening, 2014, and its financial capacity to fund project construction through the sale of bonds. It is complementary to, yet distinct from the traffic modeling and analysis of the EIS effort, which is addressing conditions in a 2030 horizon year and is primarily focused on assessing peak period impacts as "worst case".

The Regional Transportation Investment District (RTID), comprising the interests of King, Pierce and Snohomish Counties, is considering the replacement of SR-520 as one of several projects to include in a regional funding package proposal to go before the voters next year. Earlier this year, the Washington State Department of Transportation (WSDOT) and King County commissioned a study to examine the toll revenue potential of various pricing schemes for a half dozen improvement projects, including SR-520.[1] This earlier work examined toll options from a congestion pricing standpoint where pricing is used to help dampen travel demand during otherwise congested periods. Also referred to as value pricing, the main objective of this approach is to manage demand on the priced facility with user fees that are sufficient to keep the facility from becoming congested. Revenue is a welcome secondary objective, and toll revenue projections from this approach were the main product of the previous effort.

In contrast, this toll study focuses solely on the SR-520 Bridge, significantly expanding upon the earlier work to make a refined, more in-depth assessment of the feasibility of tolls for two "book-end" pricing or tolling objectives. Given that the package of RTID improvements is a work-in-progress that will ultimately require voter approval, this study makes the baseline assumption that the future road network in the projected year of opening (2014) of a replacement bridge includes only projects that are currently funded. This conservative approach is aimed at providing reasonable toll traffic and revenue projections for a tolled SR-520 bridge regardless of near term political events.

[1] *Toll Revenue Estimates for the Regional Transportation Investment District's Proposed Improvements with Value Pricing*, Parsons Brinckerhoff, January 2003

Figure 1 provides a simple map showing the location of the SR-520 Bridge and its connecting roadway and highway facilities.

Figure 1
SR-520 Bridge Toll Feasibility Study Area

Study Contents

In addition to the preceding Executive Summary and this Introduction, this report is organized around the following topics by chapter:

- Chapter 2 — background and traffic trends for the SR-520 bridge;
- Chapter 3 — understanding how bridge users value their time;
- Chapter 4 — modeling and estimation of traffic demand with tolls;
- Chapter 5 — projected toll rates by time of day and annual revenue forecasts;
- Chapter 6 — how tolls alter travel behavior (toll diversion) and time savings provided by the SR-520 bridge relative to alternate routes;
- Chapter 7 — toll bridge operating costs and associated roadway maintenance costs; and
- Chapter 8 — levels of project funding supportable by toll revenues (financial capacity).

Several Appendices are also included to provide additional analysis details.

The products of this study, including projected toll rates, traffic volumes and revenues should be considered "planning-grade" or feasibility estimates. While they represent a more refined and detailed analysis than previous efforts, they are not "investment-grade" and additional analysis would generally be required to obtain an investment credit rating and/or to issue toll revenue bonds.

What's Not Included

The following are not specifically addressed in this study, and may warrant future work.

- Policy issues and statutory restrictions regarding tolling the existing or a new SR-520 Bridge Washington statutory restrictions on tolling are not specifically addressed in this study.
- The eight-lane alternative currently being developed as part of the environmental process for the SR-520 Bridge Replacement and HOV Project was not sufficiently defined at the time of writing to be included in this study.
- Detailed construction costs and alternative-specific phasing have not been addressed.
- Bridge and roadway maintenance costs were adapted and modified from an earlier study, but an in-depth effort to update these estimates was not undertaken.

2. SR-520 BRIDGE — BACKGROUND AND TRAFFIC TRENDS

A Short Bridge History

Currently bearing the official name of the Governor Albert D. Rosellini Bridge at Evergreen Point, the SR-520 floating bridge opened to traffic on August 28, 1963. At the time, it was called the "Second Lake Washington Floating Bridge" in reference to the original floating bridge across Lake Washington, currently known as the I-90 Bridge. With two lanes in each direction, the bridge provides a key connection between I-5 in Seattle north of downtown to I-405 on the east side of Lake Washington with access to Bellevue, Kirkland and Redmond. The I-90 Bridge is the key alternative route to the SR-520 Bridge, crossing the lake approximately four miles to the south.

The SR-520 Bridge, including the approach roadways west to the I-5 interchange and east to approximately Bellevue Way, as well as the toll facilities, were completed for a cost of approximately $34 million including right of way acquisition, as summarized in Table 1. This amount excludes design costs, which were done in-house by the State. Inflated to today's dollars, the total in Table 1 would be about $170 million, or five times the original cost.

Table 1
SR-520 Bridge — Summary of Original Project Cost (1963 Dollars)

Construction Element		*Amount*
Floating Bridge and Approaches		
Bridge Floating Structure	$	10,969,597
East & West Bridge Approaches	$	3,518,767
Subtotal	$	14,488,364
West Approach Roadway		
Arboretum Interchange	$	4,547,197
R.H. Thompson Expressway — Temporary Connection	$	250,256
Roanoke Expressway — Portage Bay Viaduct to 10 Ave NE	$	3,090,362
Roanoke Expressway — Illumination & Signing	$	145,727
Subtotal	$	8,033,542
East Approach Roadway		
Toll Facilities — Buildings, Equipment & Sprinklers	$	272,731
East Expressway to Bridge — 1.9 mi + 3 Concrete Bridges	$	1,387,092
East Expressway to Bridge — Signing, Illumination, Sprinklers	$	169,063
Yarrow Bay Interchange	$	659,647
Subtotal	$	2,488,532
Subtotal Construction Contract Cost	**$**	**25,010,438**
Right of Way Acquisition	$	9,000,000
Total Project Costs	**$**	**34,010,438**

Source: Official Opening Program, Washington State Highway Commission & Washington Toll Bridge Authority, 1963

Toll bonds totaling $30 million were sold to finance the construction, and when it opened in 1963, the bridge had a 35¢ toll in each direction, collected at a toll plaza just east of the Evergreen Point Bridge. The toll was removed in June 1979 when the bonds were fully repaid, and over the next half dozen years, traffic demand grew to reach the facility's capacity during peak time periods.

In 1994, in response to the State's Public-Private Initiatives in Transportation Program (PPI) — which sought private sector assistance in developing and financing new infrastructure — a private consortium put forth a proposal to replace the SR-520 Bridge. The proposal — which included an additional transit/carpool lane in each direction, a bike lane, and mitigation of many of the original project's adverse environmental impacts to surrounding neighborhoods — was to be financed with tolls. The proposal was later withdrawn in 1995 when Governor Mike Lowry signed a law requiring a public vote of all toll projects proposed under the PPI program.

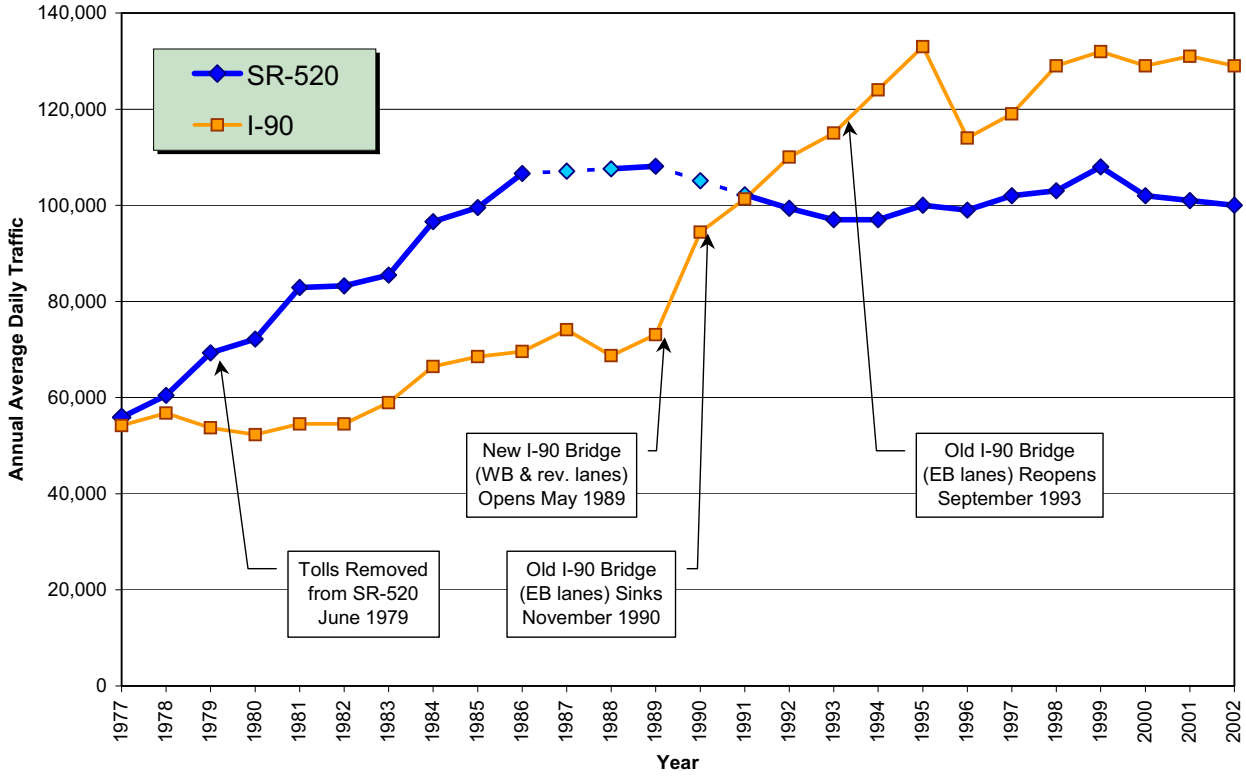
In the late 1990s, the Trans-Lake Washington project examined options for improving cross-lake travel from I-90 north. Among the options considered were replacement of the aging SR-520 bridge structure and approaches, including widening the corridor to increase capacity for general traffic, HOVs and/or high capacity transit. Recommendations from that work has segued into the SR-520 Bridge Replacement and HOV project, which is in the process of evaluating alternatives and conducting preliminary design as part of the preparation of an environmental impact statement (EIS). This effort will help the project's lead agencies and stakeholders select a final preferred alternative for implementation. Concurrent to this effort, the Regional Transportation Investment District is developing a funding proposal to put forth to voters next year to potentially help fund this and other major projects in the region.

Today the SR-520 Bridge carries about 110,000 vehicles day on a typical weekday, with very broad and directionally balanced morning and afternoon peak periods. The following provides some history and trend information regarding traffic demand on the bridge and a current perspective on the magnitude and impacts of the original toll that was lifted in 1979.

Cross-Lake Washington Traffic

Figure 2 depicts 25 years of average daily traffic volumes for both the SR-520 Bridge and the I-90 crossing. In 1977, total cross-Lake Washington travel numbered 110,000 vehicles. By 1999, SR-520 alone was carrying nearly that same volume, and the combined demand served by both bridges had reached 240,000. More recently, a slower regional economy has dampened traffic demand slightly, and volumes are down about 4.6% over their peak levels in 1999. It is interesting to note how a series of events that have affected the capacity of the I-90 bridge crossing have impacted traffic on SR-520. The capacity of I-90 increased by approximately 50% in 1989 with the opening of the new bridge; this reduced traffic and alleviated some of the congestion on the SR-520 Bridge for a few years. Although portions of the old I-90 bridge sank while undergoing repairs during a storm in November 1990, it was restored and reopened in 1993. Compared to the original floating bridge, the new and old bridges combined more than doubled the capacity of I-90 across Lake Washington.

Figure 2
Historical Average Daily Traffic Volumes Across Lake Washington



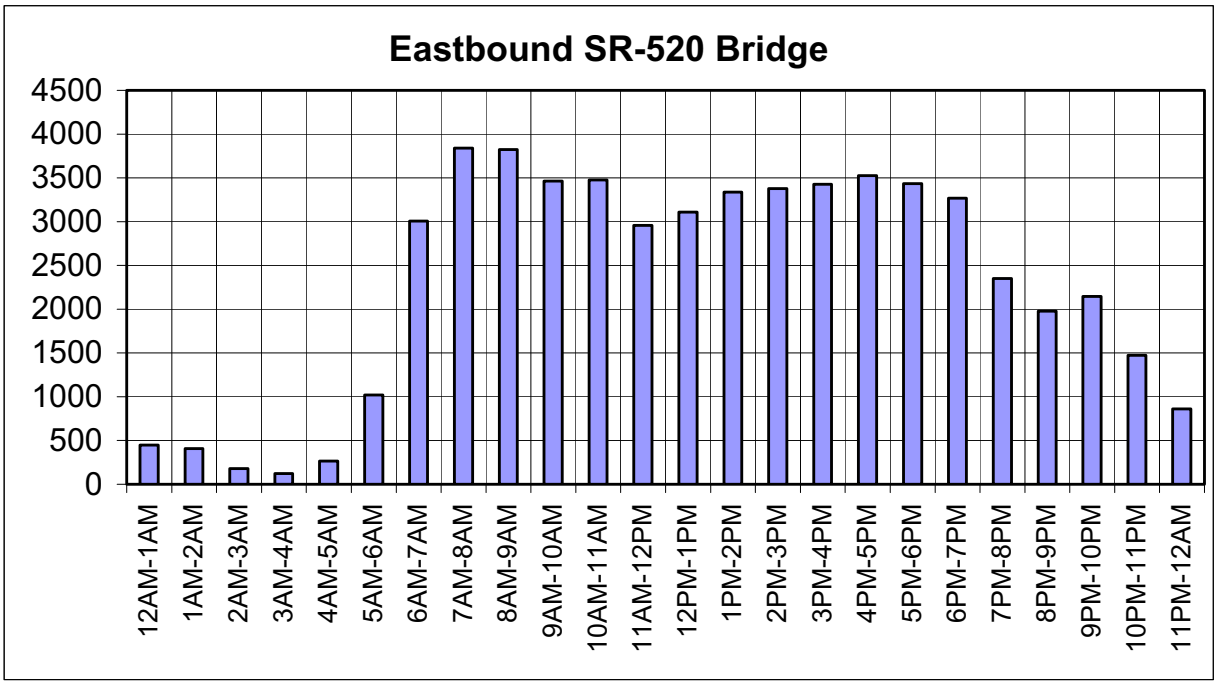
During the 1990s traffic growth on the I-90 Bridge exceeded that of SR-520 largely due to the fact that the former had excess capacity whereas the latter did not.[2] What growth has occurred in the SR-520 corridor has been primarily one of backfilling the shoulder times around the morning and afternoon peak periods, and growth in the "off-peak" direction. For at least the first 25 years, the primary weekday travel pattern on SR-520 was westbound into Seattle in the morning and eastbound out of Seattle in the afternoon, reflecting a bedroom community pattern on the east side of Lake Washington for Seattle-based employment on the west side of the lake. During the 1980s, the east side developed significant employment centers in growing technology and service industries, combined more recently with a strong housing market in Seattle and substantial new urban housing development in downtown. These trends have led to virtually balanced directional morning and afternoon peak traffic flows on the bridge.

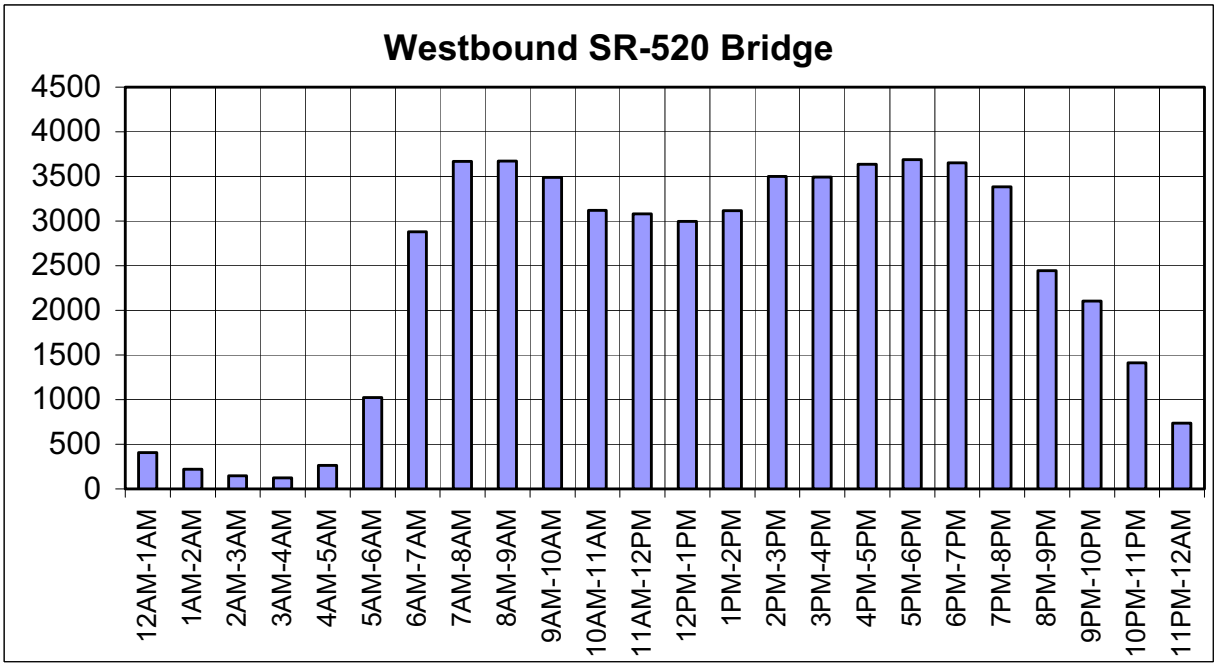
- Today, the average annual daily traffic (AADT) volume is about 100,000 vehicles. This translates to an average weekday volume of 110,000 vehicles, with about 80,000 vehicles using the bridge on weekend days.
- AADT over the past ten years has been relatively constant, a likely reflection that the bridge is operating at or beyond its capacity.

[2] Since 1993, I-90 has operated with eight lanes in a 3-2-3 configuration, with two reversible lanes comprising the center roadway.

Figure 3 illustrates the typical 24-hour distribution of weekday SR-520 bridge traffic volumes that exists today by direction of travel.

Figure 3
24-Hour Weekday Distribution of SR-520 Bridge Traffic Volumes by Direction





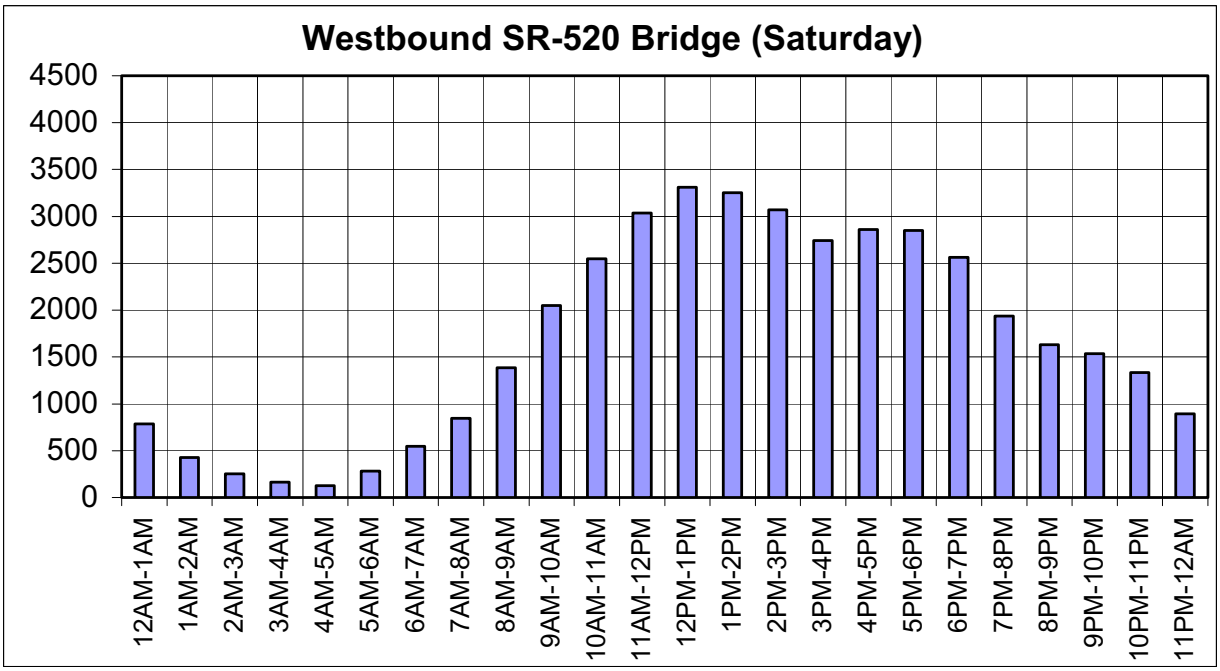
Three things are apparent from the data underlying Figure 3:

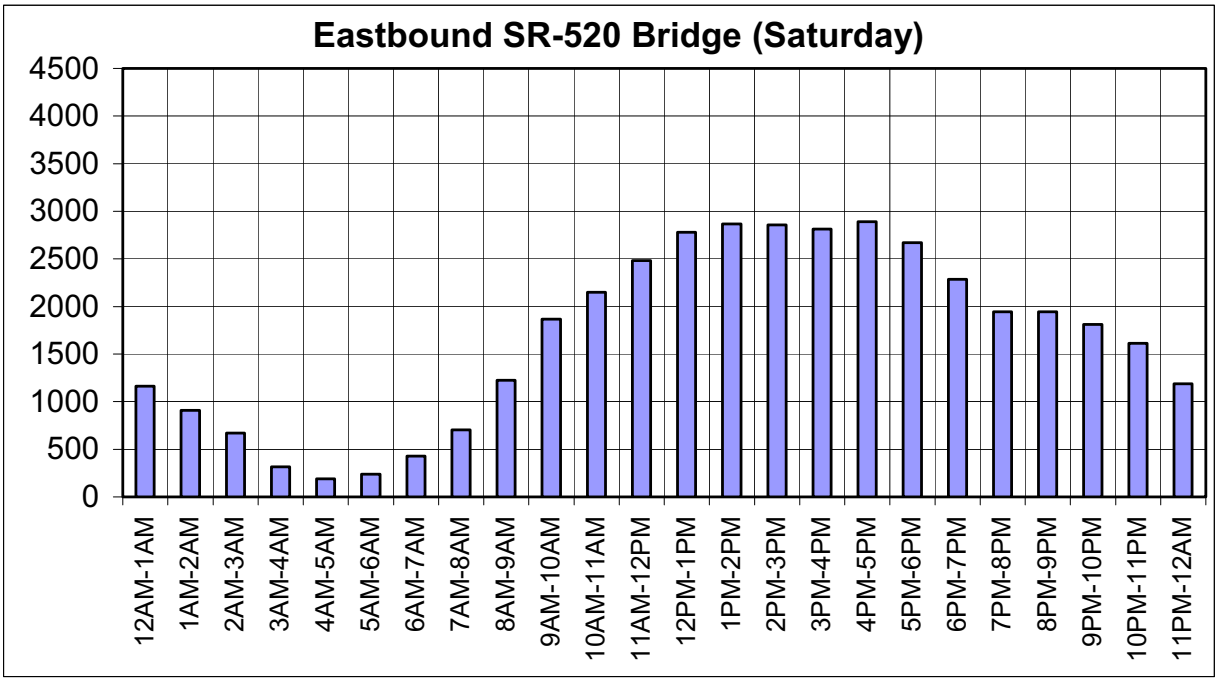
- The bridge is operating at or near capacity for at least ten hours of the day on weekdays, a phenomena that limits traffic growth in this "unmanaged" state;
- Morning and afternoon traffic has spread into the midday hours, resulting in relatively congested midday "off-peak" conditions (approximately level of service 'D'); and
- There is no longer a predominant "peak" direction of travel during either the morning or the afternoon commute periods.

The latter point is noteworthy insofar as it suggests that there are a variety of reasons and no clear economic patterns why many people choose to live and work on opposite sides of the lake. It should also be noted that this data presents vehicle trips; the distributions of person trips were not studied.

Figure 4 illustrates a 24-hour distribution of bridge traffic on a representative weekday by direction of travel. It is interesting to note that even weekend traffic remains directionally balanced across the day.

Figure 4
24-Hour Weekend Distribution of SR-520 Bridge Traffic Volumes by Direction





Historical Tolling Perspectives

A 35¢ toll in each direction was implemented at the east bridge head in August 1963 when the existing bridge was open for traffic. This toll remained in place at a fixed rate until June 1979 when the construction bonds were fully amortized and retired. To understand how this toll affected travel behavior, it is illustrative to (1) compare the traffic impacts in last full year with tolls and the first full year without tolls, and (2) to express the 35¢ toll rate in today's dollars as well as in 2014 dollars to understand the context and make a comparison with proposed future toll rates.[3]

Demand Impacts of the Former Bridge Toll

In 1978, the last full year of toll operations, annual average daily traffic (AADT) numbered 60,452 vehicles on the SR-520 Bridge, versus 56,752 on the toll-free parallel I-90 Bridge. By 1980, the first full year of toll-free operations, AADT on SR-520 had jumped 19.3% to 72,139 while traffic on I-90 fell by 7.9% to 52,283 due to SR-520 becoming a relatively more attractive route for some travelers. Even allowing for some natural growth in overall cross-lake travel, these results suggest that toll diversion on SR-520 in 1978 was approximately 16%, with over one-third of this amount credited to route diversion to I-90, and the remainder some combination of route diversion to other routes (e.g., SR-522), changes in trip destination, reduced trip frequency, travel mode shift to transit, and trip elimination.

Current and Future Values of the Former Bridge Toll

How does 35¢ toll that was in place on the existing bridge from its opening in 1963 until 1979 compare with the two sets of bookend toll schedules by time of day analyzed for 2014? Since 1963 and the present, or even 1979 and the present, a variety of factors have increased the potential willingness to pay tolls beyond that represented by general inflation. Nonetheless, considering just past and projected inflation, the 1963 toll rate of 35¢ in each direction escalates to about $1.90 in today's dollars and upwards of $2.50 in 2014 dollars.[4] Noting that the 35¢ toll remained unchanged until it was removed in 1979, escalating from that point forward gives a current value of 85¢ and about $1.10 in 2014.

A couple of points are worth noting regarding these inflation comparisons. First of all, average monetary wage and salary earnings have increased at an annual rate in excess of that of general inflation due to technology gains that have improved productivity, and this trend is projected to continue in the foreseeable future.[5] This growth in real wages suggests a higher potential willingness to pay, because toll rates somewhat higher than those indicated above could be maintained without increasing the portion of a household's budget comprised by toll expenditures for the same level of bridge use.

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[3] Note that the average toll was a bit less than 35¢ given that discounted toll coupon books good for a specified time period were sold to frequent users.

[4] The average of the Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U) and the Bureau of Economic Analysis' Implicit Price Deflator for Personal Consumption (IPD) was used to inflate historical amounts to current, year-end 2002 dollars. Global Insight's March 2003 forecast for the IPD as amended and adopted by the Washington State Office of Financial Management was used to project general inflation to future time periods, including 2014.

[5] For more information, the reader is referred to a later section discussing travelers' values of time and average wages.

Second, growth in travel demand has likely increased the willingness to pay tolls. When the toll was removed in 1979, the toll-free cross-lake travel demand via SR-520 did not immediately exceed the bridge's capacity. Prior to removing the toll, the alternative "free" routes were relatively attractive insofar as the level of congestion on I-90, SR-522, I-5 and I-405 did not significantly impede those who chose a potentially longer route over paying the SR-520 toll. For some period of time after the toll was removed, traffic flows on the SR-520 Bridge were also relatively congestion-free. In other words, the former toll was buying a more direct route for SR-520 bridge users, but virtually no travel time savings because the toll was not previously necessary to manage demand in order to avert traffic congestion.[6]

This would not be the case today, or in the future. Demand for travel via the SR-520 bridge is sufficiently high that a toll would most certainly serve as a demand management tool, diverting some trips away from the bridge (at least during peak time periods, depending on the pricing structure). This would relieve some traffic congestion, thereby improving traffic flows and generating additional time savings on SR-520 over alternative routes for those who opt to pay. Moreover, increased congestion on alternate routes such as I-90 and SR-522 via I-5 or I-405 would make these toll-free options even less attractive. The combination of toll-induced time savings on SR-520, coupled with higher time costs for alternative routes, makes for a more desirable benefit that a toll "purchases". Thus, the traveling public may now and in the future exhibit a greater potential willingness to pay tolls in real terms than mere inflationary increases of the old toll would suggest.

In summary, growth in real wages combined with increases in traffic demand without significant increases in the capacity of the area's highway network have increased the willingness to pay tolls, especially when they deliver significant time savings and trip reliability. Although it may be natural to seek a comparison of the previous toll to a current context or a future proposal, care should be exercised in understanding how the past differs from the present and future.

[6] In fact, manual toll collection may have contributed to minor traffic delays that were eliminated when toll collection ceased.

3. UNDERSTANDING BRIDGE USER VALUES OF TIME

A major component of this study involved estimating the values that users of the SR-520 bridge place on their time for various trip purposes, travel frequencies, and times of travel. Accurate estimates for the values of time under various conditions facilitates better modeling of users' willingness to pay tolls when pricing is simulated for the SR-520 bridge crossing of Lake Washington. This section documents the market research activity undertaken to estimate various values of time and income levels for SR-520 bridge users, and how these results were incorporated into the modeling and revenue calculation processes. Information about King County averages are also provided for comparison purposes.

Stated Preference Survey Research

A stated-preference survey (SPS) was developed and administered to users of the SR-520 Bridge in order to better understand the travel market served in this corridor, including the values that travelers place on their time, and their willingness to pay tolls versus changing their travel behavior. A summary of the survey research, analysis, and results estimation prepared for this study is provided below. More detailed information can be found in the separate document entitled *SR-520 Stated Preference Survey* prepared by Resource Systems Group, which is provided as Appendix D to this report.

Survey Instrument

Current travelers across the SR-520 Bridge were asked to complete a computer-based survey questionnaire that consisted of five sections covering:

(1) Trip description, including respondent's purpose, travel mode, and time of most recent trip across the bridge;

(2) Scenario presentation describing potential future bridge reconstruction, the use of tolls to fund the project, and how electronic tolling would function;

(3) Stated preference experiments to test respondent sensitivity to certain attributes, including travel time, monetary cost and travel mode, across multiple sets of travel options;

(4) Debrief questions regarding why a travel option was or was not chosen as well as respondent opinions regarding replacement of the SR-520 bridge; and

(5) Demographics information to assist in comparing the survey sample to the full population of interest.

Survey Sample

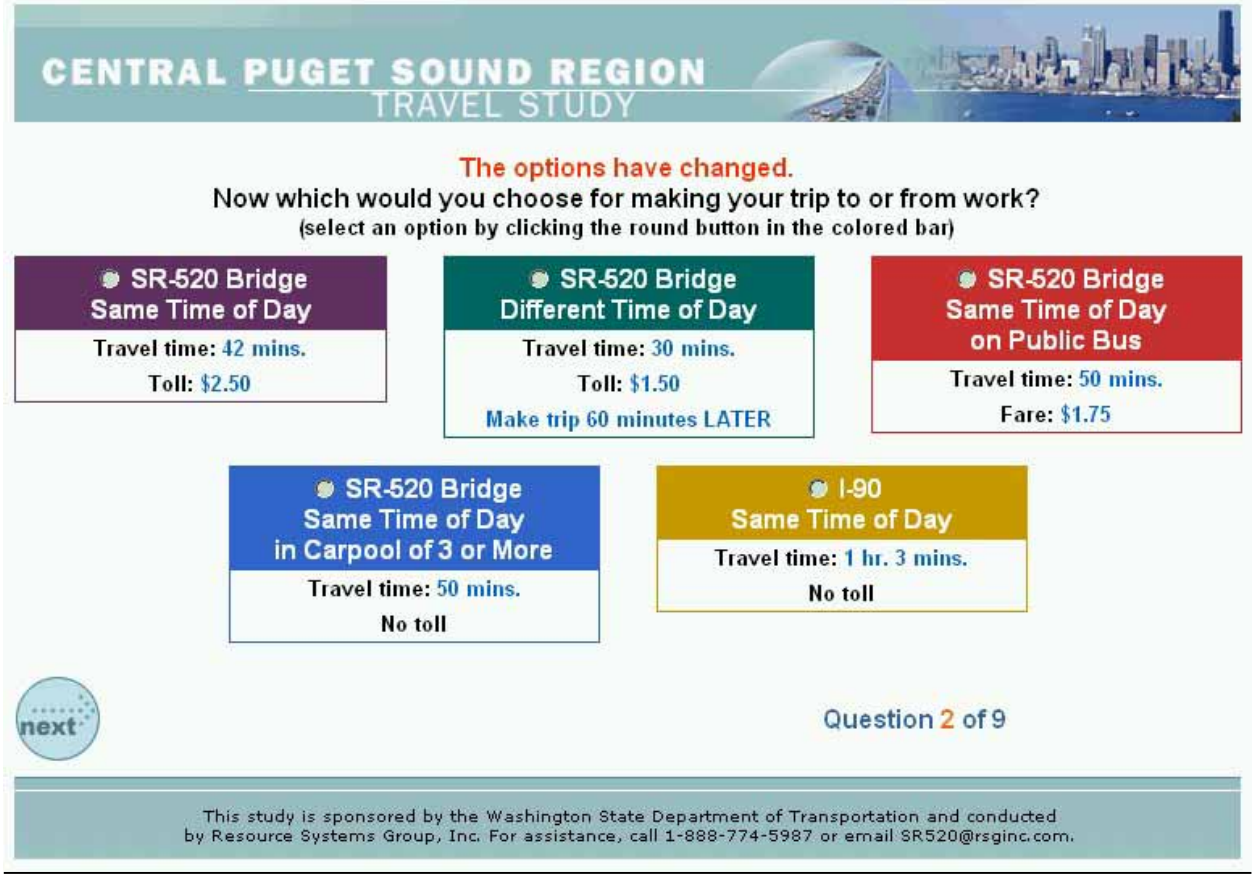
A total of 927 work and non-work SR-520 bridge travelers met the screening criteria and were included in the survey sample. Many of the participants were "intercepted" at various public locations throughout the greater Seattle/Bellevue area (e.g., employment sites, shopping centers, recreational locations, government offices, hospitals, and colleges/universities) where

survey workers directed them to take the survey using laptop computers. Other participants were recruited through employers to participate in the survey, delivered to their own computers via Internet.

Under the assumption that transit riders and persons in private vehicles with three or more total occupants (HOV 3+) would be exempted from tolling, the stated preference experiments under the third section of the survey were administered only to those 690 respondents who either drove alone or with one other person. Within this subgroup, the survey data included a mix of work and non-work trips, peak period as well as off-peak period trips, and a range of travel times and demographic representation. Participants in this subgroup were presented with nine hypothetical future travel scenarios with various route, time of day, toll, and mode options. In each case, the participant was prompted to select their preference. Overall, this process yielded a sample of over 6,000 choice set responses.

Figure 5 depicts an example of a travel options choice set as presented on the participant's computer screen. Note that the parameters of the four or five travel choices were independently varied across predefined ranges for each of the nine travel option sets completed by each participant.

Figure 5
Participant Travel Options Choice Set Example



Values of Time by Traveler Market Segments

The data compiled from the respondents' choices were then used to statistically estimate travel choice models with simple specifications including variables for travel time and monetary trip cost (toll or bus fare), as well as variables to capture the utility or disutility of time shifting to the off-peak period, the use of transit, and the use of HOV 3+ carpools.[7]

The model coefficients for travel time and trip costs are then used to estimate the implied value that travelers place on their time (value of time). In the aggregate, the implied value of time represents a composite value for the mix of travelers and trip characteristics captured in the sample of users.

In the debrief section of the survey, participants were asked to choose among five options describing their opinion of a new bridge with tolls ranging from strongly in favor to strongly opposed. A potential strategic bias was identified by the minority (17%) of respondents who indicated that they were "strongly opposed" to a new bridge with tolls. Inconsistencies in the responses by this group suggest that their stated preference for alternative routes biases down the aggregate value of time. Rather than excluding these responses, which may cause a bias toward overstating the aggregate value of time, a bias-removing travel time coefficient was introduced into the logit model.

To determine potential differences in values of time among different types of trips and travelers, a variety of market segmentation schemes were tested. Various statistical tests and confidence intervals were used to make decisions about final segments and distinct values of time among them. A total of four primary traveler segments based on travel period (peak and off-peak) and trip purpose (work and non-work) were selected. The two trip purposes within the peak period category were further segmented into frequent and infrequent travelers, resulting in a total of six final model segments. Six distinct values of time were then estimated for these segments based upon the median income reported within each segment.[8] Finally, for work trip purposes only, values of time were adjusted to reflect the average vehicle occupancy of the sample, since in the case of two occupant vehicles (HOV 2), both drivers and passengers participated in the sample.[9] Table 2 presents the traveler market segmentation scheme and the respective values of time and median income levels.

Within the survey sample, and similarly for all market segments, sensitivity to trip cost was found to vary inversely with annual household income. Those households with higher incomes were somewhat less sensitive to the trip cost (toll), reflecting higher values placed on time. However, since the version of the PSRC regional travel demand model employed for this study does not stratify travelers into income classes, the values of time reported in Table 2 (and subsequently aggregated for model use) were calculated at the median income level for each traveler market segment as reported by the SR-520 bridge users.

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[7] Multinomial logit analysis methods were used for model estimation.

[8] The median reported household income of survey participants for the six traveler market segments generally fell within the $60,000-79,999 income category.

[9] HOV 2's with work trip purposes were weighted 2× the per person value of time for that market segment.

Table 2
Median Incomes and Values of Time by Market Segment (Current Dollars)

Traveler Market Segments			*Value of Time per Person (at segment median income)*	*Occupancy Rates*		*Value of Time per Vehicle (at segment median income)*	*Median Income (by traveler market segment, in 1,000s)*
Time Period	*Trip Purpose*	*Trip Frequency*		*SOV Share*	*HOV2 Share*		
AM & PM Peak Periods	Work	5 or more trips in this direction per week	$14.07	80%	20%	**$16.89**	$81 K
		4 or less trips in this direction per week	$9.84	72%	28%	**$12.62**	$73 K
	Non-Work	1 or more trips in this direction per week	$5.03	60%	40%	**$5.03**	$70 K
		Less than 1 trip in this direction per week	$8.65			**$8.65**	$74 K
Off-Peak Periods / Weekends	Work	All trip frequencies	$10.38	81%	19%	**$12.37**	$64 K
	Non-Work	All trip frequencies	$11.92	45%	55%	**$11.92**	$66 K

Values of Time Incorporated into the Toll Modeling

As discussed in detail in Chapter 4 of this report, two different toll modeling approaches were applied for this study. The first, "Traffic Management", provides a simulation of congestion pricing whereby the "toll" is introduced as an additional time impedance in the model's volume delay functions to represent the external cost that each additional vehicle imposes on other travelers. In this case, the toll is a time cost per unit distance, and value of time does not enter directly into the model; rather, it is used in the post-model revenue calculations to convert time costs to monetary toll rates. Two values of time are essentially required to correspond to the model's peak and off-peak period outputs.

In the second "Maximum Funding" case, referred to as the approach that is used to identify the Maximum Funding toll structure, values of time are used within the model's generalized cost function to establish the monetary toll values that are iteratively tested in the assignment stage of the modeling process. As in the first case, essentially two values of time are required by the model; one for the peak period and one for off-peak times.

To arrive at a peak period value of time for the toll modeling analysis, the four peak period market segment time values in Table 2 are combined into a single weighted average peak period value, using weights based on the distribution of responses from the *1999 Trans-Lake Washington Origin and Destination Survey*. This "O-D" survey offered a sample of peak period respondents that was over six times larger than the number of peak period respondents for the stated preference survey, and thus, was considered to be a more robust data set for identifying the distributions of trip purposes by trip frequency. For example, it was determined that 86% of peak period trips were for work purposes, and within that group, 72% made five or more one-way trips in the same direction on SR-520. Similar weighting shares were identified for the

other three categories of peak period values of time, and together they were used to arrive at a single value of $14.43 per hour in today's dollars (about equivalent to year end 2002 dollars).

Estimation of an aggregate off-peak value of time only required identifying the trip purpose distribution, since trip frequency during off-peak periods was not shown to have a statistically significant impact on time values. Since the 1999 O-D survey did not examine off-peak period travel, the trip purpose distribution by off-peak respondents from the stated preference survey was used to estimate an aggregate off-peak time value of $12.08 per hour.

A common aggregate indicator of the value of travel time is one-half of the average wage rate. SPS estimated values of time are often compared to this value as a check of the reasonableness of the results. In King County, the average 2002 wage rate was $24.00, implying a value of time of $12.00.[10] This suggests that the SPS estimated values of time are within reason, particularly given that the survey respondents tended to have above average household incomes (see discussion below).

Table 3 presents the trip purpose and frequency distribution weights used to establish the values of time used in the toll modeling and revenue calculation procedures.[11]

Table 3
Values of Time used in Toll Modeling and Revenue Estimates (Current Dollars)

Traveler Market Segments			*Value of Time per Vehicle*	*Traveler Market Shares by:*		*Value of Time per Vehicle*
Time Period	*Trip Purpose*	*Trip Frequency*	*(at segment median income)*	*Frequency w/in Trip Purpose*	*Trip Purpose w/in Time Period*	*(by time period for toll analysis)*
AM & PM Peak Periods	Work	5 or more trips in this direction per week	$16.89	72%	86%	**$14.43**
		4 or less trips in this direction per week	$12.62	28%		
	Non-Work	1 or more trips in this direction per week	$5.03	52%	14%	
		Less than 1 trip in this direction per week	$8.65	48%		
Off-Peak Periods / Weekends	Work	All trip frequencies	$12.37	N/A	35%	**$12.08**
	Non-Work	All trip frequencies	$11.92	N/A	65%	

Income Perspectives

Income information for the travel market served by a toll facility is often reported with the results from value of time studies to provide additional perspective on the public's potential willingness to pay for travel benefits. The median household income among the SR-520 bridge

[10] Derived from Washington State Employment Security Department data for 2001 escalated to year-end 2002 dollars.

[11] Note that for modeling procedures where tolls are implemented in the assignment stage, time values were deflated to 1998 dollars so as to properly reflect the relative cost conditions of the model base year. Similarly, for procedures implementing tolls within the mode choice component, values of time were deflated to 1990 dollars to match the base year of other mode choice costs.

users that participated in the study's stated preference survey is $70,000. Because income was reported within predefined ranges, this median value represents an approximation of the true median income for the survey sample of bridge users. Note that the reported household income varied somewhat by market segments, but the median values generally fell within the $60,000 to $79,999 income category, as shown in Table 2.

By comparison, the median household income for all of King County — within which the vast majority of SR-520 trips originate and end — was $62,400 in 2002.[12] This suggests that the typical SR-520 bridge user's household income is approximately $8,000 higher than the countywide average.

[12] Seattle King County Economic Development Council value of $61,400 in 2001 escalated to 2002 dollars.

4. TOLL MODELING AND DEMAND ANALYSIS

The modeling methods, toll rate estimation, post-model revenue calculations, and their associated analysis objectives are covered in this section. For purposes of this study, both four-lane and six-lane replacement facilities were modeled and their toll revenue potential examined. The six-lane alternative assumed two tolled general-purpose lanes and one high occupancy vehicle (HOV) lane in each direction, the latter providing toll-free passage for transit vehicles and carpools with three or more occupants (HOV 3+). The four-lane alternative assumed two tolled general-purpose lanes in each direction in the same basic configuration that exists today. In this case, 3+ HOVs were assumed to be tolled like any other vehicle while transit vehicles remained toll-free. In addition, toll collection is assumed to be fully automated electronically under all alternatives and scenarios analyzed in this study.

Two Bookend Tolling Objectives

Two different tolling objectives representing "bookend" pricing strategies by time of day and direction of travel were analyzed for their toll revenue potential, using somewhat distinct modeling procedures.

- **Traffic Management** — Also referred to as the "Economic Efficiency" objective, this strategy implements a toll structure sufficient to minimize traffic congestion and maintain good flow conditions without unnecessarily diverting traffic to other roadways, thereby minimizing overall network travel times.
- **Maximum Funding** — Also referred to as the "Revenue Maximizing" objective, this strategy implements a higher and more time of day variable toll structure designed to capture as much revenue as possible in order to maximize toll funding of the project.

The Traffic Management and Maximum Funding tolling objectives mark the lower and upper boundaries, respectively, for the practical range of time-of-day variable tolls and their associated revenues versus demand impacts. While this study does not propose a specific toll policy, nor does it recommend an optimal trade-off between project financing needs and transportation impacts, it does establish the bookends for a reasonable set of options. It is likely that a future "optimal toll policy" will fall somewhere between the results bounded by these two objectives.

It should be noted that previous toll modeling studies, including those involving this corridor and/or conducted for the projects with pricing proposed by the Regional Transportation Investment District (RTID), have only applied the lower bound, Traffic Management/Traffic Management tolling objective.

Table 4 compares and contrasts the two bookend tolling objectives at a summary level by their analysis assumptions, modeling methods, revenue objectives and transportation network impacts.

Table 4
Characteristics and Assumptions of the Two Bookend Tolling Objectives

Traffic Management (Economic Efficiency) ***Lower Boundary Bookend***	**Maximum Funding (Revenue Maximizing)** ***Upper Boundary Bookend***
Best for managing traffic demand to maintain reasonable flow conditions.	**Best for optimizing revenue collections to maximize project funding.**
Derives a single "toll" for each model link that is equivalent to the external cost that each vehicle imposes on all others. Better suited for modeling a system of toll facilities.	Tests a range of "tolls" as inputs for a single model link to map out demand relationships and identify the Maximum Funding rate. Better suited for modeling a single toll facility.
Model establishes an optimal toll expressed as a time cost per mile, which is then converted to a flat monetary toll rate in post-model calculations using an estimated value of time.	Proposed toll rates are converted to time costs using estimated values of time, and these associated time costs serve as inputs to iterative model runs.
Tolls are assumed to vary by time of day over a **15 hour toll period** — tolls for managing congestion drop to zero when demand is low.	Tolls are assumed to vary by time of day over a **24-hour toll period** — tolls for optimizing revenue never drop below a minimum rate.
Relatively simple variable toll schedule.	More time of day variation in toll schedule.
Less diversion likely causes minimal network impacts.	**More diversion** may cause moderate network impacts.
Underlying modeling technique useful for providing a single lower bound perspective of reasonable toll policy.	Underlying modeling technique can be used to test a range of toll rates and policies including, but not limited to, revenue maximization.

In practice, it may be ill advised to implement either strategy. Specifically, an estimated Maximum Funding toll structure has two risks. First, if it truly is optimal, then there is no room to increase tolls and gain additional revenue if for some other reason collections lag their goal. Second, if it is off target, then there may be a lower toll structure that would generate more revenue and a higher level of travel benefits, or put another way, there is yet an even lower toll structure that would yield the same revenue with greater overall network efficiency/fewer adverse impacts on travel.

Modeling Assumptions and Methods

The toll-free and simulated toll modeling was conducted using the existing Puget Sound Regional Council (PSRC) regional travel model with some key modifications. Although the PSRC is in the process of testing and rolling out a new, updated travel model, it was not sufficiently tested and validated for use in this study. However, several of its key refinements were adapted into the existing model, creating a hybrid of sorts. Specifically, new, facility type-specific volume-delay functions (VDFs) integral to the new model were implemented to replace

the single compromise VDF within the existing model. These new volume delay functions (VDFs) play a key role in the model assignment stage to assess optimal toll rates — particularly under the Traffic Management toll objective — and in simulating toll diversion behavior. In addition, the assignment process for implementing the generalized cost function was also borrowed from the new model. This facilitated the iterative testing of different toll rate in the Maximum Funding case to identify the optimal toll structure from a revenue standpoint. Revised 2030 land use forecasts were also implemented by forecast analysis zone. Finally, it should be noted that the hybrid model used is based on the version of the existing PSRC model that was validated for the Trans-Lake Washington and Alaskan Way Viaduct projects.

Network and Growth Assumptions

In applying this modified PSRC regional model for this exercise, a future network including the improvements fully funded by the recent five-cent increase in the State motor fuel tax was simulated for both the model base year (1998) and the horizon year (2030). This approach was taken for both the four- and six-lane alternatives, and was applied under a toll-free case as well as the toll cases for both pricing objectives. The approach of applying a future network to the base year helps to ensure that the interpolated results for the 2014 year of opening better reflect the conditions and other improvements that will also be completed by this time. In addition, a sensitivity test was conducted for both the four- and six-lane alternatives in which a more optimistic future network was assumed, that corresponding the RTID's original list of proposed projects as contemplated in the fall of 2002.

The PSRC model includes specific assumptions for underlying demographic growth in population and employment between 1998 and 2030 for various areas known as forecast analysis zones. Within a specific geographic area that approximates the primary SR-520 bridge travel market, the following growth is predicted:

- Population — 26% higher by 2030;
- Number of Households — 42% higher by 2030; and
- Employment — 48% higher by 2030.

In addition, past experience has shown that the PSRC model overestimates some of the trip redistribution effects on total cross-lake travel of implementing tolls. As a result, this study constrained trip redistribution in order to allow more trips to continue to their desired destinations via alternative routes within the network than would have otherwise been the case.

Value of Time

As discussed in a previous section, the stated-preference survey effort yielded estimated values of time for use in the modeling and revenue calculations. These values are $14.43 per hour for peak period and peak shoulder travel, and $12.08 per hour for off-peak travel, both expressed in today's dollars.[13] Values of time were assumed to escalate in the future at the same rate as

[13] Today's dollars are equivalent to year-end 2002 dollars. Actual application within the model employed a conversion to 1998 "base year" dollars ($13.20 and $11.10 per hour, respectively) for purposes of converting toll rates to time costs within model

general inflation, in other words, with no real growth. This is a conservative assumption, considering that over the past 20 years, wages and salaries in King County have exhibited one to 2 percent annual real growth in excess of inflation. However, by taking this approach, the projected revenues are more likely to meet the mark even through typical economic cycles, despite the fact that the regional model does not simulate such cycles. Moreover, real growth in the value of time would cause a faster escalation of the optimal toll rate under either pricing objective. Achieving regular toll rate adjustments for the compound effects of inflation and growing demand would likely prove challenging enough even without the inclusion of a real growth in users' likely willingness to pay, as approximated by their values of time.

However, a sensitivity test was conducted in which the values of time and associated toll rates under both tolling objectives were escalated annually to reflect 1.0% real growth per year from 2003 through 2030. These results are discussed in Appendix B of this report.

Analysis Years and Future Network

The modeling was conducted for two analysis years, 1998 and 2030. Both years assume the same future network that includes the completion of improvements fully funded by the "Nickel Package" gas tax passed by the Legislature in 2003. As a result, the 1998 model runs with and without tolls do not accurately portray the present day network conditions, but rather provide an appropriate basis from which to interpolate results for 2014, the proposed year of opening for a new SR-520 Bridge. In fact, the model results can be applied to interpolate any future year under the optimal toll structure for either of Traffic Management or Maximum Funding pricing objectives for which it is reasonable to assume that the Nickel Package projects are completed. For this study, results were prepared for the operating years through 2030 under both tolling objectives.

In addition, the financial analysis makes some further assumptions to arrive at preliminary demand and revenue figures for a scenario involving tolls during construction from 2009 through 2013. However, additional modeling using more near term land use, growth and network assumptions would be needed to better estimate results in a ten-year forecast horizon.

Toll Collection Method and Exclusions

This study's modeling, revenue calculations and financial analysis all assume that toll collection is fully electronically automated, and that the event of collecting a toll has no detrimental impact on a vehicular speeds, travel times or traffic flow conditions. Transit was modeled as toll free in all cases; HOV 3+ was assumed to be toll-free only in the six-lane alternative where they share a dedicated HOV lane with transit vehicles.

Modeling Procedures — Traffic Management Tolling Objective

Modeling of the Traffic Management pricing objective tends to hold toll diversion to a minimum by applying a time cost "toll" just sufficiently high to maintain a reasonable traffic

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assignment stage. Values were also expressed in 1990 dollars for comparison to other costs pertinent to the model's mode choice stage.

flow relative to the toll-free case. It therefore tends to maximize overall network travel benefits by generating time some savings in the priced corridor while at the same time minimizing adverse impacts to unpriced alternative routes. Revenue is produced, particularly at times when there is considerable demand relative to available capacity, but optimizing revenue is not the focus of this objective.

On an un-priced roadway, users consider only their own travel time costs, and not the delay costs their vehicle imposes on all other users. This behavior tends to result in roadway over-consumption and congestion, especially during peak demand times. Optimal travel behavior — that which theoretically maximizes travel benefits, or in the case of relatively fixed demand, minimizes overall network travel time — could be induced by applying tolls that are equivalent to the incremental delay imposed on others, with the revenues used to make cost-beneficial transportation investments. This is referred to as the "economically efficient" toll.

The modeling methods underlying the Traffic Management objective seeks to internalize via a toll the incremental delay that an additional vehicle imposes on all other vehicles in the traffic stream. Procedurally, this is done with a modified VDF, which essentially produces a single optimal "toll" time cost for each highway segment as a function of its volume-to-capacity ratio.[14] When users are compelled to consider this additional cost, some alter their travel behavior, resulting in lower highway volumes, and higher resulting speeds. As roadway demand increases, the economically efficient or optimal toll also rises at an increasing rate to maintain reasonable speed and flow conditions, by inducing a sufficient number of would-be road users to seek alternative routes, modes, or times to travel. The optimal "toll" time cost by segment is then assigned a monetary value in the post modeling revenue calculations based upon the estimated values of time by time period. Because this approach results in a zero or near zero toll when demand levels are relatively low, the variable toll schedule modeled under this objective was limited to the 15 most heavily traveled hours of the day, from 6 AM to 9 PM.

The projected revenue under the Traffic Management tolling objective is considered to be the practical lower bound for gross collections, based upon an implicit assumption that a toll managed facility should not be priced so low that it is congested. However, because the toll rate is an output of the modeling process (converted to dollars using estimated values of time), this methodology does not facilitate the testing of alternative toll policies.

Modeling Procedures — Maximum Funding Tolling Objective

In contrast, the Maximum Funding tolling objective emphasizes toll collections over efficient demand management. Whereas the Traffic Management objective stresses traffic flow management with revenue as a byproduct, the opposite bookend represented by the Maximum Funding objective seeks to optimize revenues. This more aggressive management of demand may result in traffic conditions with excess capacity even at peak travel times.

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[14] More information on these methods can be found in *Transportation Pricing Alternatives Study — Technical Memorandum 3: Simulating Congestion Pricing in EMME/2*, Puget Sound Regional Council (ECONorthwest, 2000); WSDOT *Regional Toll Revenue Feasibility Study*, WSDOT (Parsons Brinckerhoff, 2002); and *Toll Revenue Estimates for the Regional Transportation Investment District's Proposed Improvements with Value Pricing* (Parsons Brinckerhoff, 2003).

Proposed toll rates enter the model directly as time costs within the generalized cost function, using the estimated values of time by time period to make the conversion. As a result, this methodology requires valid estimates for users' values of time as inputs to arrive at demand estimates, let alone revenue projections. By comparison, the Traffic Management procedures produce toll traffic volumes without an estimate for the value of time. Values of time are only required to express the optimal toll in dollar terms and/or to estimate toll revenues.

In the Maximum Funding case, the model is then iteratively run with different toll rates by direction and time period to establish a revenue curve and identify the Maximum Funding toll combinations by time period and direction. A variable toll schedule was established which includes all 24 hours of the day. The resulting revenues under the Maximum Funding objective can be viewed as the practical upper bound for gross collections taking full advantage of a variable toll schedule. Moreover, the modeling procedures used to identify this toll structure can also be used to test the traffic and revenue impacts of alternative toll policies, because unlike the Traffic Management procedures, the toll rates are inputs to rather than outputs of the modeling process.

Under the Maximum Funding case, the mode choice stage of the model was only run after the optimal toll structure by time period had been identified. For the six-lane alternative, the existence of a toll-free HOV lane for carpools of three or more persons results in some mode shift to 3+ HOVs when tolls are implemented. Put another way, those users willing to pay the toll at any given time do so, and among those that opt not to pay the toll, some continue to travel on SR-520 in 3+ HOVs and transit vehicles. Under the four-lane alternative, there is little, if any, incentive to mode shift into a 3+ HOV, and transit is the only option for travelers who wish to continue to use SR-520 without paying the toll.[15]

The distinctive nature of SR-520 traffic patterns led to the development of special procedures for devising an appropriate toll schedule and allocating the model's daily toll traffic forecasts by time of day. The current modified PSRC model used in this study provides demand estimates for three different time periods — a three-hour AM peak period, a three-hour PM peak period, and an 18-hour off-peak period, the latter emphasizing the top eight midday and evening hours for statistics such as the volume-to-capacity ratio. These time periods and the factors that allocate traffic to them are based upon overall regional conditions and travel patterns. However, the traffic patterns on SR-520 are somewhat atypical. The peak periods have spread well beyond the representative three hours, midday traffic volumes can be quite heavy, and there is no predominant "peak direction" at any time period. In fact, as previous Figure 3 shows, traffic is almost perfectly directionally balanced hour-by-hour during the day.

[15] The incentive to form an HOV 3+ carpool due to the bridge toll under the four-lane alternative is only the savings from cost-sharing of the toll, less the additional travel time costs that may arise from carpool formation.

Toll Traffic Demand

This section describes how the model outputs for the four- and six-lane alternatives were applied to yield traffic projections by weekday time periods. Traffic forecasts from the model by three time periods, with and without tolls, were directly applied to calculate toll diversion rates and demand impacts to other facilities. These topics are discussed in more detail in Chapter 6, Toll Diversion and Time Savings. However, because of the atypical traffic patterns observed on the SR-520 Bridge, the model's toll volumes by time period were not directly applied to calculate toll revenues. Rather, the model's daily toll volumes — as established using different toll rates across the three daily time periods — were allocated by time of day using the empirical traffic distributions underlying Figure 3.

This post-processing of the model outputs allows analyzing demand by more than three time periods and/or the extension of the AM and PM peak periods beyond the model's three-hour intervals. Moreover, it effectively lets the travel forecasts reflect the unique characteristics of this facility rather than the representative regional average patterns dictated by the model.

For the modeling conducted under the Maximum Funding tolling objective, this process also facilitates the use of a more tailored variable toll structure that accommodates both peak and peak shoulder time periods, and recognizes that toll diversion may be different during the midday than late at night for the same toll rate.

Six-Lane Alternative

The travel demand projections for the six-lane alternative are divided into ***toll traffic*** and ***toll-free traffic***, given that 3+ HOVs are assumed to be exempt from tolls and provided with a separate travel (HOV) lane. Table 5 below presents the resultant vehicle volumes for the six-lane alternative in 2014.

Although the hourly volumes were originally calibrated to the model's daily demand levels, the model's general off-peak period toll diversion rate was relaxed somewhat in assessing midday and evening shoulder demand, resulting in post-processed daily toll traffic levels that are about 4 percent higher than the base model estimates for the Maximum Funding tolling objective.

Table 5
2014 Weekday Traffic Demand by Objective — Six-Lane Alternative

SR-520 Traffic Demand by Tolling Objective	Traffic Volumes by Tolling Objective & Time Period			
	6 to 11 AM	2 to 7 PM	6 AM to 9 PM[3]	Daily Total
Toll-Free Baseline	40,950	41,350	115,240	130,550
SOV & HOV 2[1]	*38,900*	*39,600*	*111,000*	*126,100*
HOV 3+[2]	*2,050*	*1,750*	*4,240*	*4,450*
Traffic Management Tolling Objective	33,660	32,940	93,650	106,900
SOV & HOV 2[1]	*31,200*	*30,900*	*88,600*	*101,600*
HOV 3+[2]	*2,460*	*2,040*	*5,050*	*5,300*
Gross Toll Diversion (SOV & HOV 2 Only)	*– 19.8%*	*– 22.0%*	*– 20.2%*	*– 19.5%*
Net Toll Diversion with 3+ HOV Attraction	*– 17.8%*	*– 20.3%*	*– 18.7%*	*– 18.1%*
Maximum Funding Tolling Objective	27,340	29,940	78,350	87,020
SOV & HOV 2[1]	*24,400*	*27,600*	*72,500*	*80,800*
HOV 3+[2]	*2,940*	*2,340*	*5,850*	*6,220*
Gross Toll Diversion (SOV & HOV 2 Only)	*– 37.3%*	*– 30.3%*	*– 34.7%*	*– 36.0%*
Net Toll Diversion with 3+ HOV Attraction	*– 33.2%*	*– 27.6%*	*– 32.0%*	*– 33.3%*

[1] Aggregated across both travel directions for toll eligible traffic only (excludes 3+ HOVs & transit vehicles)
[2] Aggregated across both travel directions for toll-free traffic only (excludes transit vehicles)
[3] Reflects the full extent of tolling under the EE case. The RM case expands the toll period from 15 to 24 hours.

Table 5 also presents gross and net toll diversion rates by selected time periods for the six-lane alternative in 2014. A portion of the gross toll diversion takes the form of mode conversion to toll-free 3+ HOVs; therefore, the net diversion rates based on total vehicle volumes are lower than the gross diversion rates base only on tolled vehicles.[16]

It should also be reiterated that the toll period for the Traffic Management objective is 15 hours from 6 AM to 9 PM, whereas the Maximum Funding objective employs 24/7 tolling. This explains the drop in the toll diversion rate in the Traffic Management case in the 24-hour data relative to the 15-hour data.

Table 6 presents ***person-trip*** travel demand information for the six-lane alternative. The addition of the toll-free HOV lane when the general-purpose lanes are tolled results in mode diversion to 3+ HOVs. The end result is a decline in person-trips that is significantly less than the decline in vehicle trips via toll diversion. In particular:

- The Traffic Management toll objective causes net daily toll diversion of about 18%, but less than a 13% drop in person-trips, relative to the toll-free case; and
- The Maximum Funding toll objective diverts one-third of the daily toll-free vehicle demand, but only about 18% of the person-trip demand.

[16] See Chapter 6, Toll Diversion and Time Savings for a discussion of toll diversion and its impacts on other facilities.

Table 6
2014 Weekday Person-Trip Travel Demand by Objective — Six-Lane Alternative

SR-520 Travel Demand by Tolling Objective	*Daily Person-Trips by Tolling Objective*			
	SOV & HOV2	*HOV 3+*	*Transit* [1]	*Total*
Toll-Free Baseline	150,975	31,677	19,616	202,268
Traffic Management Tolling Objective	118,789	36,887	20,439	176,115
% Change vs. Baseline	*– 21.3%*	*+ 16.4%*	*+ 4.2%*	*– 12.9%*
Maximum Funding Tolling Objective	88,000	51,332	26,062	165,395
% Change vs. Baseline	*– 41.7%*	*+ 62.0%*	*+ 32.9%*	*– 18.2%*

[1] Represents approximately 520 daily transit vehicles
[2] Reflects the full extent of tolling under the EE case. The RM case expands the toll period from 15 to 24 hours.

Four-Lane Alternative

The level of "toll eligible" demand in the four-lane alternative for both the toll and toll-free cases turned out to be lower than for the six-lane alternative, despite the fact that the volumes for the four-lane alternative also ***include*** 3+ HOVs. The *a priori* expectation was that the four-lane alternative would have the same if not higher "toll eligible" demand than the six-lane bridge, since the former would have all of the SOV and HOV 2 toll demand of the latter, plus some portion of the 3+ HOVs that would have traveled toll-free in the six-lane alternative. However, analysis of the model results revealed that the six-lane alternative increases the overall demand for cross-lake travel by a larger margin than 3+ HOVs contribute to the toll-paying demand under the four-lane alternative. As a result, the toll volume excluding 3+ HOVs in the six-lane case exceeds the total volume of vehicles in the four-lane case (all of which are tolled), especially under the Maximum Funding tolling objective.

Table 7 summarizes the resultant vehicle volumes (including 3+ HOVs) and the associated diversion rates for the four-lane alternative in 2014. Because all vehicles are tolled in this case, there is no distinction between gross and net toll diversion rates. The person-trip volumes for the four-lane alternative are considerably lower than for the six-lane alternative, as there is much less incentive for three-person carpool formation when 3+ HOVs pay the toll.

Table 7
2014 Weekday Traffic Demand by Objective — Four-Lane Alternative

SR-520 Traffic Demand by Tolling Objective	*Traffic Volumes by Tolling Objective & Time Period* [1]			
	6 to 11 AM	*2 to 7 PM*	*6 AM to 9 PM* [2]	*Daily Total*
Toll-Free Baseline[1]	38,500	39,100	109,900	124,800
Traffic Management Tolling Objective[1]	30,800	30,700	87,700	100,400
Toll Diversion Rate	*– 20.0%*	*– 21.5%*	*– 20.2%*	*– 19.5%*
Maximum Funding Tolling Objective[1]	22,300	25,800	67,300	75,500
Toll Diversion Rate	*– 42.1%*	*– 34.0%*	*– 38.8%*	*– 39.5%*

[1] Aggregated across both travel directions for toll eligible traffic only (includes 3+ HOVs; excludes transit vehicles)
[2] Reflects the full extent of tolling under the EE case. The RM case expands the toll period from 15 to 24 hours.

5. TOLL RATES AND REVENUE PROJECTIONS

Building on the toll demand projections presented in the previous chapter, this section presents the time of day toll schedules by pricing objective and alternative, the revenues they would yield in 2014, and different ways of looking at revenue over time.

Two Types of Revenue Numbers

There are many ways to examine and measure toll revenues, each with distinct purposes. For the two bookend tolling objectives considered in this study, revenues have been categorized into two general sets of numbers.

- **Modeled Gross Revenue** — the predicted toll collections in every year of the forecast horizon, in which it is assumed that the modeled nominal toll rates will be adjusted annually for both inflation and growing demand so as to maintain optimality for the assumed tolling objective (Maximum Funding or Traffic Management). Given that 100% electronic toll collection (ETC) is a key assumption of this study — and carries with it potential efficiency losses from violations, errors, and/or an allotment of free trips per vehicle— a 5%deduction for ETC losses is included as an adjustment to the modeled revenue.
- **Net Revenue** — a measure of net financial revenue during the years that bonds are outstanding, which is based on the modeled adjusted gross revenue in the year of opening, less operating and maintenance costs and less a deduction for traffic "ramp-up" period during which public acceptance is developing. Net revenues are those available for debt service payments. In this study, net revenue growth in years subsequent to the bridge opening is capped at 3.0% annually — a slower rate than the modeled revenues — due to assumed constraints on maintaining an optimal toll structure over time.

For a given scenario, the toll schedule behind these two ways of looking at revenue are identical in the year of opening, though the implicit assumption is that the tolls would, in practice, increase either more slowly or less frequently, resulting in a slower rate of financial revenue growth.

While this chapter presents the steps that lead to both sets of revenues, emphasis is placed on modeled gross revenues. The financial net revenues are the subject of the Financial Capacity Analysis of Chapter 8.

Toll Schedules

Weekday Tolls

For the Traffic Management tolling objective, a relatively simple variable toll schedule was derived from the model results in which three basic toll rates apply: (1) an extended AM peak period rate over five hours; (2) an extended PM peak period rate over five hours; and (3) an off-peak rate applied to three midday hours and two early evening hours. The remaining nine hours from 9 PM to 6 AM were left toll-free, in part because the Traffic Management toll is a function of congestion, which is non-existent during the night hours, and because this tolling objective was intended to represent the lower bound bookend of pricing strategies.

Under the Maximum Funding objective, the variable toll schedule takes full advantage of travelers' potential willingness to pay by time of day as a proxy for varying trip purposes. The model was used to test different toll rates within its three time periods, and these results were then used to further simulate shoulder period levels between the peak, off-peak and night conditions. Figure 6 graphically illustrates the estimated year of opening weekday toll schedule by time period for both tolling objectives under the six-lane alternative — in 2014 dollars. Figure 7 on the following page illustrates the same for the four-lane alternative. Because the demand is virtually directionally balanced over the course of the day, only very minor directional toll differences were derived in the modeling. These figures illustrate the higher of any directional differences.

In the six-lane alternative, the Traffic Management toll is zero at night and otherwise ranges from a minimum of $0.62 to a maximum of $3.00 each way in 2014 dollars, as shown in Figure 6. Over the 15-hour toll period, the weighted average toll is $1.74, though no single driver would actually pay this amount. Expressed in today's dollars, the Traffic Management range is from $0.46 to $2.25 each way, with an average rate of $1.31.

For the Maximum Funding case, the toll ranges from $0.75 to $4.60 each way in 2014 dollars, with a weighted average of $3.07 over the 24-hour toll period, as shown in Figure 6. In today's dollars, this is equivalent to $0.55 to $3.45 each way, with an average rate of $2.31.

Figure 6
Opening Year Toll Schedules by Toll Objective — Six-Lane Alternative (2014 $s)

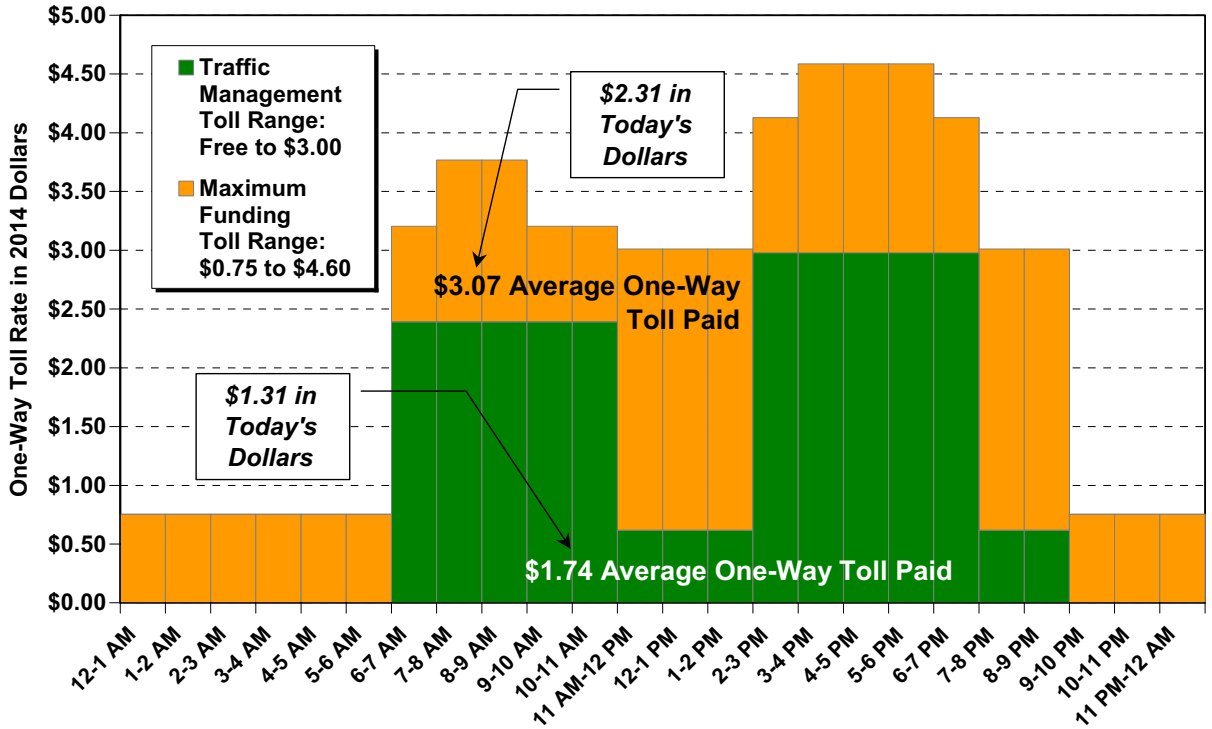
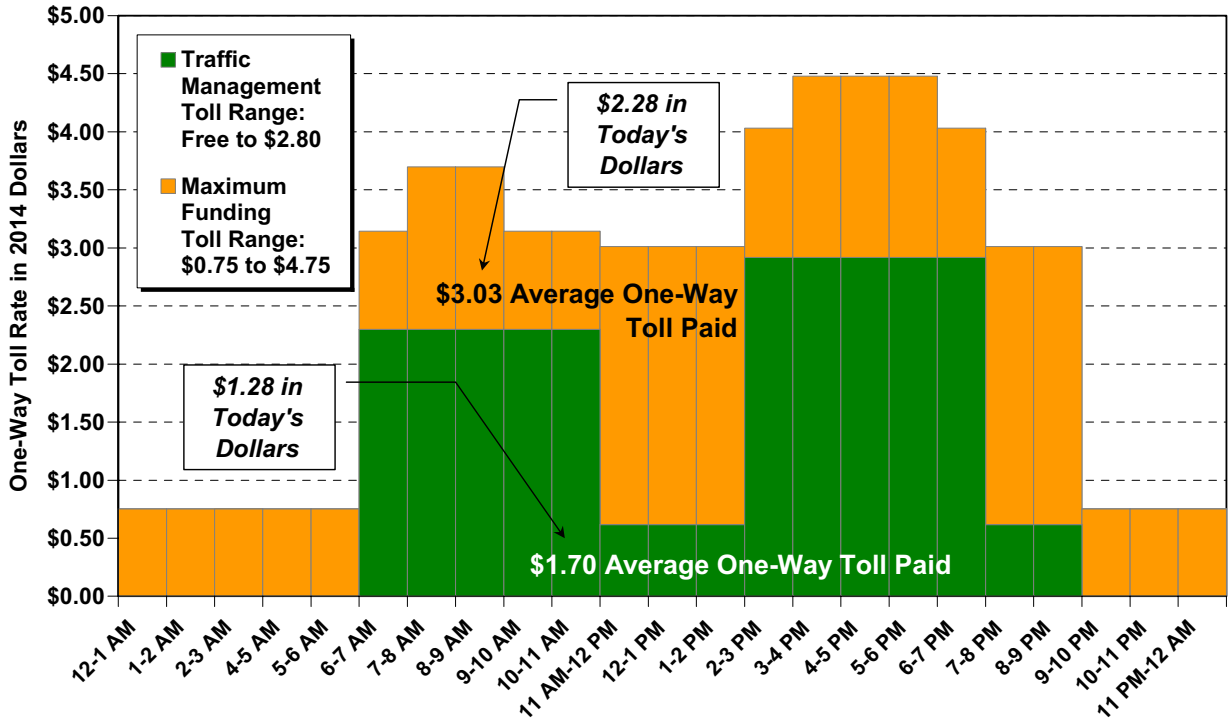


Figure 7
Opening Year Toll Schedules by Toll Objective — Four-Lane Alternative (2014 $s)



The optimal toll rates under the four-lane alternative, as shown in Figure 7, are nearly identical to the six-lane. In some ways, this is not surprising, given that the six-lane alternative only adds a toll-free HOV lane in each direction. However, as mentioned earlier, the six-lane alternative causes a small increase in overall cross-lake demand, which may explain why it results in slightly higher toll rates even without charging 3+ HOVs.

Appendix A provides more detailed toll schedules by alternative and tolling objective for both 2014 and 2030.

Weekend Tolls

For the Traffic Management tolling objective, the model derived off-peak toll of $0.62 in 2014 dollars was applied each way over the entire 15-hour toll period. This derived toll rate was essentially identical between the four- and six-lane alternatives. The rate of diversion was assumed to be the same as weekday off-peak periods.

Under the Maximum Funding tolling objective, a variable weekend toll schedule was based upon the weekday night rate of $0.75 and then scaled upward by 2x or 3x multipliers to fit the typical demand distribution on a Saturday or Sunday (see Figure 4). In the absence of a modeling tool tailored to weekend travel patterns, there is no method to establish the level of toll diversion for this proposed toll schedule. As such, it was conservatively assumed that the toll diversion on weekends was 50% in all time periods.

In 2014 dollars, the Maximum Funding weekend toll schedule is as follows:

- $0.75 from 9 PM to Midnight and Midnight to 8 AM;
- $1.50 from 8 to 11 AM, and 6 to 9 PM; and
- $2.25 from 11 AM to 6 PM.

In today's dollars, the above three values would be $0.57, $1.13 and $1.70, respectively.

Trucks Tolls

Trucks larger than a pick-up truck or passenger van account for about 5.5% of existing weekday traffic on SR-520, and about 3.0% of weekend traffic. In both absolute and percentage terms, maximum truck traffic occurs during the midday between 10 AM and 3 PM. These figures represent a mixture of truck sizes, and most existing toll facilities charge trucks a size-based multiplier of the base auto toll. Typically, the multiplier is based on the number of axles, e.g., a two axle truck may pay 2x the auto toll, a three axle truck may pay 3x, etc. with a ceiling value of 5x or 6x the standard auto toll. For purposes of this study, trucks were not broken out by axle count; rather it was assumed that the average truck toll is 3x the base auto toll. The auto diversion rates were applied to predicting tolled truck traffic — an assumption that maintains the same proportion of trucks as in the toll-free case.

Toll Revenue Projections

Table 8 captures the range of gross annual revenue projections for the six-lane alternative by tolling objective in inflated or year of collection dollars. These values are presented for selected years applying each year's optimal toll schedules and include weekend tolling plus the 5% revenue deduction for electronic toll collection inefficiencies.

Table 8
Annual Toll Revenue by Year in Inflated Dollars — Six-Lane Alternative

Value of Time from SPS Survey • Weekend Tolling • 3× Truck Tolls				
SR-520	***Year of Collection Dollars in Millions***			
Bookend Tolling Strategy	***2014***	***2020***	***2025***	***2030***
Traffic Management Toll Objective	**$53.2 M**	$70.6 M	$88.2 M	$107.0 M
Maximum Funding Toll Objective	**$82.9 M**	$113.1 M	$149.6 M	$197.4 M

Note: Revenue amounts net of 5% deduction for ETC inefficiencies.

As discussed previously, the revenue growth underlying the 2020, 2025 and 2030 figures in Table 8 assume that the optimal tolls as modeled for implementation in 2014 under either tolling objective would be increased annually for inflation and growing demand.

Table 9 presents the same information for the four-lane alternative. Given that the toll-paying traffic volumes and toll rates under the four-lane alternative were equal to or slightly less than those of the six-lane alternative, it follows that the gross annual revenues are marginally lower as well. All of the above caveats apply.

Table 9
Annual Toll Revenue by Year in Inflated Dollars — Four-Lane Alternative

Value of Time from SPS Survey • Weekend Tolling • 3× Truck Tolls				
SR-520	***Year Year of Collection Dollars in Millions***			
Bookend Tolling Strategy	***2014***	***2020***	***2025***	***2030***
Traffic Management Toll Objective	**$51.5 M**	$68.8 M	$86.8 M	$106.3 M
Maximum Funding Toll Objective	**$77.5 M**	$107.8 M	$144.9 M	$188.8 M

Note: Revenue amounts net of 5% deduction for ETC inefficiencies.

Figure 8 presents the projected trends for the various ways of looking at toll revenue in the six-lane alternative under the Traffic Management tolling objective. Figure 9 presents the same for the Maximum Funding objective. In both cases, electronic tolling inefficiencies and/or policies are assumed to reduce the modeled revenues, and assumed ramp-up and annual growth constraints would likely further dampen gross revenues. Finally, the deduction of toll collection operations and bridge maintenance costs — discussed further in Chapter 7 — yield the likely level of net revenues to support project financing.

Figure 8
Traffic Management Toll Revenue Projections Before and After Deductions — Six-Lane Alternative

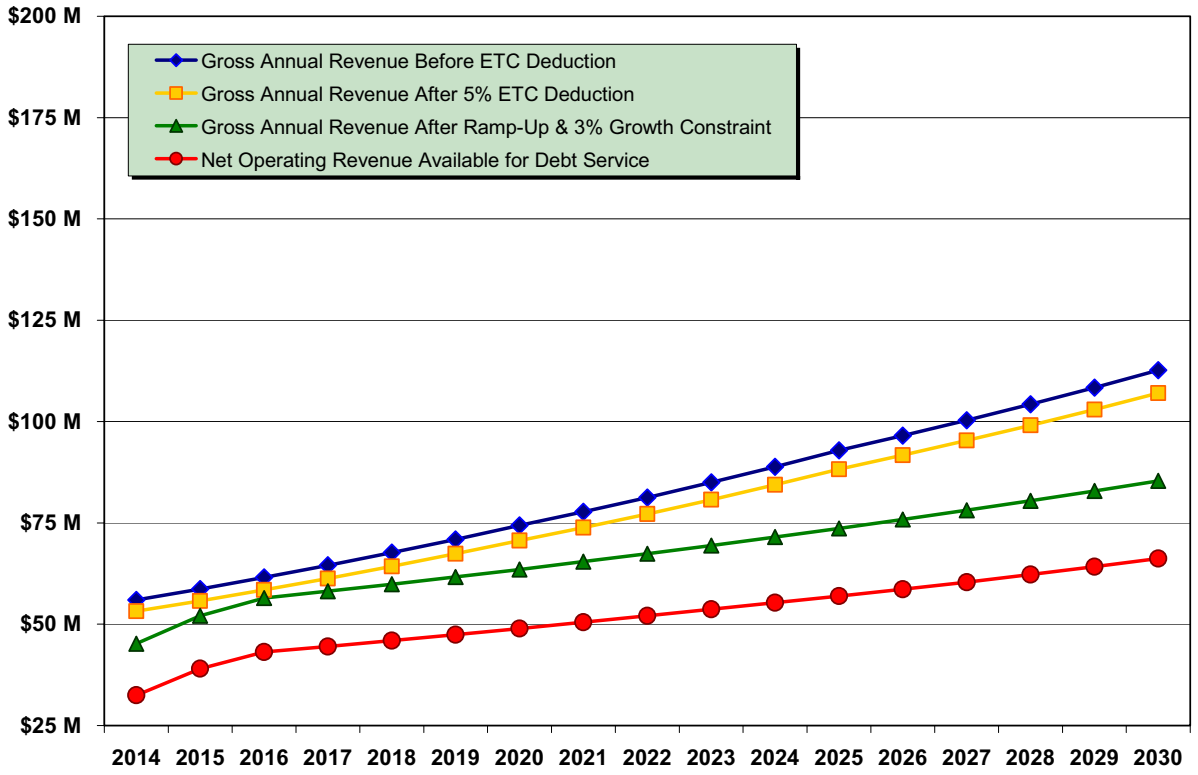
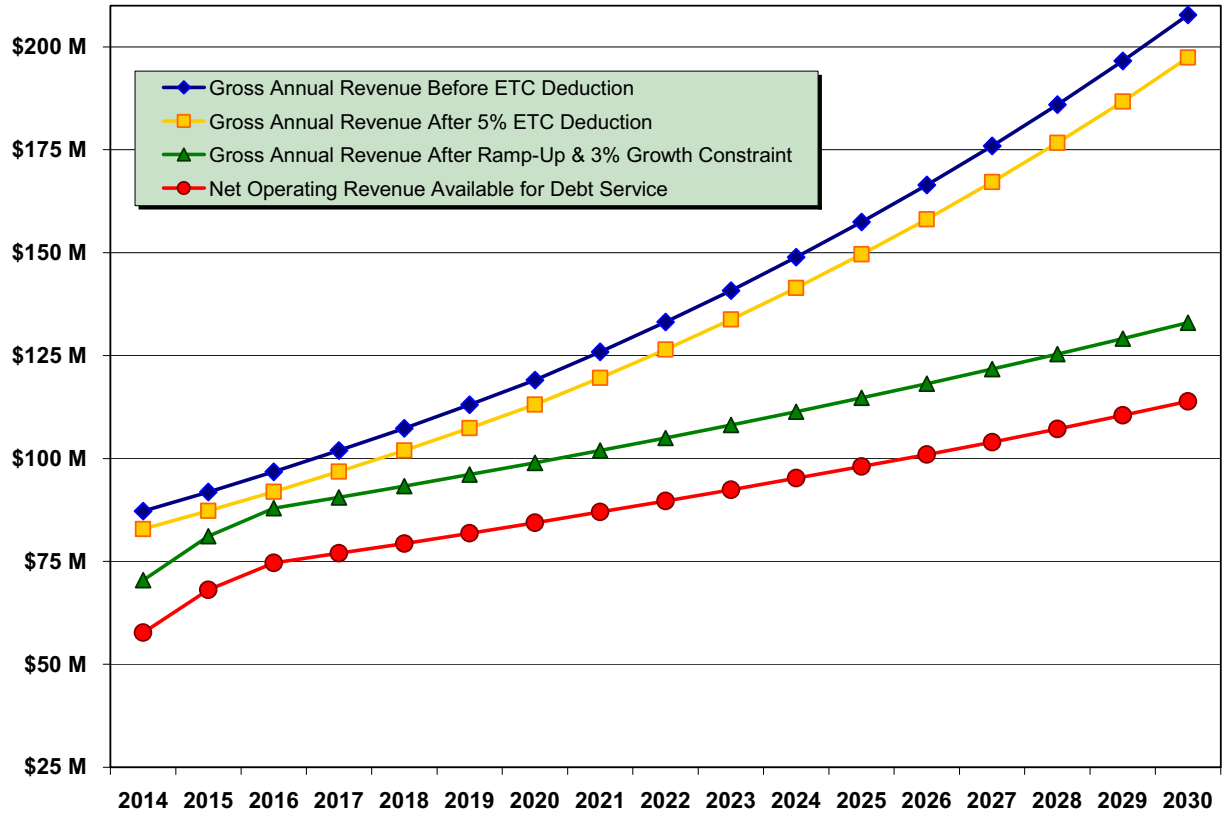


Figure 9
Maximum Funding Toll Revenue Projections Before and After Deductions — Six-Lane Alternative



The revenue trend charts for the four-lane alternative are not presented herein, as they are very similar to the above two charts.

Revenue Impacts of Toll Policies between the Two Bookends

The process by which the Maximum Funding toll structure was identified included the iterative testing of multiple toll rates. Table 10 presents the toll rates tested, in both 2014 and today's dollars, and the associated tolled traffic demand in the PM peak hour for each toll rate. Note that tolled traffic demand excludes 3+ HOVs and transit vehicles. Analysis of these rates and their associated demand levels allows a revenue curve to be plotted around the Maximum Funding toll rate for a particular time period that shows how revenue would likely change as the toll rate is varied.

Figure 10 shows such a curve for the PM peak period in 2014 under the six-lane alternative. This figure also identifies the economically efficient toll rate as the lower bookend toll rate analyzed in this study. The Traffic Management modeling process differs from the Maximum Funding iterative process used to generate the curve; nevertheless, the single Traffic

Management toll rate lies close to this curve. For the central three hours of the PM peak period, the Traffic Management toll of just under $3.00 (in 2014) is expected to generate 77% of the revenue associated with the upper bookend Maximum Funding toll.

Table 10
PM Peak Hour Toll Rates and Tolled Traffic Volumes (Six-Lane Alternative)

PM Peak Hour Toll Rate		*PM Peak Hour Volume (Both Directions)**
Current Dollars	*2014 Dollars*	
$0.00	$0.00	8,000
$1.83	$2.43	7,900
$2.22	$2.95	7,500
$2.60	$3.46	7,000
$2.89	$3.84	6,700
$3.17	$4.21	6,200
$3.45	$4.59	5,900
$3.73	$4.96	5,300

* Excludes toll-free 3+ HOVs and transit vehicles

Figure 10
PM Peak Toll Rates versus Percentage of Maximum Revenue (2014 Dollars — Six-Lane Alternative)

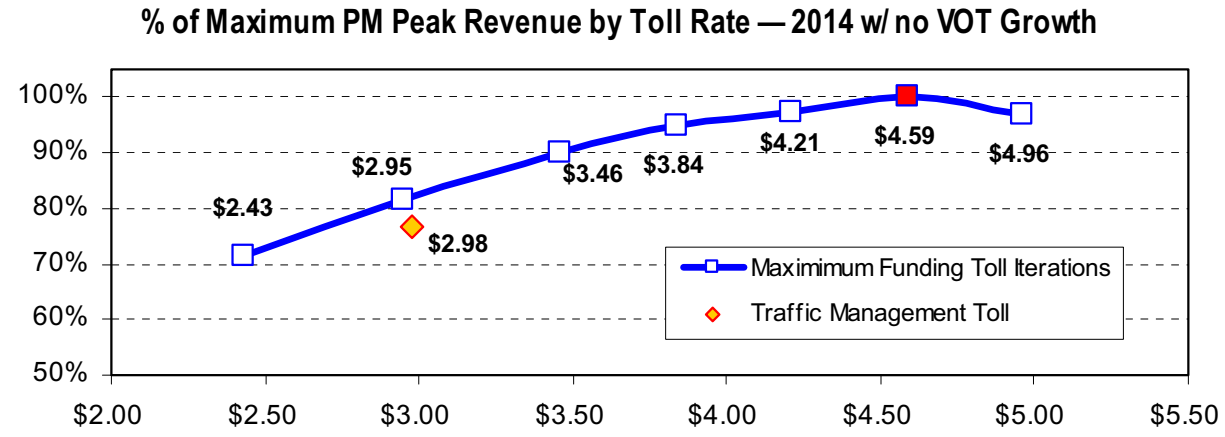


Figure 10 also conveys that it takes an increasingly larger percentage escalation in the PM peak toll rate to generate the same percentage increase in revenue as the rate approaches the Maximum Funding point. Put another way, there is room to back off the toll a fair amount from its Maximum Funding point — and with it, toll diversion — without sacrificing too much revenue. For example, the PM peak Maximum Funding toll could be reduced 25% (from about $4.60 down to $3.45) with only a 10% drop in revenue generation.

This suggests that a compromise toll policy that strikes a balance with a PM peak rate midway between the lower Traffic Management bookend — the minimum needed to effectively manage congestion — and the upper Maximum Funding bookend — the rate that optimizes revenue — would yield collections in excess of the revenue midpoint. At a midpoint PM peak toll rate of about $3.80 one-way, the revenue yield is nearly 95% of that achieved under the Maximum Funding toll of $4.60.

6. TOLL DIVERSION AND TIME SAVINGS

This section presents a brief analysis of the toll diversion impacts that could result from a priced SR-520 bridge and documents the opportunities for time savings and reduced vehicle operating costs for users who opt to use the toll facility.

Toll Diversion Impacts

There are many challenges in modeling toll diversion impacts with the PSRC regional model, and the results can be inexact, particularly for certain types of diversion behavior. In addition, the *SR-520 Bridge Replacement and HOV Project* will examine some of the diversion impacts in more depth. For purposes of this study, it is useful to describe the many forms of toll diversion and summarize the general conclusions of the toll modeling conducted.

Forms of Toll Diversion

Compared with the toll-free case, the introduction of tolls on the SR-520 Bridge will result in the diversion of some vehicle trips away from this facility during the toll period(s). These diverted trips fall into the following categories individually or in combination:

- Route diversion — travelers who make the same trip but divert to an alternate, un-priced route (e.g., SR-522 or I-90);
- Time diversion — travelers who make the same trip at a different time of day when there would be a lower toll rate;
- Mode diversion — travelers who continue to make the same trip at the same time of day via a different mode (e.g., from an SOV to an HOV 2 for cost sharing, or from an SOV or HOV 2 to a toll-free HOV 3+ or bus);
- Destination diversion — travelers who opt to change their destination for a substitute that does not require using the tolled route (e.g., a similar destination that does not require crossing the lake); and
- Reduced trip frequency diversion — travelers who opt to make fewer cross-lake trips (e.g., combining multiple trips into fewer trips, or completely eliminating some travel).

The modeling procedures and assumption used in this study do a reasonable job of identifying overall toll diversion, but do not provide a conclusive means to allocate diverted trips among the many forms of diversion. Additional research and analysis into the model processes for determining diversion, interpretation of the resulting diversion rates, and the impacts on the arterial system is warranted, and will be better facilitated in the new PSRC regional model.

SR-520 Diversion Rates and Impacts on Alternate Routes

Two types of toll diversion rates are introduced and reported in the text and tables that follow.

- The ***"gross" toll diversion rate*** measures the percentage decrease in ***toll-paying*** traffic volumes due to tolling, as compared to the toll-free case; and
- The ***"net" toll diversion rate*** considers the total change in all traffic — both toll-paying and toll-exempt vehicles — which also accounts for any mode shift from toll-paying to toll-exempt vehicles.

For the SR-520 six-lane alternative, only SOV and HOV 2 volumes are tolled, as 3+ HOVs travel toll-free in a separate lane. In this case, the implementation of pricing causes some travelers to form carpools of three or more passengers to avoid paying the toll. By considering the 3+ HOV volumes using the facility both with and without tolling, the effective net diversion rates for the six-lane alternative are lower, as the attraction of 3+ HOVs would offset some of the toll-induced reduction in SOVs and two person HOVs.

In the case of the SR-520 four-lane alternative, all vehicles (except transit) are assumed to be tolled, and there is no distinction between the gross and net toll diversion rates.

Estimated diversion rates, relative to a toll-free case, vary somewhat by time of day and direction of travel. During the morning and afternoon peak periods, the modeling results suggest that route diversion is less prevalent than some of the other types. This is because there is projected to be little, if any, available peak capacity in 2014 on the primary east-west alternatives of I-90 to the south and SR-522 to the north. When combined with the expected congestion on I-5 and/or I-405 to access these alternative routes, the time and vehicle operating costs become too high to attract many SR-520 trips. Table 11 and Table 12 support this conclusion with three hour PM peak period data for 2014 for the six- and four-lane alternatives, respectively.[17]

Under the Traffic Management tolling objective, the PM peak toll causes an 18.6% gross reduction in the number of toll-paying vehicles, and a 16.9% reduction in total vehicles, relative to the toll-free case. Despite this level of diversion, the increase in demand on I-90 is expected to be negligible, because the existing demand projection already meets or exceeds available capacity. Moreover, although the Maximum Funding objective results in a higher level of toll diversion, there expected to be virtually no additional route diversion to I-90 within the PM peak period.

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[17] The PSRC regional model applies a three hour PM peak period to all facilities. Use of this three-hour data facilitates the analysis of impacts to I-90 and SR-522. However, the actual PM peak period on SR-520 is approximately five hours, and over this more extended period, diversion rates are slightly higher. Preceding Table 5 and Table 7 in Chapter 4 — Toll Modeling and Demand Analysis document 2014 toll diversion rates as well as toll-paying and toll-exempt traffic volumes over the extended 5 hour PM peak period and other selected analysis periods that are unique or specific to SR-520.

Table 11
2014 Toll Diversion Impacts by Tolling Objective — Six-Lane Alternative

SR-520 Toll Diversion and Alternate Facility Impacts by Tolling Objective	*Average Diversion (–%) / Attraction (+%) Rates*			
	3 Hr PM Peak Period [1]		*Daily Toll Period* [1]	
	Gross % [2]	*Net %* [3]	*Gross %* [2]	*Net %* [3]
Traffic Management Tolling Objective	– 18.6%	– 16.9%	– 19.5%	– 18.1%
Impact on I-90 Traffic Volumes	+ 0.4%		+ 3.1%	
Impact on SR-522 Traffic Volumes	+ 3.9%		+ 4.3%	
Maximum Funding Tolling Objective	– 27.0%	– 24.2%	– 36.0%	– 33.3%
Impact on I-90 Traffic Volumes	+ 0.5%		+ 14.5%	
Impact on SR-522 Traffic Volumes	+ 7.4%		+ 11.0%	

[1] PM Peak Period based on the PSRC model results for the highest 3 PM hours; Daily Toll Period reflects 15 hours in the Traffic Management case and 24 hours in the Maximum Funding case.
[2] Aggregated across both travel directions for ***tolled traffic only*** (excludes 3+ HOVs)
[3] Aggregated across both travel directions for ***all vehicles*** (includes 3+ HOV attraction)

Table 12
2014 Toll Diversion Impacts by Tolling Objective — Four-Lane Alternative

SR-520 Toll Diversion and Alternate Facility Impacts by Tolling Objective	*Average Diversion (–%) / Attraction (+%) Rates*	
	3 Hr PM Peak Period [1]	*Daily Toll Period* [1]
Traffic Management Tolling Objective	– 17.9%	– 19.5%
Impact on I-90 Traffic Volumes	+ 0.5%	+ 5.2%
Impact on SR-522 Traffic Volumes	+ 4.0%	+ 3.4%
Maximum Funding Tolling Objective	– 31.6%	– 39.5%
Impact on I-90 Traffic Volumes	+ 0.7%	+ 14.3%
Impact on SR-522 Traffic Volumes	+ 9.3%	+ 13.1%

[1] Aggregated across both travel directions for all tolled traffic (includes 3+ HOVs)
[2] Reflects the PSRC model's demand impacts for a 3-hour PM peak period.
[3] Reflects 15 hours in the Traffic Management case and 24 hours in the Maximum Funding case.

The impacts on SR-522 are also relatively modest under both tolling objectives. Though the percentage increases in traffic on SR-522 are greater than those for I-90, the base level of traffic from which the percentages are generated is approximately one-quarter that of I-90. Moreover, the base levels of traffic on SR-522 when SR-520 is not tolled are actually lower with the improvements to SR-520 under either alternative than would otherwise be the case. The additional un-priced capacity on SR-520 actually attracts some trips away from SR-522, hence the appearance of a larger percentage impact on SR-522 when tolls are implemented on SR-520.

Note route diversion appears to be more prevalent during off-peak times, despite lower toll rates on SR-520. The combination of a lower average value of time for off-peak travel plus more available capacity on the alternative routes induces more users to alter their travel behavior — specifically to an alternate route — to avoid paying the SR-520 toll.

It is also worth mentioning that in the case of SR-520, the overall PM peak and daily toll diversion rates decline between 2014 and 2030 despite the assumption of annual toll increases to keep the toll schedule optimal for either of the two tolling objectives modeled. Essentially, a relatively stable and consistent travel time on the SR-520 Bridge due to the demand management that pricing provides, combined with increasing congestion elsewhere, causes the time cost of alternate routes to grow at a faster rate than the SR-520 toll.

Historical Toll Diversion Experience

By way of comparison, an analysis of how traffic changed when the 35¢ toll was removed from the existing bridge in 1979 suggests that toll diversion then was approximately 16%, with about one-third of this amount reflecting route diversion to I-90. It is difficult to compare the 1979 flat-rate 35¢ toll (unchanged since 1963) to the proposed variable toll schedules for 2014, especially since factors other than general inflation — i.e., growth in real wages, changing demand patterns, and higher levels of traffic congestion — need to be part of the comparison. Nevertheless, escalating the former toll from 1979 to 2014 dollars would yield a toll of about $1.05 each way.[18] In contrast, the "average" 2014 Traffic Management toll of $1.75 each way is estimated to produce about 20% diversion over its 15-hour toll period. Given the increase in real incomes, higher levels of congestion, and the move toward directionally balanced demand by time of day, the model results appear to be relatively consistent with past experience in this corridor.

Diversion Travel Time and Operating Costs for Selected Trips

An analysis of route diversion was conducted to estimate the increase in travel time and operating costs that could be experienced by drivers who choose to avoid using a tolled SR-520 Bridge. Four representative cross-lake trips were selected and examined:

1. Downtown Redmond – University of Washington
2. Downtown Seattle – Downtown Kirkland
3. Downtown Bellevue – Capital Hill
4. Downtown Kirkland – Roosevelt District

I-90 was assumed to be the best alternative route to SR-520 for the first three representative trips, and SR-522 was assumed to be the best alternative for the fourth trip.

[18] Had the escalation occurred from the year of opening, 1963, the 35¢ toll would be equivalent to $2.30 in 2014 dollars.

Estimation of Diversion Route Travel Times

A combination of travel time runs conducted in the field and model outputs were used to estimate travel times for each of the four representative cross-lake trips. The field results were used to supplement model outputs to estimate present day travel times. Interpolation between the present-day estimates and 2030 model outputs was used to arrive at estimated 2014 or year of opening travel times.

Results for each diversion route were then compared to those for the corresponding toll route, and the marginal increases in travel time and distance traveled were calculated. For example, the marginal increase in travel time of the toll diversion route between Downtown Redmond and the University of Washington during peak periods is estimated to be 24 minutes, with a marginal increase in the distance traveled of about eight miles.

Toll Diversion Time and Operating Costs

In order to arrive at a marginal cost difference for using these diversion routes, the average peak period value of time was applied to the increase in travel time for each alternative route. In addition, a vehicle operating cost per mile was applied to the marginal increase in distance traveled. Resulting estimated costs for present day and year of opening (2014) are shown in Figure 11 and Figure 12, respectively. Example PM peak period toll rates under the Traffic Management and Maximum Funding tolling objectives are also plotted in the figures for comparison. The estimated value of time for peak period travel was taken from the stated preference survey results presented earlier, at $14.43 per hour today and $19.18 per hour for 2014. For vehicle operating costs, the 2003 IRS rate of $0.36 per mile was assumed. It should be noted that actual vehicle operating costs including the costs of ownership exceed this rate.[19] However, some cost components such as depreciation and insurance that may not be fully perceived or considered by many drivers in making route decisions. Therefore, the more conservative IRS rate was used (though the PSRC model uses an even lower rate per mile). Also, the value of time would be lower during off-peak times, but so too would travel time savings, though an off-peak analysis was not conducted.

Figure 11 and Figure 12 illustrate that the marginal increases in time and operating costs are anticipated to exceed the estimated Maximum Funding toll for three of the four cross-lake trips examined. In other words, the incremental time and operating cost of driving an alternate route to SR-520 would, on average, exceed the toll required for these particular peak period examples.

For the trip between downtown Bellevue and Capitol Hill, the marginal cost for the diversion route is expected to be approximately the same as the Maximum Funding toll amount for both study years. In other words, for this particular trip, a driver with the average value of time who also considers vehicle operating costs would be indifferent to using the tolled SR-520 Bridge or the toll-free I-90. If that driver effectively ignored any differences in vehicle operating costs, then faced with a Maximum Funding toll rate, he/she would likely opt to use I-90 for this trip.

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[19] The American Automobile Association (AAA) estimates that average vehicle operating costs can be in the range of $0.46 to $0.64 per mile, depending on the miles driven per year. *Your Driving Costs 2003*, American Automobile Association, http://www.aaamissouri.com/news/library/drivingcost).

Figure 11
Present Day Alternative Route Travel Costs versus Peak Period SR-520 Toll

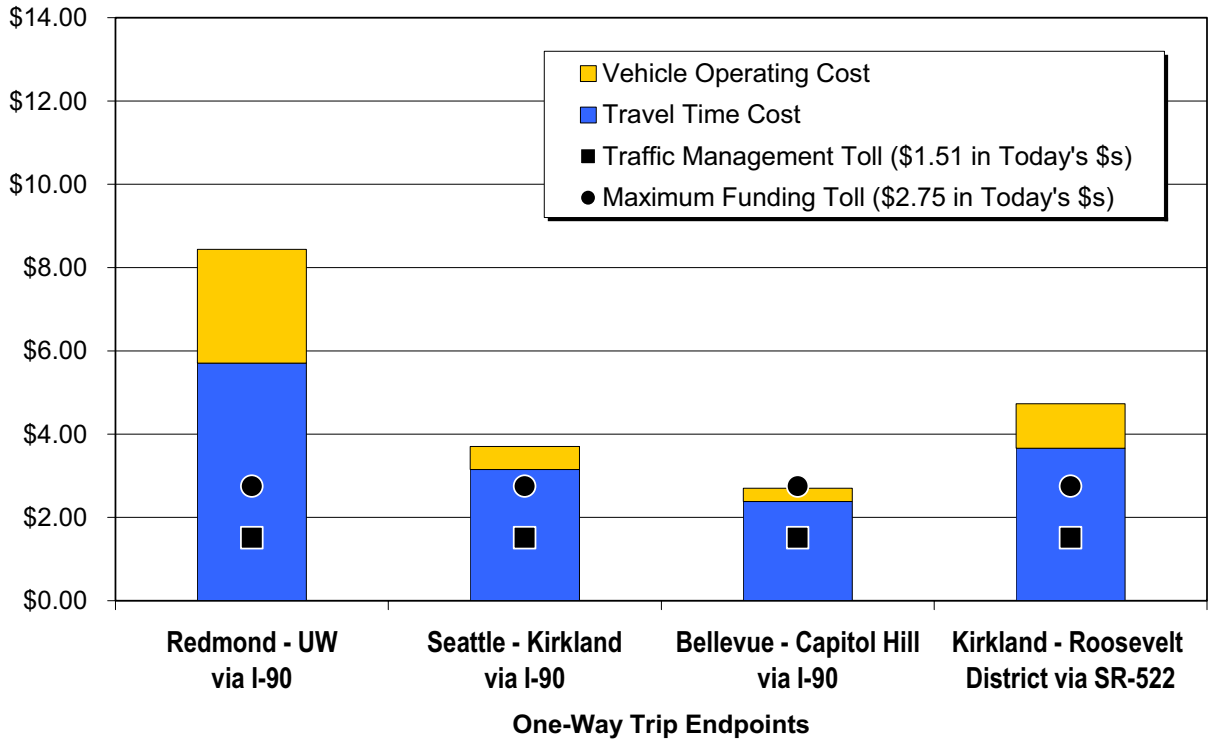
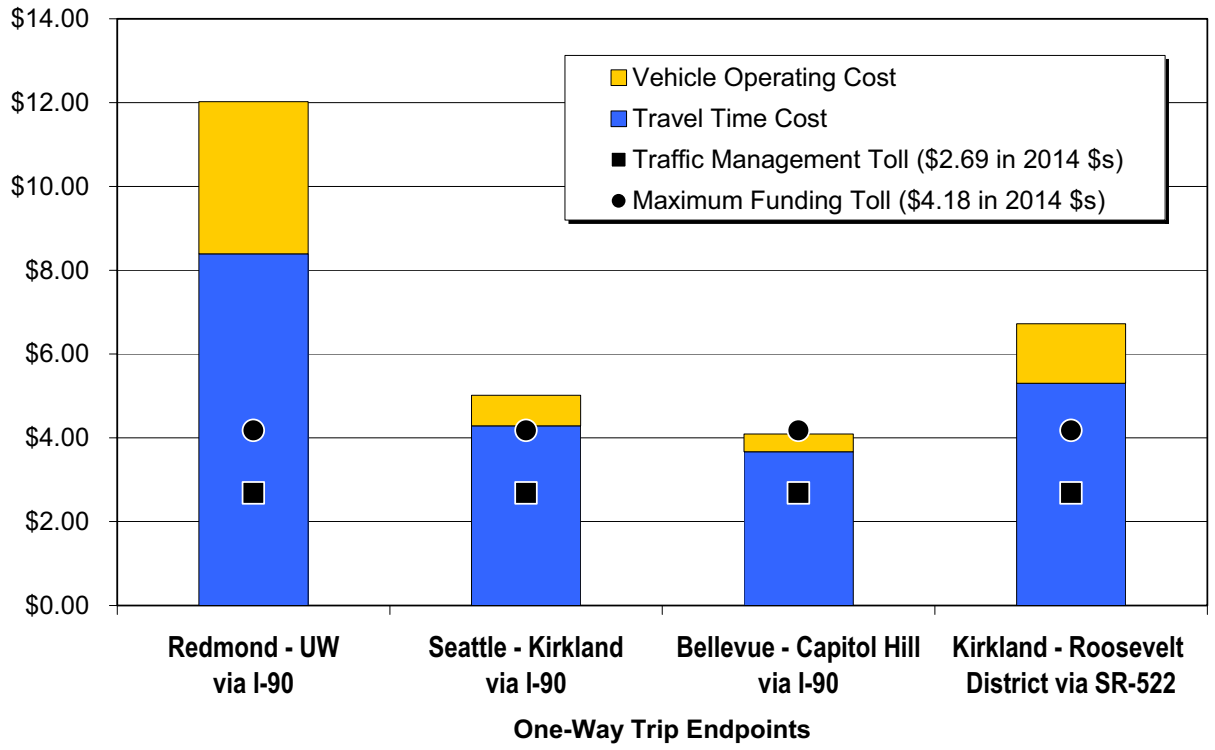


Figure 12
2014 Alternative Route Travel Costs versus Peak Period SR-520 Toll



Obviously, each driver or vehicle passenger will have different values of time and perceptions of cost, and even these will vary by trip purpose and circumstance. A toll on SR-520 is bound to cause some diversion, including route diversion. In fact, such diversion is typically necessary to manage traffic flows to within the available capacity of the bridge, so as to generally provide free flow conditions, and their associated time savings, for those who opt to use the tolled facility.

7. TOLL COLLECTION AND ROADWAY MAINTENANCE COSTS

Consideration of roadway pricing, specifically electronic toll collection, raises two basic questions about costs: (1) what are the capital costs to implement the necessary roadside and back office equipment and functions to collect tolls, and (2) what are the ongoing operations, administration and maintenance costs of collecting tolls and preserving the roadway capital?

Of particular interest to this study are the ongoing costs associated with toll facility. The collection, customer service, enforcement and violations processing costs of toll collection must be deducted from gross toll revenues in order to arrive at the revenue stream available for paying debt service on bonds. In addition, under most circumstances, the marketability of bonds would also be dependent on covenants requiring that gross toll revenues also be used to properly maintain the investment, a further deduction in arriving at net revenues available for debt service. These two items combined are not insignificant relative to the likely level of gross revenue collections.

In contrast, the capital investment costs for fully electronic toll collection are almost negligible, given that the replacement of the SR-520 Bridge and its associated improvements is estimated to be a multi-billion dollar effort. A preliminary estimate for the combined costs of in-road electronic toll collection equipment and back-office computer complex investments totals about $2.5 million in 2014 dollars.[20] Even if the true cost turned out to be double this amount, it would still be less than 1 percent of the current cost estimates for the replacement alternatives under consideration. In general, the capital investment costs of toll collection would be included in the overall bridge replacement project cost, and thus, would become part of the debt amount to be repaid from net toll revenues, rather than a deduction from gross toll revenues.

Costs Associated with Toll Collection

This section of the report focuses in on the ongoing costs of operating the SR-520 Bridge as a fully electronic toll facility. It summarizes assumptions and other bases used to develop estimates of the recurring cost for operations and maintenance (O&M) associated with the toll collection activity. In addition, existing preliminary roadway and bridge maintenance costs for four- and six-lane facilities are cited. The reader should keep in mind that the level of detail of the cost estimates proposed or cited herein should not be construed as investment-grade projections.

For purposes of the current study and the estimates developed, a six-lane facility with four general-purpose tolled lanes and two HOV non-tolled lanes was assumed, though the toll collection costs for a four-lane facility are not expected to be significantly different. Two back office alternatives are analyzed:

[20] *Toll Revenue Estimates for the Regional Transportation Investment District's Proposed Improvements with Value Pricing*, Parsons Brinckerhoff, January 2003

- A full scale Customer Service Center (CSC) under the "Full Operations" option; and
- A reduced scale CSC under a "Reduced Operations" option.

Consideration of the latter reflects the presence of either a regional CSC — the most likely scenario involving a shared CSC with the Tacoma Narrows Bridge — or the ability to join with other agencies and leverage scale to contract out certain CSC services at some time in the future.

The cost estimates assume that the operations of a CSC as well as a violations center (VC) will be contracted out by WSDOT. Generally, most aspects of CSC/VC operations are contracted to and run by the entity providing the toll application software that is used to manage accounts and process the toll transactions, referred to in this study as the "prime contractor". This contractor may use in-house resources entirely or in combination with subcontractors and/or other specialty firms to complete the work. Some public agencies have taken over specific component functions of the operation (e.g. commercial accounts), but rarely are all services completed in-house by the public agency. For purposes of this study estimate, all aspects of CSC/VC operations are assumed contracted with the exception of Violation Hearing Examiners (WSDOT) and on-site enforcement (Washington State Patrol), discussed later. For the "Reduced Operations" option, it is further assumed that certain component CSC/VC functions are subcontracted to specialty firms, who in combination with joining all regional tolling activities, can provide for more cost-effective services.

With CSC/VC operations contracted, WSDOT will need to oversee and manage the contractor. Since the nature of the services contract and an agency's overall approach to managing contractors influence the management cost, no explicit costs have been included in any of the estimates relating to WSDOT management oversight of the contracted customer service center and tolling operations.

In all cases, it was assumed that toll collection would be fully electronic. Recent technological progress suggests the assumption of 100% electronic toll collection (ETC) is reasonable, especially considering the probable 2014 implementation time frame. There are already several 100% ETC facilities in North America, including: SR-91 in Orange County, CA; I-15 in San Diego, CA; Westpark Tollway in Houston, TX (opening winter 2004); and 407 Express Toll Route in Toronto, Ontario.

No capital costs relating to the toll collection equipment or annual equipment spares have been included in the study estimates.

Additionally, while the cost of providing a Violation Center (VC) for the processing of toll evasions was estimated, no estimates have been included for potential violation fine and fee revenues. It is not unreasonable to assume that with an enforceable, legislated photo enforcement program that employs a reasonable fine structure, collected revenues can cover the processing costs, thereby reducing the overall costs of toll operations. The study estimates do include costs relating to WSDOT personnel used to determine the disposition of all violation appeals/hearings as well as the cost of on-site enforcement by the Washington State Patrol (WSP) of HOV and toll evasion violations.

Toll Collection Maintenance Costs

The estimate for maintenance of the toll collection equipment and facilities assumes a mix of on-site and on-call coverage for the SR-520 facility as described above to be provided by a contractor. Because toll systems are largely proprietary, maintenance services are usually contracted with component equipment suppliers and/or the original system integrator/ installer for the life of the system. The agreement between the contractor and the owner should address performance criteria for repairing any toll collection equipment malfunctions and include provisions for risk sharing and/or damages if such performance criteria are not met and result in substantial loss of revenue.

On-site maintenance involves a normal eight-hour shift completing preventative maintenance type activities, relating to cleaning, aligning, tuning, inspecting, replacing components and equipment as necessary and in accordance with manufacturer recommendations. Additionally, resources are on-call 24-hours a day, seven days a week in the event corrective maintenance is needed to repair, replace and/or restore damaged or malfunctioning components and equipment. Generally, these on-call services will provide for a two-hour repair and response time. A total of 2.0 local technical full-time equivalents (FTE) have been assumed to provide coverage.

The local technicians will typically require support from a central office. In most instances this support is remotely provided through secure communication connections into the toll system and involves diagnosis, maintenance, updating, patching, and upgrading various third party and application software and hardware. These resources provide support for other system administration activities involving data and system backups, data purging and archiving, and access and security management. For purposes of the estimate, 0.5 FTE have been assumed to provide remote hardware and software support.

A Maintenance Manager will manage the local technicians regionally. Depending on the number of regional facilities, this manager's time is usually divided across all the agencies and/or facilities supported. For purposes of the estimate, a conservative 0.5 FTE has been assumed.

Costs have been allocated for various items needed to complete the maintenance services, including for purposes of the estimate:

- Supplies and consumables covering office products as well as miscellaneous hardware and common electronic parts;
- Equipment lease/maintenance agreements covering any necessary vehicles and specialty vehicles as well as support agreements with toll equipment manufacturers;
- Software licensing covering toll system products and maintenance applications; and
- Support contracts from computer hardware equipment manufacturers.

The study estimate does not include any facility costs and it is assumed that 250 square feet of building space could be made available in the vicinity of the ETC equipment to serve as a

staging area for maintenance services.[21] An annual spares inventory for the toll system was not included in the study estimate.

Overhead costs at 130% have been included on payroll to cover benefits and other corporate labor costs. Contractor profit has been assumed as 10% of all payroll and direct costs. For more information on the labor cost breakdown, refer to the tables in Appendix C.

A summary of the annual costs for toll collection maintenance services is provided in Table 13 below for both the full and reduced operations options.

Table 13
Annual Toll Collection Maintenance Estimates by Operations Option

Maintenance Services by Operations Scenario	*Payroll & Overhead*	*Directs & Profit*	*Total (Today's $)*	*Total (2014 $)*
Full Operations (Standalone CSC)	$395,200	$71,200	$466,400	$608,000
Reduced Operations (Shared CSC)	$225,200	$54,200	$279,400	$364,200

For the reduced operations option, it is assumed that other regional tolling entities exist (e.g., the Tacoma Narrows Bridge) and use the same contractor for system integration and maintenance. In this scenario, the State is able to realize a cost savings through the availability of pooled resources from the contractor. Specifically, under the reduced operations option, the same maintenance services and coverage are provided. However the local technician FTE is reduced to 1.0 assuming that other coverage is readily available regionally to support on-call needs. Additionally, the regional maintenance manager's time is spread across multiple facilities and pooled staff, and it is assumed the FTE can be reduced to about 0.2.

The presence of other regional tolling facilities using the same Contractor for toll system integration and maintenance support can reduce the annual maintenance cost by as much as 40% through reducing Contractor staffing inefficiencies associated with providing 24/7 coverage of a single facility.

In either option presented above, the incorporation of additional toll lanes at the facility will not materially affect the annual cost based on the assumptions above.

Customer Service Center Costs

The Customer Service Center (CSC) operations cost estimate was developed by defining the component functions of the operation. For each component function, general work activities were identified and a staffing count was defined. In general, the Full Operations option

[21] This building space could potentially be located in the vicinity of the previous toll plaza.

assumes all functions are completed in-house by the operations contractor's direct staff or subcontractors. No explicit outsourcing of functions to specialty firms or to any shared resources (i.e. another CSC) is assumed for Full Operations.

The study estimate assumes an annual volume of 36 million toll transactions, which is conservative insofar as it is well above the toll demand range projected for 2014 and closer to the likely number of toll transactions forecasted for 2030. Based on an assumed average of 100 transactions per year per transponder, this translates into roughly 360,000 transponders, or 240,000 customer accounts assuming an average of 1.5 transponders per account. Note that transponders are transferable to different vehicles.

With no experience in the region regarding transponder use, it is difficult to assess what the average number of transactions per transponder will be, though there will likely be significant variance around this average. To be conservative, the assumed volume of toll transactions in the opening year (2014) was overstated by 20 to 30%. This provides some cushion in the CSC cost estimates should the assumptions for transactions per transponder or the total number of transponder accounts prove to be on the low side. Beyond 36 million transactions (or some other equivalent measure of the customer base,) each additional 10 million toll transactions are expected to add $1.5 million in operating costs, expressed in current dollars. Estimated another way, CSC operations are assumed to average roughly $1.25 per month per transponder for this study. Within the industry, CSC operating costs typically average $1.10 to $1.40 per month, per transponder.

In developing the staffing count associated with each component function, lower staff levels are budgeted as if they will be subcontracted to temporary agencies or other clerical type businesses in order to streamline some costs. For the purpose of this study estimate, the prime operations contractor's staff is paid higher hourly wages and 130% overhead, and must provide staff for all key personnel positions. Subcontracted staff is paid lower hourly wages and 40% overhead. For estimating purposes a 10% profit margin was assumed against all costs. For more information on itemized labor costs, refer to the tables in Appendix C.

Management of the CSC operations accounts for 2.0 FTEs that would be responsible for managing all staff and the day-to-day operations of the facility. CSC management is responsible for reporting to the State and will be staffed by the prime contractor.

The following summarizes the component functions and staffing count assumed for the CSC functions:

1. Transponder Management is responsible for inventory controls, tag ordering, tag encoding, etc. Assumes 2.0 FTE.

2. Application/Account Processing is responsible for processing applications, opening accounts, updating account information, processing mailed/faxed/e-mailed account correspondence, closing accounts, etc. Assumes 9.0 FTE.

3. Commercial Account Processing is responsible for tailored service to established commercial accounts, managing account transponders, updating information, invoicing, commercial discount programs, commercial phone support, etc. Assumes 7.0 FTE.

4. QA/Customer Service is responsible for walk-in transactions, QA oversight and programming, data analysis and reporting, etc. Assumes 5.0 FTE.

5. Payment Processing is responsible for processing cash and check payments, monitoring credit card and bank account debit transactions, reconciling all financial information, auditing change funds, issuing refunds, processing credits, etc. Assumes 8.0 FTE.

6. Call Center/Phone Support is responsible for receiving and addressing all patron calls. Assumes 14.0 FTE.

7. Statement Production is responsible for producing, packaging and distributing monthly patron statements. Assumes 6.0 FTE.

8. Mail Room Support is responsible for all outgoing and incoming mail processing in a timely fashion. Assumes 7.0 FTE.

9. SC Technical Support is responsible for all hardware and software supporting the data center and call center operations. Assumes 2.0 FTE.

Costs have been allocated for various items needed to complete the CSC operations, including for purposes of the estimate:

- Supplies and consumables covering office products;
- Equipment lease/maintenance agreements covering copy machines, faxes, mail sorters, etc. as well as support agreements;
- Leased facilities allowance for all inclusive rent of 10,000 square feet for office space for CSC and Violations Center (VC) operations;
- Janitorial services for cleaning the office space;
- Miscellaneous human resources/contracting to manage subcontracts and staff;
- Software licensing covering products used in the toll system and for maintenance tools;
- Support contracts from computer hardware OEMs;
- Banking fee allowance for cash handling; and
- Credit card fees (based on a 1% transaction fee for 70% credit card accounts of $80 million in annual toll revenues).

The study estimate does not include the capital cost of computer equipment, data servers, data storage, software, telephone system, furniture, fixtures, and security systems, as these were assumed to be included in the toll collection capital investments as part of the project costs. An annual spares inventory for these capital investments was also not included in the study estimate.

For the Reduced Operations option, it is assumed that other regional tolling entities exist and provide the same CSC services for a compatible transponder technology. In this scenario, the

State is able to realize a cost savings through outsourcing component functions of the CSC operations.

Under this Reduced Operations option, it is assumed that the call center and payment processing functions are outsourced to a third party. The outsourcing results in staff reductions for call center/phone support, payment processing, statement production, and mail room support. The clearinghouse operation may also be able to leverage more favorable rates for credit card and other processing fees, and as operations scale increases, additional savings in postage and other directs may be achieved. In addition to the labor savings, for purposes of this study estimate, the direct costs for banking and credit card fees were cut 50% and the facilities cost was trimmed by 25% to reflect these economies of scale.

Total savings in the Reduced Operations option is partly offset by a new service payment on the shared outsource contract. The estimated 35% reduction in the cost for CSC functions requires this new service payment, and thus, nets a cost reduction of approximately 25%. The new payment was assumed to be about 30% of the estimated cost reduction.

The staffing reductions are assumed as follows:

1. QA/Customer Service is reduced from 5.0 FTE to 4.0 FTE.
2. Payment Processing is reduced from 8.0 FTE to 3.0 FTE.
3. Call Center/Phone Support is reduced from 14.0 FTE to 2.0 FTE.
4. Statement Production is reduced from 6.0 FTE to 2.0 FTE.
5. Mail Room Support is reduced from 7.0 FTE to 3.0 FTE.
6. SC Technical Support is reduced from 2.0 FTE to 1.0 FTE.

All other CSC assumptions discussed previously remain the same. Table 14 summarizes the annual costs for both the Full Operations and the Reduced Operations options. From this table, it is evident that presence of other regional tolling facilities that would join together to leverage their collective size in order to secure more favorable outsourced contracts for call center and central clearinghouse operations can reduce the annual CSC operations cost for the SR-520 Bridge by approximately 25%.

Table 14
Annual Customer Service Center Estimates by Operations Option

Customer Service Center by Operations Scenario	*Payroll & Overhead*	*Directs & Profit*	*Total (Today's $)*	*Total (2014 $)*
Full Operations (Standalone CSC)	$3,522,000	$1,792,300	$5,314,300	$6,926,700
Reduced Operations (Shared CSC)	$2,259,700	$1,730,900	$3,990,600	$5,201,300

Finally, it should be noted that neither the cost of acquiring nor distributing transponders has been included in the study estimate for either operations option. A typical purchase cost for a transponder today is about $25. The cost for transponders can be borne entirely by the user, by the State, or shared. A shared arrangement may include a "first one free" per household until a pre-defined fixed quantity have been distributed, thereby providing an incentive for customers to act quickly to begin participation and thus avoid the transponder purchase expense.

Another shared arrangement could have the user buy the transponder but receive a partial or full credit of the purchase cost in bridge use privileges. In addition, some agencies are looking at "lease" type arrangements where the cost is recovered from the patron over a period of years (with the period tied to the transponder warranty) via a monthly or annual charge to the account. Under this scenario, a $25 tag with five-year warranty would be leased for $5 per year. The expense (less interest) is recovered at the duration of the warranty, and if the transponder continues to function, the agency comes out ahead. If the transponder fails within the warranty period, the agency receives some replacement value. This approach may have benefits for some consumers; if the transponder user moves after a year, he/she is not stuck having paid the full cost.

For a scenario in which the State might choose to underwrite part or all of the cost of an <u>initial</u> distribution of transponders, this expense could potentially be capitalized as part of the project cost rather than as an annual expense. Should the State opt to provide ongoing subsidization of transponders, then an annual expense for this would need to be estimated and included in the financial assumptions.

Distribution costs for the transponders would vary widely depending on how the acquisition costs are borne.

For a 100% ETC facility, given that there is a cost to maintaining an active customer account and an objective to distribute as many transponders as possible, there may be transponder customers who rarely use the bridge. In a scenario where the State is subsidizing all or part of the transponder costs and/or if the State wants to ensure that it is capturing the cost of maintaining the relatively inactive accounts of infrequent users, it may want to establish a minimum annual fee that goes into effect if the value of annual toll transactions for that customer falls short of this minimum threshold.

Violations Center Operations Costs

The Violations Center (VC) Operations Cost Estimate was developed by defining the component functions of the operation. For each component function, general work activities were identified and a staffing count was defined. In general, the Full Operations option assumes all functions are completed in-house with the operations contractor's direct staff or subcontractors. No explicit outsourcing of functions to specialty firms or to any shared resources (i.e., another CSC) is assumed for Full Operations.

The study estimate assumes a conservatively high annual volume of 36 million toll transactions. Industry average violation rates are typically 1.5% to 2.5% of the toll transaction volume. It should be noted that the above rates are predicated on the existence of violations enforcement and a reasonably high probability of capturing intentional violations accompanied by a financial penalty for repeat violations. For purposes of this study, it is assumed that the violation rate is 2.0% or 720,000 violations per year. Within the industry, VC operating costs typically average $2.00 to $3.00 per processed violation.

In developing the staffing count associated with each component function, lower staff levels are budgeted as if they will be subcontracted to temporary or other clerical type business in order to streamline some costs. For the purpose of this study estimate, the prime operations contractor staff is paid higher hourly wages and 130% overhead, and the contractor must staff all key personnel positions. Subcontracted staff is paid lower hourly wages and 40% overhead. For estimating purposes a 10% profit margin was assumed against all costs. For more information on itemized labor costs, refer to the tables in Appendix C.

Management of the VC operations accounts for 2.0 FTE responsible for managing all staff and the day-to-day operations of the facility. VC management is responsible for reporting to the State and will be staffed by the prime operations contractor. Note that if the CSC and VC operations are integrated and co-located, it may be possible to combine and reduce management staff. However, for purposes of this study, it's assumed that the operations are co-located but the management staffing has not been streamlined.

The following summarizes the component functions and staffing count assumed:

1. Violation Image Review is responsible for identifying license plate numbers, verifying violation information, batching records for Department of Licensing (DOL) lookup, processing violation notices, etc. Assumes 2.0 FTE.
2. Appeals/Phone Support is responsible for receiving and addressing all calls regarding violations/payments/appeals/hearings, receiving and processing violation appeals according to State policy, preparing evidence packages for hearings, etc. Assumes 5.0 FTE.
3. Payment Processing is responsible for processing cash and check payments, monitoring credit card and bank account debit transactions, reconciling all financial information, auditing change funds, issuing refunds, processing credits, etc. Assumes 4.0 FTE.
4. Mail Room Support is responsible for all outgoing and incoming mail processing in a timely fashion. Assumes 3.0 FTE.

5. VC Technical Support is responsible for all hardware and software supporting the data center and call center operations. Assumes 1.0 FTE.
6. Hearing Examiners are responsible for rendering final disposition of violation appeals. Assumes 1.0 FTE (usually a State agency staff position).
7. On-Site Enforcement is responsible for enforcing HOV restrictions, toll collection and other motor vehicle violations. Assumes an additional 2.0 FTE (Washington State Patrol) above existing enforcement levels; actual enforcement requirements may vary upon implementation.

Costs have been allocated for various items needed to complete the VC operations, including for purposes of the estimate:

- Supplies and consumables covering office products;
- Equipment lease/maintenance agreements covering copy machines, faxes, mail sorters, etc. as well as support agreements;
- Software licensing covering products used in the toll system and for maintenance tools;
- Miscellaneous human resources/contracting to manage subcontracts and staff; and
- Support contracts from computer hardware OEM's.

The study estimate does not include the capital cost of computer equipment, data servers, data storage, software, telephone system, furniture, fixtures, and security systems, which would likely be capitalized as part of the project cost. An annual spares inventory for these capital investments was also not included in the study estimate. Also, the costs of enforcement interconnections with the DOL have not been included, however these costs can typically be recovered through escalations in the fine/fee structure as a violation ages.

For the Reduced Operations option, it is assumed that other regional tolling entities exist and provide the similar VC services with identical policies. In this scenario, the State is able to realize a cost savings through outsourcing component functions of the VC operations.

Under the Reduced Operations option, it is assumed that the call center and payment processing functions are outsourced to a third party. The outsourcing results in staff reductions for call center/phone support and payment processing. For purposes of this study estimate, it is assumed that the direct cost savings are equal to the payment for outsourced services, and therefore net savings is labor cost alone.

The staffing reductions are assumed as follows:

1. Appeals/Phone Support is reduced from 5.0 FTE to 3.0 FTE.
2. Payment Processing is reduced from 4.0 FTE to 2.0 FTE.
3. VC Technical Support is reduced from 1.0 FTE to 0.5 FTE.

All other VC assumptions remain the same. Table 15 below summarizes the annual VC costs for both the Full Operations and the Reduced Operations options. These costs are gross costs

insofar as they include no offset (credit) for violation fines. With the appropriate statutory authority, it may be possible to cover part or all of the violation-related costs, including enforcement, with the revenue collected from fines. This would improve the overall bottom line net revenue for the operation. However, to be conservative, it was assumed that any violation fine revenue was not directly available to offset these or any other toll operating costs.

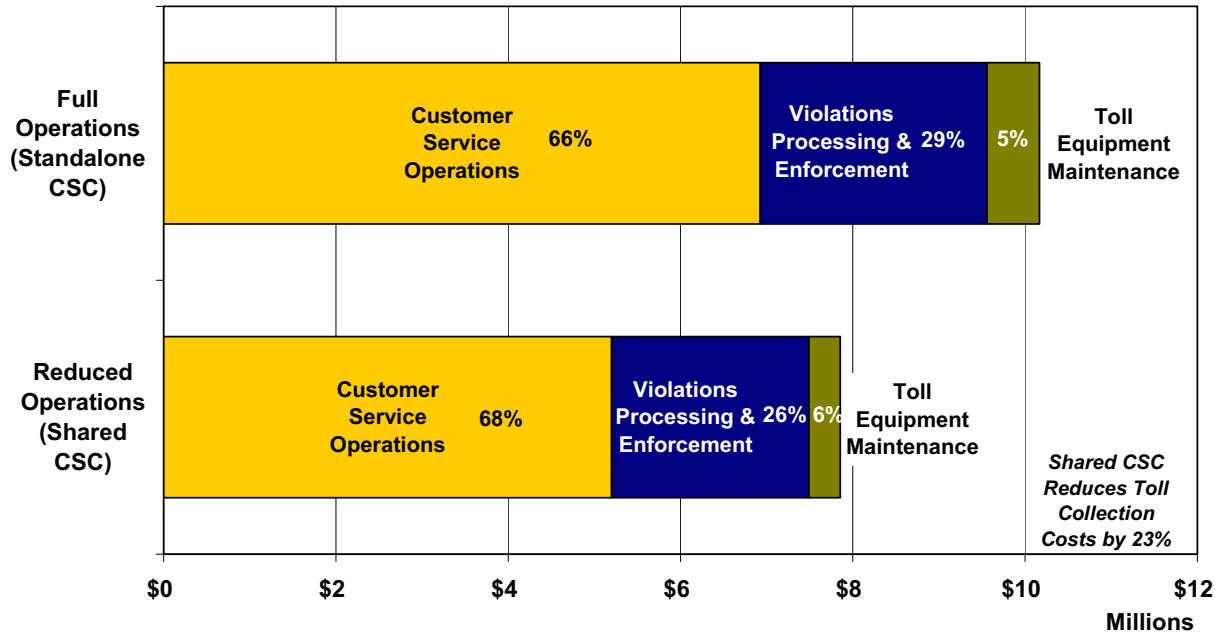
Table 15
Annual Violations Center Cost Estimates by Operations Option

Violations Center by Operations Scenario	*Payroll & Overhead*	*Directs & Profit*	*Total (Today's $)*	*Total (2014 $)*
Full Operations (Standalone VC)	$1,778,800	$240,200	$2,019,000	$2,631,600
Reduced Operations (Shared VC Functions)	$1,546,500	$210,400	$1,756,900	$2,290,000

Again, the presence of other regional tolling facilities that will join together to leverage their collective size in order to secure more favorable outsourced contracts for call center and central clearinghouse operations can also reduce the annual VC operations cost, in this case, by approximately 13%.

Figure 13 shows the distribution of the toll collection costs by the three main categories discussed above for both the Full Operations and Reduced Operations options. Overall, the pooling of resources under the Reduced Operations Option lowers toll collection costs for SR-520 by about $2.3 million, a 23% reduction.

Figure 13
Distribution of Toll Collection Costs by Function and Operating Option (2014 $)



Costs Associated with Bridge and Roadway Maintenance

It is likely that the bond covenants for a tolled SR-520 bridge would stipulate setting aside a portion of the toll revenues for maintenance of the facility. The bond holders would want to be assured that the investment in the bridge would be kept in good condition and that preventative maintenance is undertaken to minimize any risks of failure or events that might close the facility or otherwise undermine the toll revenue stream. This study assumes that these bridge and roadway maintenance activities would be the responsibility of WSDOT.

Preliminary annual maintenance cost estimates for the bridge and roadway elements for the sections to be replaced were prepared as part of the Trans-Lake Washington study.[22] More detailed estimates will be part of the forthcoming effort under the SR-520 Bridge Replacement and HOV Project. As these estimates were not yet available, the preliminary values were updated by WSDOT to reflect the current project limits for the four- and six-lane alternatives. In addition, WSDOT also included estimated costs for some periodic maintenance items based upon experience with other floating bridges. Table 16 summarizes these preliminary annual maintenance costs for the above referenced alternatives. Costs are allocated by category and identified as either routine annual expenditures or the annual equivalent of some periodic expenditure. Values are expressed in current dollars, with the totals also given in 2014 dollars, the proposed first year of operations.

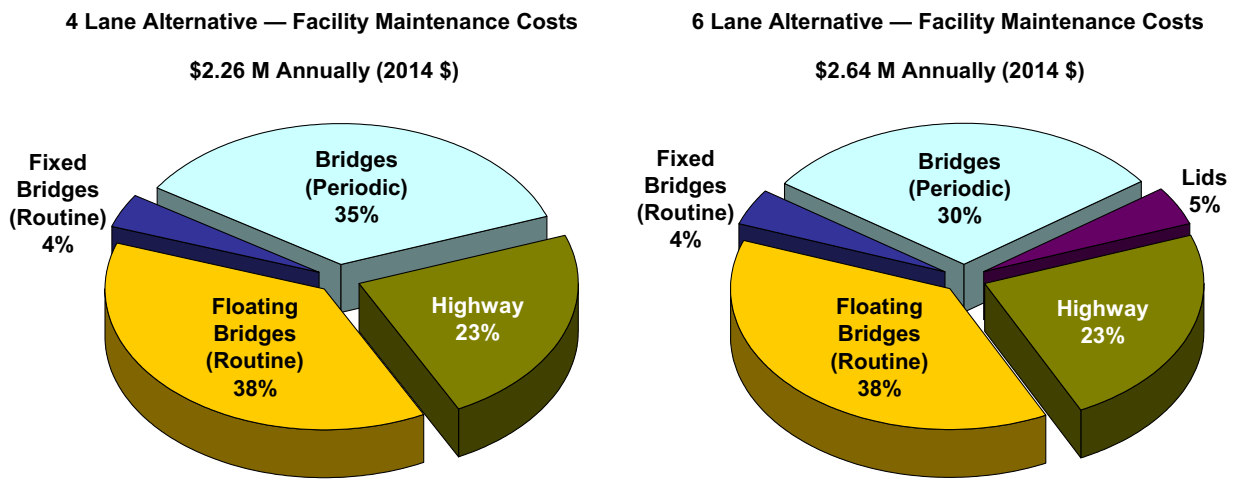
[22] *Trans-Lake Washington Project: Preliminary Design Plans Cost Methodology and Cost Opinions*, Parametrix et al, September 2002.

Table 16
Annual Bridge and Roadway Maintenance Costs by Alternative

Maintenance Activity		*4 Lane Alt.*	*6 Lane Alt.*
Routine Maintenance			
Highway		$ 393,000	$ 462,000
Floating Bridges (Routine)		$ 642,000	$ 755,000
Fixed Bridges (Routine)		$ 68,000	$ 80,000
Lids		$ -	$ 91,000
Subtotal Routine Maintenance		$ 1,103,000	$ 1,388,000
Periodic Maintenance			
Floating Bridge Inspections	(annual average)	$ 100,000	$ 100,000
Anchor Cable Replacements	(annual average)	$ 250,000	$ 250,000
Steelwork Painting	($5 M every 20 years)	$ 250,000	$ 250,000
Subtotal Periodic Maintenance		$ 600,000	$ 600,000
Total Annual Maintenance Costs (Today's $)		$ 1,703,000	$ 1,988,000
Total Annual Maintenance Costs (2014 $)		$ 2,264,000	$ 2,643,000

Figure 14 presents the distribution of these costs by major category for both alternatives. Note that the six-lane alternative adds about $380,000 in annual maintenance over the four-lane in the proposed year of opening, 2014. This difference accounts for the wider cross-section and the assumption of lids under the six-lane alternative.

Figure 14
Distribution of Bridge and Roadway Maintenance Costs



8. FINANCIAL CAPACITY ANALYSIS

The overall goal of this financial capacity analysis is to establish the range of project costs that could be supported by the annual revenue stream under various SR-520 toll revenue and financing scenarios. Variables affecting this financial capacity include the revenue projections by tolling objective, together with when toll collection begins; operating and maintenance costs for the toll facility; consideration of both stand-alone project toll revenue bonds, stand-alone bonds with subordinated debt in the form of a Transportation Infrastructure Finance and Innovation Act (TIFIA) federal loan, and bonds that would be backed by the State of Washington (i.e., "Motor Fuel Tax General Obligation Bonds"); and a host of other financial assumptions documented herein.

A total of 24 financial scenarios were analyzed by testing combinations of key variables and assumptions, including both the Traffic Management and Maximum Funding tolling objectives, for the revenue projections from the six-lane alternative. Table 17 lists 12 of these combinations for the assumption that toll collection begins at project completion, assumed to be January 1, 2004. The same 12 scenarios were also assessed for the alternative assumption that toll collection begins during construction at "discounted" rates, beginning January 1, 2009.

Financial capacity results for the revenue stream under the four-lane alternative, while not modeled, would be approximately 95% of that under the six-lane alternative, or in proportion to the ratio of the toll revenues between the six- and four-lane options (see Table 8 and Table 9).

Table 17
Financial Scenarios Modeled for Each Tolling Objective

Toll Collection Begins At Bridge Completion (January 1, 2014)											
Traffic Management Objective Toll Structure						Maximum Funding Objective Toll Structure					
Stand-alone Toll Facility (Customer Service Center)			Part of a Regional Toll System (Shared Customer Service Ctr)			Stand-alone Toll Facility (Customer Service Center)			Part of a Regional Toll System (Shared Customer Service Ctr)		
Stand-alone Toll Revenue Bonds	Stand-alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds	Stand-alone Toll Revenue Bonds	Stand-alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds	Stand-alone Toll Revenue Bonds	Stand-alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds	Stand-alone Toll Revenue Bonds	Stand-alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds

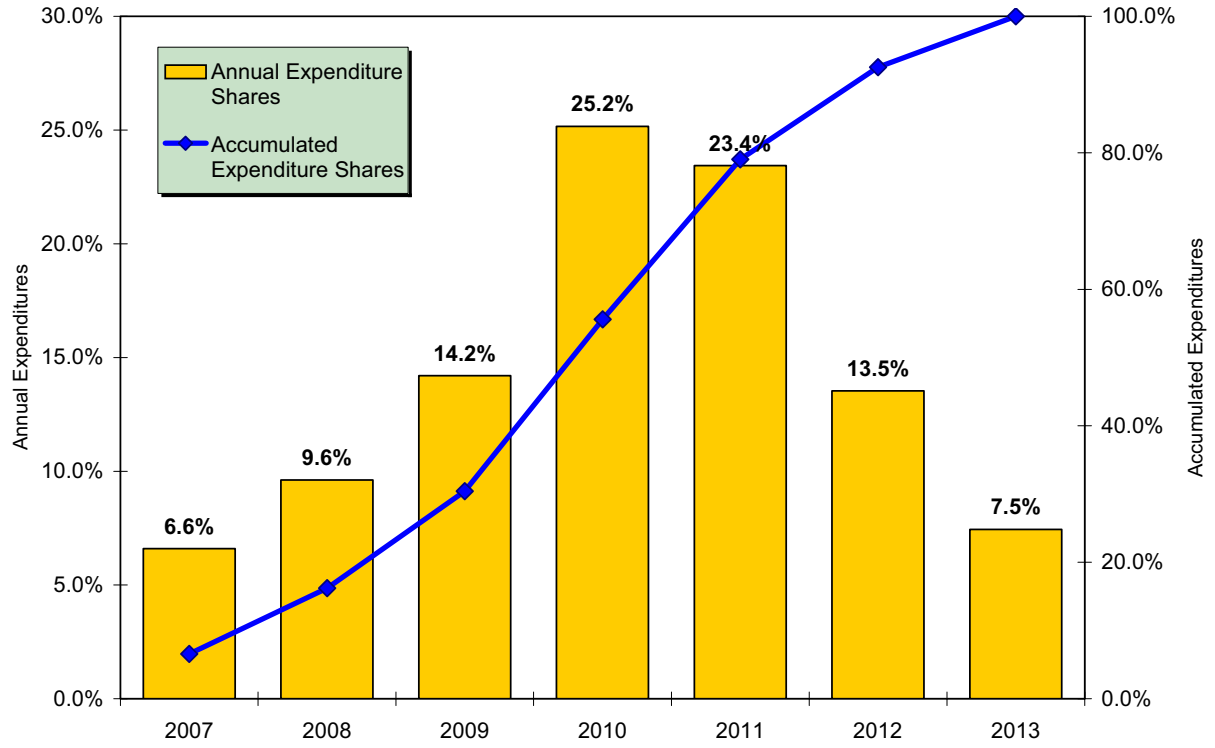
The methodology to accomplish the goal of identifying what level of expenditures tolls support involves structuring a toll revenue bond issue to maximize the project funds that can be generated from the bond issuance. This process involves evaluating the appropriate values to use for a variety of inputs. The proposed key assumptions are documented below.

Capital Costs and Project Funding Requirements Schedule

The capital program is a function of an assumed total cost and an expenditure curve representing the spend-down. The expenditure curve was developed using cost information provided by WSDOT for one of the options under the six-lane alternative. Project expenditures (right-of-way acquisition and construction) are expected to take place between January 1, 2007 and December 31, 2013 in the proportions represented by the expenditure curve, with construction beginning in 2008. Expenditures are assumed to be in future, year of expenditure dollars.

A simplified, representative construction expenditure curve for the six-lane alternative is shown in Figure 15. While the total construction cost for a four-lane alternative could be substantially different, the annual expenditure pattern is expected to be very similar; as such, only this single expenditure curve was utilized in the financial analysis.

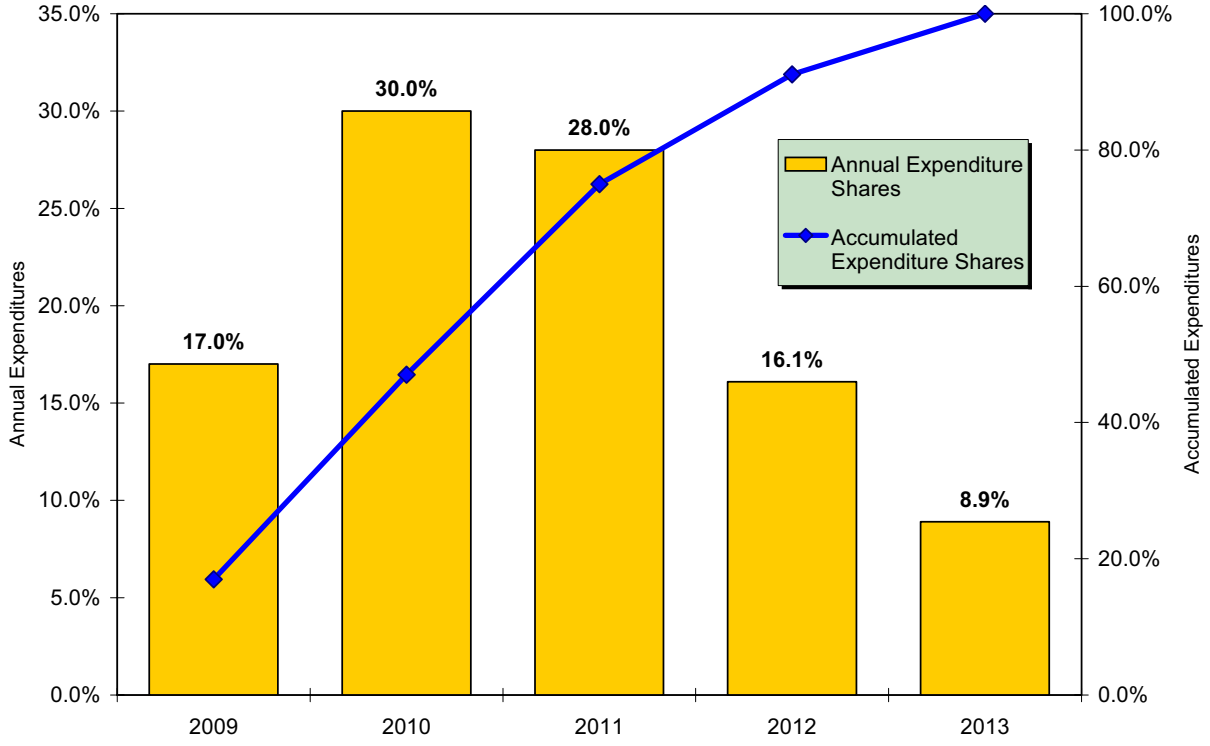
Figure 15
Simplified Annual Construction Expenditure Curve



Although right-of-way acquisition would begin in 2007, with construction beginning in 2008, the first bond issue was assumed to occur no sooner than 2009. Given that full revenue operations would commence in 2014, it was assumed that bonds could be issued no sooner than five (5) years prior to this point, or 2009. Recognizing that toll bond proceeds would not be the only source of funding for this project, other funding sources were assumed to cover the 16.2% of project costs allocated to 2007 and 2008. Reallocating the expenditures from 2009 through

2013 as those that could potentially be partially or fully covered by bond proceeds results in a modified "bond proceeds" expenditure curve shown in Figure 16.

Figure 16
Bond Proceeds Annual Expenditure Curve



Toll Revenue Estimates, Growth Rates and Ramp Up Effects

This financial capacity analysis employs the volume of toll transactions and gross revenue projections for the six-lane alternative under the two tolling objectives presented in this study, with a few noted exceptions. Two primary scenarios are presented related to the timing of revenue generation:

1. Toll collection begins relatively early during construction (January 1, 2009) at a suboptimal or "discounted" toll rate; and
2. Toll collection begins with bridge completion.

In either case, the new facility is assumed to be fully completed and open for regular revenue operations under some adopted toll policy beginning January 1, 2014. This date of completion was selected to coincide with the previously established initial horizon year for the toll revenue forecasts. Construction of the new facility would occur largely alongside the existing facility with the latter generally remaining fully open during construction, at least during daytime hours.

Tolling After Project Completion

Full toll operations are assumed to commence on January 1, 2014. In this case, the annual revenue stream is based on the 2014 toll demand projections by tolling objective, as documented in Chapter 5, *Toll Rates and Revenue Projections*. Figure 6 in Chapter 5 illustrates the corresponding post-completion 2014 toll schedules for both the Traffic Management and Maximum Funding tolling objectives.

However, in contrast to the travel demand modeling assumption, which perpetuates the optimal toll structure under either of the two tolling objectives, a more conservative annual growth rate for revenue was assumed for the financial analysis.

Modified Revenue Growth Rate Assumption

The gross revenue forecasts under either tolling objective are in future, year of collection dollars. As previously discussed, these gross revenue estimates already reflect a 5-percent deduction for electronic toll collection violation losses, inefficiencies and/or an annual allotment of "free passes" for occasional users.

In the opening year of 2014, it was assumed that the optimal toll schedule under both the Traffic Management and Maximum Funding tolling objectives would be implemented. In the Traffic Management case, if this optimal toll schedule were maintained each year by escalating the toll rates to account for the compound effects of inflation and growing travel demand, then revenues would be expected to grow, on average, by about 4.9% per year through 2030. Under the Maximum Funding case, the revenue growth would be even higher, at an average annual rate of 6.0% through 2030.

In contrast to these rates of growth based upon maintaining the optimality of an initial toll schedule, the financial analysis has constrained the annual revenue growth to 3.0% per year throughout the life of the debt. These different trends were illustrated previously in Figure 8 for the Traffic Management toll structure and in Figure 9 for the Maximum Funding toll structure. Holding revenue growth to 3.0% per year recognizes that there may be policy constraints or political events that constrain the State's ability to make annual, super-inflationary toll increases. While the toll operating authority would have some ability to adjust toll rates to maintain certain operating objectives, in all likelihood, the State would get periodic approval, perhaps every few years, to implement a general toll structure increase, which may or may not fully compensate for growing demand in addition to some measure of inflation. The 3.0% growth rate assumption is somewhat higher than the expected traffic demand growth with no further toll increases, while still reflecting the reality that approved toll increases will be suboptimal and/or infrequent.

Tolling During Construction

For purposes of the financial analysis, a sensitivity test was conducted to assess the potential additional funding capacity generated by daytime tolling the existing and/or new bridge segments during construction, beginning January 1, 2009. Because this scenario was not specifically modeled, its traffic demand and toll rates/revenue results are not reported in

Chapters 4 and 5, respectively. As such, the assumptions and interpolated estimates for these items are provided below.

Modeling results for the four-lane alternative in 2014 were used to provide estimated toll traffic demand levels that would correspond to the existing four-lane facility. A 13-hour (daytime) variable toll schedule was assumed during construction where the AM and PM peak one-way toll rates were set at $2.50, the projected level of a cross-lake transit fare in 2009. Peak shoulder and midday toll rates were somewhat lower and rounded off to the nearest quarter, as shown in Figure 17. The corresponding traffic demand expected under these toll rates in these years was reduced by approximately 5 percent to account for the substandard design and slightly lower speed limit encountered on the existing facility, which causes it to have marginally less capacity than the four-lane replacement alternative.

In addition, the bridge was assumed to be toll-free from 7 PM to 6 AM, in part because disruptive construction activities and partial bridge closures would likely take place during night hours, making tolling impractical. The weekend toll rates were assumed to be $0.75 from 8 to 11 AM and 6 to 9 PM, and $1.25 between 11 AM and 6 PM. Finally, in contrast with post construction operations, the nominal toll schedule in Figure 17 was assumed to remain constant over the construction period.

Figure 17
Weekday Toll Schedule during Construction (2009-2013 in 2009 Dollars)

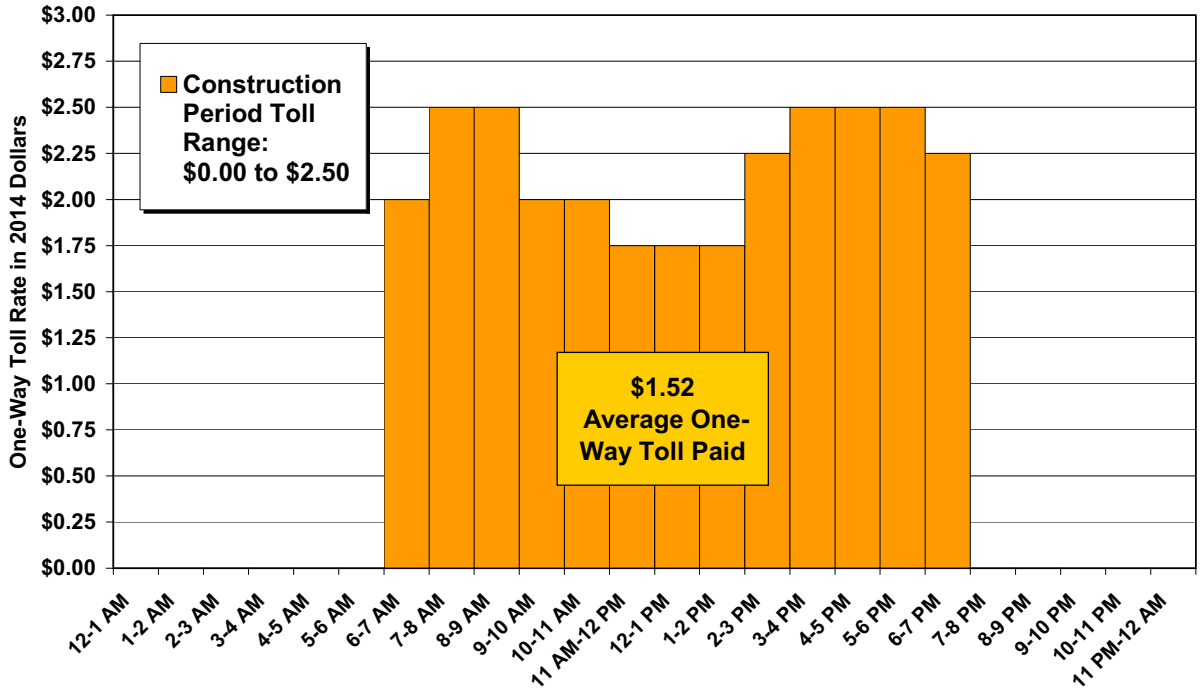


Table 18 shows the estimated revenue from tolling the existing bridge during construction for the years 2009 through 2013.

Results for the option of tolling during construction should be considered preliminary, and additional demand modeling and analysis may be warranted to better simulate this condition.

Table 18
Revenue Projections for Tolling Existing Facility During Construction

Year	Tolling During Construction						
	Annual PCE Toll Trans-actions [1]	Annual Toll Trans-actions [1]	Gross Annual Revenue	ETC Adj. Gross Revenue [2]	Operations & Maint. Cost [3]	Net Annual Revenue	Revenue Growth Rate
2009	27.0 M	24.5 M	$39.4 M	$37.4 M	($8.9 M)	$28.6 M	2.4%
2010	27.5 M	25.0 M	$40.6 M	$38.5 M	($9.1 M)	$29.4 M	3.0%
2011	28.1 M	25.5 M	$41.7 M	$39.7 M	($9.4 M)	$30.3 M	3.0%
2012	28.7 M	26.0 M	$43.0 M	$40.8 M	($9.6 M)	$31.2 M	3.0%
2013	29.3 M	26.6 M	$44.2 M	$42.0 M	($9.9 M)	$32.1 M	3.0%

[1] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[2] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[3] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Traffic Ramp-Up Adjustments

It is customary practice to make ramp-up adjustments to the expected toll collections in the early years of operations to reflect the market inefficiencies that may slow the eventual public acceptance of the facility. Many travelers will have imperfect information about the time and operating costs of alternate routes and/or modes to paying the toll, and the time savings and reliable travel times that the priced bridge would provide. Over time, the market inefficiencies dissipate and users make more rational decisions about opting to pay the toll versus other travel options as they become more informed about these benefits and costs of these choices.

Ramp-up periods of reduced revenue collections were incorporated into both the tolling during construction and post-completion commencement of tolling options. For tolling during construction, revenue was adjusted downward by 20% in 2009, 15% in 2010, 10% in 2011 and 5% in 2012. Furthermore, after the toll is increased and the hours of tolling are extended upon project completion, revenue was adjusted downward by 10% in 2014 for another year.

For the case where toll collection begins after project completion, revenue collections were reduced by 15% in 2014 and 5% in 2015, with revenue trends shown previously in Figure 8 and Figure 9. Note that all of these ramp-up adjustments are in addition to a global deduction of 5% for electronic toll collection violations, free passes and/or operational inefficiencies.

Annual O&M Estimates

Toll collection operations, customer service, violations processing and enforcement cost estimates were prepared as part of this study and are documented in Chapter 7. Roadway and structure maintenance costs were provided by WSDOT. All O&M costs were escalated to year of expenditure dollars, as appropriate, using a State projection for inflation based upon Global Insight's projection for the Implicit Price Deflator.

Financing Assumptions

Issuance Year or Years

Our analysis assumes that debt will be issued annually to fund each year's capital costs, subject to the constraint that no issue will be more than five years prior to project completion. Therefore, debt is issued annually from 2009 through 2013 (five annual issues of debt). For purposes of this analysis, it is assumed that debt is issued on January 1 of each year to fund the capital cost requirements for that year. The amount of capital costs required in each year is based on the expenditure curve detailed above in Figure 15, which is 17% in 2009, 30% in 2010, 28% in 2011, 16.1% in 2012, and 8.9% in 2013. Therefore, the debt amounts issued in each year are the annual amounts that collectively yield the largest contribution to the project cost, given the revenue stream available and the financing assumptions made. The assumption to issue debt annually can be changed to more or less frequently, with the goal being to maximize the funds available for capital expenditures in light of financing and other costs. Testing of alternative issuance schedules have indicated that an annual bond issuance schedule maximizes the project funds generated.

It should be noted that an annual bond issuance schedule for standalone toll revenue bonds (bonds not backed by the state) — assuming no other source of funding — is unlikely to be acceptable in the market due to investor concerns about future bond issues (and the project itself) being cancelled or delayed. For example, a bond holder of the 2009 bonds will have little chance of repayment if the future bond issues are cancelled and the project is not completed. Therefore, an annual issuance approach with standalone toll revenue bonds would require an underlying State commitment to complete the project, which could include another dedicated source of funding. Given that this project would likely include other State funding, and to facilitate a consistent comparison of project funds generated under the "Standalone Toll Revenue Bonds Scenario" and the "State Backed Bonds Scenario," it is assumed that an annual bond issuance schedule is possible using standalone toll revenue bonds.

Alternatively, the State could reassure bondholders by selling all of the stand-alone bonds in 2009. The portion of proceeds not immediately needed could be reinvested in short-term instruments for some level of interest earnings. However, this approach would yield less overall project funds than an annual issuance schedule because (1) capitalized interest would be required for all of the bonds for the full five-year period; and (2) the revenue available to be leveraged would only be the 30-year period from 2009 through 2038, which is a shorter overall

time period than the 30-year periods available from 2009, 2010, 2011, 2012, and 2013 under an annual issuance schedule.

Debt Structure

The financial analysis used an annual amortization of principal repayment using serial bonds — bonds issued at the same time but having different principal repayment schedules. The principal repayment structure incorporates an increasing annual debt service based on the shape of the projected revenue stream. For example, if the revenue stream increases by 3.0% each year then the debt service repayment is structured to increase by the same annual percentage. This produces level debt service coverage, as the debt service matches the projected revenue stream.

Testing of alternative principal repayment structures have indicated that the principal repayment structure outlined above maximizes project funds generated. However, when an actual debt issuance is undertaken, a stronger out-year coverage may be necessary which would reduce the up-front bonding capacity.

Type of Bonds

Our analysis utilizes a mixture of Current Interest Bonds (CIBs) and Capital Appreciation Bonds (CABs), with the mixture chosen to maximize bond proceeds subject to matching the debt service stream with the net revenue stream. In general, CABs were structured to constitute between 20% and 35% of the total debt issued depending on the scenario and revenue stream being analyzed.

CABs are zero coupon bonds that accumulate interest so they do not require current debt service payments. The total amount due is paid on the due date. CABs typically require a yield premium (for the same maturity, all else equal) over CIBs. Our analysis assumes that this yield premium will be 50 basis points (0.5%), meaning that if a CAB is used, its yield will be 0.5% higher than for a CIB of comparable maturity.

CABs benefit the bond structure because they minimize the bond interest payments due in the early years of revenue collection. Using only CIBs would mean that interest payments in the early years are too high to maximize bond proceeds. Alternatively, using only CABs would make the bonds more difficult to market, and could increase the interest premium. In this analysis, where net revenues are assumed to increase at a steady annual rate, mixing CABs into the bond structure allows for a higher level of project funds to be generated.

Term of Debt

This analysis assumes a 30-year maximum final maturity for each bond issue, in accordance with State statutes that prohibit a final maturity of greater than 30 years (for State Backed debt). Given an annual issuance program that includes serial bonds, the final payment on each bond issue will be structured to end on a different date.

Estimated Borrowing Yields

This analysis used current market yield scales obtained from Municipal Market Date (MMD) for October 31, 2003. However, an upward adjustment of 100 basis points (1.00%) was made to the current market yield curve to provide for a probable increase in future borrowing yields. Since current borrowing rates are at historic lows, using today's rates for financings five to ten years in the future is not a realistic assumption. Also, as mentioned previously, an additional 50 basis points (0.5%) was added to the yield if CABs were used.

The current market yield scale selected will vary depending upon the applicable bond ratings. Rating assumptions will vary depending upon whether the bonds are assumed to be Stand-Alone Toll Revenue Bonds or State Backed Bonds. Stand-Alone Toll Revenue Bonds are assumed to receive a Aaa Rating due to the purchase of bond insurance (discussed below). Therefore, the borrowing yield scale assumed for Stand-Alone Toll Revenue Bonds is the Aaa Insured MMD Scale. State Backed Bonds are assumed to have a Aa Rating and it is assumed that bond insurance would not be purchased. Therefore, the borrowing yield scale assumed for State Backed Bonds is the Aa MMD Scale.

It is assumed that the State will endeavor to maintain its current credit rating (Moody's Aa1/Standard & Poor's AA+/Fitch AA). This includes managing other debt issues, including concurrent debt issued directly or through a special purpose entity such as the Regional Transportation Investment District for other transportation projects so as to prevent a major shift in the bond market appetite for Washington State debt.

Bond Insurance

Bonds issued using bond insurance receive a Aaa rating as a result of the bond insurance policy. Bond insurance is paid at the time of issuance out of bond proceeds and the premium paid is quoted as a percentage of total debt service.

The purchase of bond insurance was evaluated over the financial scenarios to determine whether its purchase decreases borrowing rates and therefore increases bond proceeds. Given the State's reasonably high credit rating of Aa1 (Moody's), AA+ (Standard & Poor's) and AA (Fitch), it is assumed that bond insurance will not be needed for State Backed Bonds but would be used for Stand-Alone Toll Revenue Bonds. For Stand-Alone Toll Revenue Bonds, it is assumed that bond insurance will be purchased, as the nature of the standalone credit will make bond insurance highly desirable, if not necessary. The bond insurance premium is assumed to be 1.00% (100 basis points).

Debt Service Fund

In all of the bond scenarios, it is assumed that a Debt Service Fund (DSF) also referred to as a Debt Service Withdrawal Fund), will be established and that this fund will be funded in advance of the debt service payment date according to an agreed-upon schedule. For example, the bond covenant documents may read that funds will be set aside monthly in the DSF in an amount that equals 1/6th of the upcoming principal payment and 1/12th of the upcoming

interest payment. In this way, funds will be set aside and available in advance of the debt service payment date.

Debt Service Reserve Fund

It is assumed that a Debt Service Reserve Fund (DSRF) is required only in the scenarios involving Stand-alone Toll Revenue Bonds. For the scenarios utilizing State Backed Bonds, it is assumed that a DSRF will not be required. Rather, the State will, on a monthly basis, fund any shortfall in the Debt Service Fund in any month that net toll revenues are not sufficient to meet the DSF requirement. If State funds are used to back up a shortfall in toll revenues, and subsequently, net toll revenues exceed the DSF requirements, then the State will receive these funds back. It is this State funding mechanism, which provides an additional assurance that debt service payments will be made on time and in the required amount, that allows this analysis to assume that no Debt Service Reserve Fund (DSRF) is required in the State Backed scenarios.

The size of the DSRF requirement is calculated, as required by tax laws, to be the lesser of the maximum annual debt service amount, 10% of the par amount issued, or 125% of average annual debt service.

This analysis assumes that a DSRF surety bond will be purchased to fund the DSRF requirement in lieu of actually having this fund. A surety bond for the DSRF requirement can be purchased from a financial provider for a premium that is quoted as a percentage of the DSRF requirement. The provider of the DSRF surety bond agrees to fund the DSRF if required. The DSRF surety premium is paid with bond proceeds at the time of issuance. The DSRF surety premium used in this analysis is based on market information and is currently assumed to be 5.0% of the total DSRF requirement.

The difference in project funds generated between (1) using a DSRF surety bond and (2) funding a DSRF and earning interest on the DSRF balance was analyzed. The results indicate that using a DSRF surety bond to satisfy the DSRF requirement maximizes project funds generated. The analysis assumed a DSRF surety premium of 5.0% and an earnings rate on the DSRF of 3.0%. If different assumptions are made about the DSRF earnings rate and the DSRF surety bond rate, the conclusion could be different.

Capitalized Interest

It is assumed that the debt issued includes an amount to pay for debt service expenditures through and including January 1, 2014, which is the assumed completion date of the facility. At that time toll revenue operations will either commence or, if started during construction, the toll schedule will be increased to reach the stated policy objective level.

Capitalized interest is to be funded with bond proceeds at the time of issuance of each bond issue up through 2013. Therefore, for each annual bond issue, a decreasing number of years of capitalized interest is required, as follows:

- 2009 Issue – five years of capitalized interest
- 2010 Issue – four years of capitalized interest
- 2011 Issue – three years of capitalized interest
- 2012 Issue – two years of capitalized interest
- 2013 Issue – one year of capitalized interest

In scenarios where revenue generation (toll collection) begins with bridge construction, one possibility is that these revenues could be used to reduce capitalized interest. This possibility was analyzed, and the results indicate that project funds are maximized by using toll revenues during construction to help pay for project construction costs rather than to reduce the level of capitalized interest.

Costs of Issuance

Issuance costs for bond issues include the underwriter's discount and costs of issuance for such items as legal fees, traffic and revenue estimates, rating agency costs, printing costs, and other miscellaneous bond issue costs. In our analysis, we have assumed the following bond issue costs:

- Underwriter's Discount: 0.50% ($5 per bond)
- Costs of Issuance: 0.50% ($5 per bond)

Therefore, the total cost of issuance is assumed to be 1.00%

The issuance costs are likely to be higher for standalone toll revenue bonds due to more work and risk being required for this type of credit. However, in the absence of additional information and given the assumption of bond insurance, it is assumed that the issuance costs will be the same under each scenario to maintain a consistent comparison between the Stand-alone Toll Revenue Bonds and the State Backed Bonds scenarios.

Reinvestment Rates

When bonds are issued, project funds that are received are not all spent immediately. In addition, money is often borrowed to fund a Debt Service Reserve Fund (DSRF) and a capitalized interest fund. These funds that are either not spent immediately or set aside in accounts for a period of time are assumed to be invested at various investment yields.

The project fund is assumed to be reinvested at an annual rate of 3.0%. Within each year, it is assumed that the project funds will be spent equally on a monthly basis within that year. Similarly, had a DSRF been assumed rather than a DSRF surety bond, the funds would also be reinvested at a 3.0% annual rate. The capitalized interest fund is also assumed to earn interest at a 3.0% annual rate.

Coverage Levels

Our analysis assumes that the minimum debt service coverage levels allowable will be different based on whether the bonds are standalone toll revenue bonds or State Backed bonds. For Stand-Alone Toll Revenue Bonds, we are assuming a minimum debt service coverage ratio of 1.80 times net annual revenue. For State Backed Bonds, the minimum debt service coverage ratio is assumed to be 1.15 times net annual revenue. The coverage requirements may change in the future based on how the financing is structured and backed, but these assumptions appear reasonable given market conditions at this time.

The bonds are structured to maintain a level debt service coverage ratio annually, with the debt service coverage target being the minimum allowable coverage ratio for each scenario.

Subordinate Debt

Both the stand-alone toll bond and the State Backed bond scenarios consider only the issuance of senior revenue debt that has a first lien on all net revenues of the project. The use of one or more forms of subordinate debt could be applicable to this project. Subordinate debt is a secondary loan or security that takes advantage of excess revenues available after payments on the senior debt. Subordinate debt could be used to generate additional funds for the project.

Since the financial scenarios involving State Backed Bonds have a relatively low coverage ratio (1.15x), subordinate debt would generate very little or no additional project funds, as even subordinate bonds require a minimum coverage ratio of about 1.10x or more. However, in the Stand-Alone scenarios (with an assumed coverage ratio of 1.80x) there are sufficient excess revenues after the payment of senior bonds to make subordinate debt more beneficial.

For purposes of this financial capacity analysis, subordinate debt was considered in the form of a loan through the U.S. Department of Transportation's TIFIA program. The Transportation Infrastructure Finance and Innovation Act (TIFIA) allows for subordinate loans from the Federal DOT to the Project. The loan would be repaid from remaining revenues after the senior debt service is paid. The interest rate on a TIFIA loan is set based on the comparable Treasury yield, which in this case would be the 30-year U.S. Treasury Bond. For purposes of this analysis, the TIFIA loan borrowing rate was assumed to be 6.0%. Depending on market conditions, the borrowing yield on a TIFIA loan may exceed those available via the tax-exempt market.

Some advantages of a TIFIA loan are:

- The yield can be "locked in" well before funds are needed;
- Interest does not accrue until funds are drawn;
- Interest repayment can be deferred until five years after substantial project completion;
- The final maturity on the loan can be up to 35 years from substantial project completion;
- The minimum coverage on all debt can go as low as 1.10x; and
- The loan can be prepaid at any time without penalty.

Financial Analysis Results

Table 19 summarizes the project funds that would be generated under the 12 scenarios tested for the six-lane alternative with tolling beginning when the project is completed and open for full operations (January 1, 2004). Both tolling objectives are assessed across six sets of financial and operating assumptions. The most conservative scenario yields $321 million using standalone toll revenue bonds, a stand-alone customer service center operation, and the lower bound, Traffic Management toll schedule implemented in 2014. In contrast, the most optimistic scenario tested without tolling during construction yields $930 million with State Backed bonds, a shared customer service center operation, and the Maximum Funding toll schedule.

Table 19
Project Funds Generated by Scenario — Tolling After Completion
(Six-Lane Alternative)

Tolling Objective	Toll Collection Begins at Project Completion (January 1, 2014)					
	Stand-Alone Toll Facility (Customer Service Center)			Part of a Regional Toll System (Shared CSC)		
	Stand-Alone Toll Revenue Bonds	Stand-Alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds	Stand-Alone Toll Revenue Bonds	Stand-Alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds
Traffic Management	**$321 M**	**$486 M**	**$521 M**	**$338 M**	**$513 M**	**$549 M**
Maximum Funding	**$554 M**	**$844 M**	**$899 M**	**$571 M**	**$871 M**	**$930 M**

Note: Amounts are net of capitalized interest and represent year of expenditure dollars based upon five years of bond proceeds during construction.

Table 20 summarizes the project funds that would be generated under the 12 scenarios tested with tolling beginning during construction (January 1, 2009) during daytime hours under a relatively low overall toll schedule. For analysis purposes, the construction period tolls are then upgraded to either the Traffic Management or Maximum Funding toll schedule at the assumed completion date (January 1, 2004).

By generating revenue earlier in the project life, capitalized interest is reduced, and additional project funds are generated in all 12 scenarios tested with tolling during construction. The most conservative scenario with tolling during construction yields $452 million using standalone toll revenue bonds, a standalone customer service center operation, and the lower bound, Traffic Management toll schedule implemented in 2014. In contrast, the most optimistic scenario tested with tolling during construction yields $1.07 billion with State Backed bonds, a shared customer service center operation, and the Maximum Funding toll schedule.

Figure 18 summarizes the range of project funds that could be generated by the 24 financial scenarios tested. The horizontal range bars capture the key financial assumptions varied with

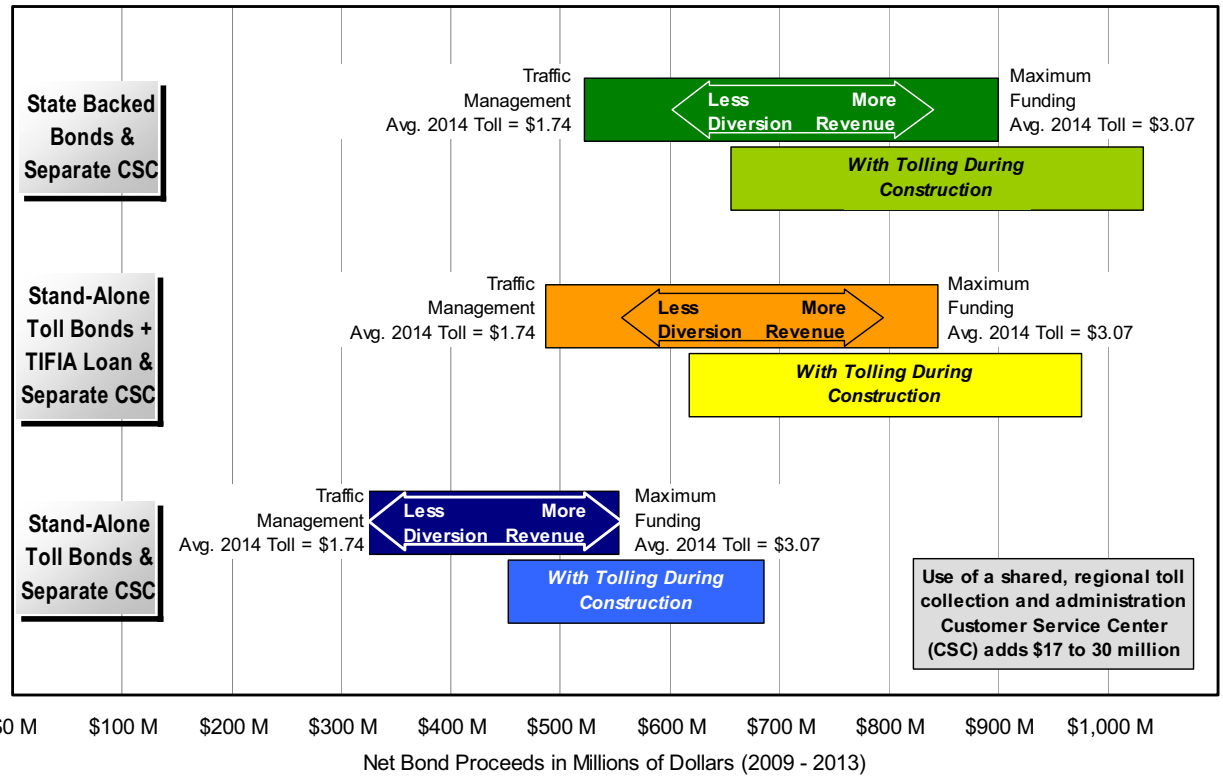
the exception of the use of a shared, regional toll collection and administration customer service center, which would add between $17 and 30 million.

Table 20
Project Funds Generated by Scenario — Tolling During Construction (Six-Lane Alternative)

Tolling Objective	Toll Collection Begins During Construction (January 1, 2009)					
	Stand-Alone Toll Facility (Customer Service Center)			Part of a Regional Toll System (Shared CSC)		
	Stand-Alone Toll Revenue Bonds	Stand-Alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds	Stand-Alone Toll Revenue Bonds	Stand-Alone Toll Revenue Bonds + TIFIA Loan	State Backed Bonds
Traffic Management	**$452 M**	**$617 M**	**$655 M**	**$480 M**	**$655 M**	**$693 M**
Maximum Funding	**$686 M**	**$976 M**	**$1,031 M**	**$714 M**	**$1,014 M**	**$1,072 M**

Note: Amounts are net of capitalized interest and represent year of expenditure dollars based upon five years of bond proceeds during construction.

Figure 18
Ranges of Project Funds Generated — Six-Lane Alternative



Observations

Several observations about the factors contributing to the project funds generated can be made.

- First, it is no surprise that the Maximum Funding (Revenue Maximizing) scenarios produce a much higher level of project funds than do the Traffic Management (Economic Efficiency) scenarios, increasing the project funds from about 50% to as much as 70%, depending on the scenario.
- Second, state backing of the bonds, by lowering debt service coverage requirements and eliminating the need for bond insurance to achieve a favorable rating, dramatically increases the project funds generated, with an increase of between 44% and 62% over stand-alone bonds, depending upon the scenario.
- Third, a preliminary analysis of the use of subordinated debt in the form of a TIFIA loan to augment the stand-alone bond scenarios could produce an additional 30%-40% in project funds, or well over 90% of the project funds generated under the State-backed scenarios.
- Fourth, the cost savings associated with using a shared customer service facility have a relatively minor impact on the level of project funds that could be generated, increasing project funds by between $27 and $41 million depending upon the scenario.
- Finally, relatively conservative assumptions for toll collection during construction increases the project funds generated between about $131 million and $142 million, depending on the scenario.

Table 21 and Table 22 present additional summary information for all of the financial scenarios, grouped by the Maximum Funding and Traffic Management toll schedules, respectively, under the six-lane alternative.

Table 21
Financial Scenario Summary for the Maximum Funding Tolling Objective

Summary of Financial Scenarios	Maximum Funding Tolling Objective							
	Toll Collection During Bridge Construction				Toll Collection Begins After Bridge Completion			
	Stand-Alone Toll Facility (Customer Service Center)		Part of a Regional Toll System (Shared CSC)		Stand-Alone Toll Facility (Customer Service Center)		Part of a Regional Toll System (Shared CSC)	
	Stand-Alone Toll Revenue Bonds	State Backed Bonds	Stand-Alone Toll Revenue Bonds	State Backed Bonds	Stand-Alone Toll Revenue Bonds	State Backed Bonds	Stand-Alone Toll Revenue Bonds	State Backed Bonds
Rating and Borrowing Yields:								
Rating:	Aaa Insured	Aa	Aaa Insured	Aa	Aaa Insured	Aa	Aaa Insured	Aa
Bond Insurance Used:	Yes	No	Yes	No	Yes	No	Yes	No
Bond Insurance Premium:	1.00%	0.00%	1.00%	0.00%	1.00%	0.00%	1.00%	0.00%
Increase in Current Market Yield Scale:	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Increase in Yield from CIBs to CABs:	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Debt Service Coverage								
Minimum Coverage:	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×
Maximum Coverage (2014-2037):	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×
Average Coverage (2014-2037):	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×
Debt Summary:								
Arbitrage Yield:	6.09%	5.85%	6.09%	5.84%	6.10%	5.86%	6.10%	5.86%
All-In True Interest Cost:	6.17%	5.92%	6.17%	5.92%	6.18%	5.93%	6.18%	5.93%
Final Maturity of Bonds (Years from Issuance):	30	30	30	30	30	30	30	30
Years of Currrent Interest Bonds (at End of Amort.):	10	10	10	10	8	8	8	8
Year of First Issue:	2009	2009	2009	2009	2009	2009	2009	2009
Year of Last Maturity:	2043	2043	2043	2043	2043	2043	2043	2043
Total Current Interest Bonds Issued:	538,480,000	841,205,000	554,865,000	867,860,000	471,680,000	737,915,000	485,445,000	761,450,000
Total Capital Appreciation Bonds Issued:	135,290,933	212,502,573	140,299,498	220,651,066	188,221,185	295,442,037	194,851,883	306,657,797
Total Principal Issued:	673,770,933	1,053,707,573	695,164,498	1,088,511,066	659,901,185	1,033,357,037	680,296,883	1,068,107,797
Total Interest:	992,714,339	1,548,638,648	1,023,442,959	1,598,532,700	995,994,733	1,556,117,342	1,025,829,745	1,606,934,616
Total Debt Service:	1,666,485,272	2,602,346,221	1,718,607,457	2,687,043,766	1,655,895,918	2,589,474,379	1,706,126,628	2,675,042,413
Debt Service Reserve Fund Required?	Yes	No	Yes	No	Yes	No	Yes	No
Surety Bond in Lieu of Debt Service Reserve Fund?	Yes	No	Yes	No	Yes	No	Yes	No
Surety Bond Premium:	5.00%	0.00%	5.00%	0.00%	5.00%	0.00%	5.00%	0.00%
Project Fund Summary (Senior Debt):								
Total Principal Issued:	673,770,933	1,053,707,573	695,164,498	1,088,511,066	659,901,185	1,033,357,037	680,296,883	1,068,107,797
Plus: Net Toll Revenues During Construction:	132,080,032	132,080,032	142,779,409	142,779,409	0	0	0	0
Less: Surety Bond Fee for DSRF	(3,368,855)	0	(3,475,822)	0	(3,299,506)	0	(3,401,484)	0
Less: Debt Service Reserve Fund Deposit	0	0	0	0	0	0	0	0
Less: Underwriter's Discount	(3,368,855)	(5,268,538)	(3,475,822)	(5,442,555)	(3,299,506)	(5,166,785)	(3,401,484)	(5,340,539)
Less: Costs of Issuance	(3,368,855)	(5,268,538)	(3,475,822)	(5,442,555)	(3,299,506)	(5,166,785)	(3,401,484)	(5,340,539)
Less: Bond Insurance	(16,664,853)	0	(17,186,075)	0	(16,558,959)	0	(17,061,266)	0
Less: Capitalized Interest Deposit	(104,073,698)	(160,238,730)	(107,318,848)	(165,390,452)	(88,434,896)	(138,010,431)	(91,018,923)	(142,416,107)
Less: Rounding of Bond Issuances	(5,850)	(11,799)	(11,517)	(14,913)	(8,812)	(13,035)	(12,241)	(10,612)
Plus: Interest Earnings on Bond Funds	10,950,407	16,466,168	11,404,647	17,115,081	8,841,440	14,357,201	9,117,228	14,843,886
Total Project Funds Generated	**685,950,407**	**1,031,466,168**	**714,404,647**	**1,072,115,081**	**553,841,440**	**899,357,201**	**571,117,228**	**929,843,886**
Additional Funds From a TIFIA Loan:								
Par Amount of Loan	405,667,393		419,586,959		405,667,393		419,586,959	
Less: Costs of Issuance	(2,000,000)		(2,000,000)		(2,000,000)		(2,000,000)	
Less: Accrued Interest During Deferral Period	(113,667,393)		(117,586,959)		(113,667,393)		(117,586,959)	
Total Project Funds from a TIFIA Loan	**290,000,000**		**300,000,000**		**290,000,000**		**300,000,000**	
Overall Debt Service Coverage (Including TIFIA Loan):								
Minimum Coverage:	1.15 ×		1.15 ×		1.15 ×		1.15 ×	
Maximum Coverage (2014-2037):	1.21 ×		1.21 ×		1.21 ×		1.21 ×	
Average Coverage (2014-2037):	1.20 ×		1.20 ×		1.20 ×		1.20 ×	
All-In Borrowing Cost of TIFIA Loan	6.03%		6.03%		6.03%		6.03%	
Total Project Fund Summary								
Total Funds Generated from Bond Issues	685,950,407	1,031,466,168	714,404,647	1,072,115,081	553,841,440	899,357,201	571,117,228	929,843,886
Total Funds Generated from TIFIA Loan	290,000,000	0	300,000,000	0	290,000,000	0	300,000,000	0
Total Project Funds Generated	**975,950,407**	**1,031,466,168**	**1,014,404,647**	**1,072,115,081**	**843,841,440**	**899,357,201**	**871,117,228**	**929,843,886**
Percentage of Comparable State-Backed Scenario	94.6%		94.6%		93.8%		93.7%	

Table 22
Financial Scenario Summary for the Traffic Management Tolling Objective

Summary of Financial Scenarios	Traffic Management Tolling Objective							
	Toll Collection During Bridge Construction				Toll Collection Begins After Bridge Completion			
	Stand-Alone Toll Facility (Customer Service Center)		Part of a Regional Toll System (Shared CSC)		Stand-Alone Toll Facility (Customer Service Center)		Part of a Regional Toll System (Shared CSC)	
	Stand-Alone Toll Revenue Bonds	State Backed Bonds	Stand-Alone Toll Revenue Bonds	State Backed Bonds	Stand-Alone Toll Revenue Bonds	State Backed Bonds	Stand-Alone Toll Revenue Bonds	State Backed Bonds
Rating and Borrowing Yields:								
Rating:	Aaa Insured	Aa	Aaa Insured	Aa	Aaa Insured	Aa	Aaa Insured	Aa
Bond Insurance Used:	Yes	No	Yes	No	Yes	No	Yes	No
Bond Insurance Premium:	1.00%	0.00%	1.00%	0.00%	1.00%	0.00%	1.00%	0.00%
Increase in Current Market Yield Scale:	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Increase in Yield from CIBs to CABs:	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Debt Service Coverage								
Minimum Coverage:	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×
Maximum Coverage (2014-2037):	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×
Average Coverage (2014-2037):	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×	1.80 ×	1.15 ×
Debt Summary:								
Arbitrage Yield:	6.09%	5.85%	6.09%	5.85%	6.10%	5.87%	6.10%	5.86%
All-In True Interest Cost:	6.17%	5.93%	6.17%	5.93%	6.18%	5.94%	6.18%	5.94%
Final Maturity of Bonds (Years from Issuance):	30	30	30	30	30	30	30	30
Years of Currrent Interest Bonds (at End of Amort.):	9	9	9	9	7	7	7	7
Year of First Issue:	2009	2009	2009	2009	2009	2009	2009	2009
Year of Last Maturity:	2043	2043	2043	2043	2043	2043	2043	2043
Total Current Interest Bonds Issued:	294,905,000	463,405,000	309,335,000	485,705,000	251,795,000	393,835,000	264,330,000	413,005,000
Total Capital Appreciation Bonds Issued:	91,792,349	145,180,380	97,319,945	153,819,873	126,707,669	198,797,922	134,325,610	210,525,106
Total Principal Issued:	386,697,349	608,585,380	406,654,945	639,524,873	378,502,669	592,632,922	398,655,610	623,530,106
Total Interest:	577,086,904	905,691,333	606,046,730	950,394,281	580,048,856	906,140,309	609,835,959	951,705,475
Total Debt Service:	963,784,253	1,514,276,713	1,012,701,675	1,589,919,155	958,551,525	1,498,773,231	1,008,491,569	1,575,235,581
Debt Service Reserve Fund Required?	Yes	No	Yes	No	Yes	No	Yes	No
Surety Bond in Lieu of Debt Service Reserve Fund?	Yes	No	Yes	No	Yes	No	Yes	No
Surety Bond Premium:	5.00%	0.00%	5.00%	0.00%	5.00%	0.00%	5.00%	0.00%
Project Fund Summary (Senior Debt):								
Total Principal Issued:	386,697,349	608,585,380	406,654,945	639,524,873	378,502,669	592,632,922	398,655,610	623,530,106
Plus: Net Toll Revenues During Construction:	132,080,032	132,080,032	142,779,409	142,779,409	0	0	0	0
Less: Surety Bond Fee for DSRF	(1,933,487)	0	(2,033,275)	0	(1,892,513)	0	(1,993,278)	0
Less: Debt Service Reserve Fund Deposit	0	0	0	0	0	0	0	0
Less: Underwriter's Discount	(1,933,487)	(3,042,927)	(2,033,275)	(3,197,624)	(1,892,513)	(2,963,165)	(1,993,278)	(3,117,651)
Less: Costs of Issuance	(1,933,487)	(3,042,927)	(2,033,275)	(3,197,624)	(1,892,513)	(2,963,165)	(1,993,278)	(3,117,651)
Less: Bond Insurance	(9,637,843)	0	(10,127,017)	0	(9,585,515)	0	(10,084,916)	0
Less: Capitalized Interest Deposit	(58,330,062)	(89,569,955)	(61,197,100)	(93,897,725)	(47,228,825)	(73,690,993)	(49,582,947)	(77,283,056)
Less: Rounding of Bond Issuances	(9,016)	(9,604)	(10,413)	(11,308)	(10,789)	(15,600)	(7,914)	(11,749)
Plus: Interest Earnings on Bond Funds	7,219,158	10,463,723	7,657,174	11,063,967	5,126,413	8,322,310	5,402,201	8,760,326
Total Project Funds Generated	**452,219,158**	**655,463,723**	**479,657,174**	**693,063,967**	**321,126,413**	**521,322,310**	**338,402,201**	**548,760,326**
Additional Funds From a TIFIA Loan:								
Par Amount of Loan	231,672,827		245,592,393		231,672,827		245,592,393	
Less: Costs of Issuance	(2,000,000)		(2,000,000)		(2,000,000)		(2,000,000)	
Less: Accrued Interest During Deferral Period	(64,672,827)		(68,592,393)		(64,672,827)		(68,592,393)	
Total Project Funds from a TIFIA Loan	**165,000,000**		**175,000,000**		**165,000,000**		**175,000,000**	
Overall Debt Service Coverage (Including TIFIA Loan):								
Minimum Coverage:	1.15 ×		1.15 ×		1.15 ×		1.15 ×	
Maximum Coverage (2014-2037):	1.22 ×		1.22 ×		1.22 ×		1.22 ×	
Average Coverage (2014-2037):	1.21 ×		1.21 ×		1.21 ×		1.21 ×	
All-In Borrowing Cost of TIFIA Loan	6.05%		6.05%		6.05%		6.05%	
Total Project Fund Summary								
Total Funds Generated from Bond Issues	452,219,158	655,463,723	479,657,174	693,063,967	321,126,413	521,322,310	338,402,201	548,760,326
Total Funds Generated from TIFIA Loan	165,000,000	0	175,000,000	0	165,000,000	0	175,000,000	0
Total Project Funds Generated	**617,219,158**	**655,463,723**	**654,657,174**	**693,063,967**	**486,126,413**	**521,322,310**	**513,402,201**	**548,760,326**
Percentage of Comparable State-Backed Scenario	94.2%		94.5%		93.2%		93.6%	

Additional Financial Considerations

The financial structure used in this analysis is a "market acceptable" structure that attempts to maximize project funds generated. However, there are other acceptable methodologies that may increase the amounts of project funds generated. A few of these other possibilities are outlined below.

More Aggressive Use of Capital Appreciation Bonds

It may be possible to marginally increase the project funds generated for this project by increasing the amount of Capital Appreciation Bonds (CABs) used and shortening the maturity of the Current Interest Bonds (CIBs). This structure minimizes the negative arbitrage in the capitalized interest account, thereby increasing proceeds generated. This alternative structure was tested in Scenario RM2 and net proceeds generated were increased by about $50 million (about 4.8% above the structure used in this analysis). However, the amount of CABs used increased from $212 million to $378 million, an increase of about 78%. In addition, the CABs amortization was pushed further out into the future. Although this structure may be possible, the fact that more CABs are used and that the duration of the CABs are extended could make this structure a more difficult one to issue in the capital markets. Due to the potential difficulty of the structure in the market and the marginal benefit in proceeds from using this structure, the original structure described previously was not changed. However, if this project progresses closer to a financing, a structure utilizing more CABs should be considered depending on capital market conditions at the time.

Gross Revenue Pledge Option

Another financial structuring possibility that could potentially improve project funds generated — particularly if the State does not back the bond issues — involves using a gross revenue pledge for the bonds. In a gross revenue pledge, repayment of debt service is not subordinated to payment of operating and maintenance costs. In other words, gross toll revenues are first pledged to debt service repayment and then to payment of operating and maintenance costs. In contrast, the structure described and modeled in this study involves a net revenue pledge in which operating and maintenance costs are paid prior to the payment of debt service.

A gross revenue pledge could be beneficial to the structure, especially if the State would prefer not to back the bonds. For example, it may be possible for the bonds to receive an "A" category rating without State backing (and without bond insurance) if WSDOT commits to loan the project or system any funds necessary to cover operating and maintenance expenditures should the revenues available after debt service come up short. In this example, the gross debt service coverage requirement would still be about 1.40 times gross annual revenue (due to the subordination of operating and maintenance costs) and the State would not have to formally back the bonds beyond a commitment to fund shortfalls in operating and maintenance costs. As this project progresses closer to financing, a gross revenue pledge with various operating and maintenance cost funding arrangements should be explored.

Additional Subordinate Debt Options

The Stand-Alone bond scenarios (with an assumed coverage ratio of 1.80x) provide sufficient excess revenues after the payment of senior bonds to make subordinate debt beneficial. While a TIFIA loan option was considered, depending on how the project develops and the market conditions at that time, it may be possible to issue subordinate debt in other forms. Because the analysis of a TIFIA loan demonstrates the substantial amount of potential additional funds that could be generated with subordinate debt, additional options should be explored as the actual time of the financing approaches.

Use of Longer Maturing Debt

This analysis assumes that all debt issued will have a final maturity 30 years from issuance. Under current Washington statutes, any bonds backed by State revenues cannot have a final maturity longer than 30 years from issuance. However, for the Stand-Alone toll revenue bonds it may be possible to have a final maturity of up to 40 years from issuance. Many financings for toll facilities in the last several years have been issued with final maturities of 40 years.

A sensitivity test was conducted to consider the additional proceeds that could be generated by issuing Stand-Alone toll revenue bonds with a 40-year final maturity. Using the same structuring techniques as in the 30-year case, the 40-year structure could generate approximately an additional 13% to 17% in project funds, depending on the scenario.[23] As the actual financing for the project approaches, the pros and cons of extending the financing to a 40-year structure should be evaluated based upon the market conditions at that time.

Excess Revenue Uses

An important policy consideration has to do with the use of net revenues remaining after debt service payments are made. Since all of the financial scenarios modeled include some level of debt service coverage in excess of 1.0, if revenues are produced as forecasted there will be excess revenues available at the end of each year. There are many ways in which excess revenues can be used, the most common of which is to accelerate the retirement of debt prior to maturity.

However, if this project ends up being part of a tolling system or other package of projects such as those conceived by the Regional Transportation Investment District (RTID), the excess revenues could be used to help fund other related projects or services including transit. In addition, many bond covenants for toll facilities require a certain amount of funds to be set aside for a major maintenance reserve fund. For example, the first $100 million of excess revenues could be placed in a major maintenance reserve fund.

The use of excess revenues was not considered in the financial analysis for this study, but may become an important factor in the actual financial structure.

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[23] For example, in Scenario RM3, an additional $99 million in project funds could be generated by using 40-year bonds rather than 30-year bonds, which is an increase of 13.8% in project funds generated.

APPENDIX A — TOLL SCHEDULES AND REVENUE PROJECTIONS: 2014-2030

Table A-1
Toll Revenue Detail — Traffic Management Objective — Six-Lane Alternative

Year	Traffic Management Objective*								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$1.74	32.2 M	29.0 M	$56.0 M	$53.2 M	5.6%	$45.2 M	($12.8 M)	$32.5 M
2015	$1.81	32.4 M	29.2 M	$58.7 M	$55.8 M	4.8%	$52.1 M	($13.0 M)	$39.0 M
2016	$1.89	32.6 M	29.4 M	$61.5 M	$58.5 M	4.8%	$56.4 M	($13.3 M)	$43.1 M
2017	$1.97	32.8 M	29.6 M	$64.5 M	$61.3 M	4.8%	$58.1 M	($13.6 M)	$44.5 M
2018	$2.05	33.0 M	29.8 M	$67.7 M	$64.3 M	4.8%	$59.9 M	($13.9 M)	$45.9 M
2019	$2.13	33.3 M	30.0 M	$70.9 M	$67.4 M	4.8%	$61.7 M	($14.3 M)	$47.4 M
2020	$2.22	33.5 M	30.2 M	$74.4 M	$70.6 M	4.8%	$63.5 M	($14.6 M)	$48.9 M
2021	$2.31	33.7 M	30.4 M	$77.7 M	$73.9 M	4.5%	$65.4 M	($14.9 M)	$50.5 M
2022	$2.39	33.9 M	30.6 M	$81.3 M	$77.2 M	4.5%	$67.4 M	($15.3 M)	$52.1 M
2023	$2.49	34.2 M	30.9 M	$85.0 M	$80.7 M	4.5%	$69.4 M	($15.7 M)	$53.7 M
2024	$2.58	34.4 M	31.1 M	$88.8 M	$84.4 M	4.5%	$71.5 M	($16.2 M)	$55.3 M
2025	$2.68	34.6 M	31.3 M	$92.9 M	$88.2 M	4.5%	$73.6 M	($16.7 M)	$57.0 M
2026	$2.77	34.9 M	31.5 M	$96.5 M	$91.7 M	3.9%	$75.8 M	($17.2 M)	$58.6 M
2027	$2.86	35.1 M	31.7 M	$100.3 M	$95.3 M	3.9%	$78.1 M	($17.8 M)	$60.3 M
2028	$2.95	35.3 M	31.9 M	$104.3 M	$99.1 M	3.9%	$80.5 M	($18.2 M)	$62.3 M
2029	$3.05	35.6 M	32.1 M	$108.4 M	$103.0 M	3.9%	$82.9 M	($18.7 M)	$64.2 M
2030	$3.14	35.8 M	32.3 M	$112.6 M	$107.0 M	3.9%	$85.4 M	($19.1 M)	$66.2 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Table A-2
Toll Revenue Detail — Maximum Funding Objective — Six-Lane Alternative

Year	Maximum Funding Objective*								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$3.07	28.5 M	25.8 M	$87.3 M	$82.9 M	5.7%	$70.5 M	($12.8 M)	$57.7 M
2015	$3.19	28.8 M	26.2 M	$91.9 M	$87.3 M	5.3%	$81.1 M	($13.0 M)	$68.1 M
2016	$3.31	29.2 M	26.5 M	$96.8 M	$91.9 M	5.3%	$87.9 M	($13.3 M)	$74.6 M
2017	$3.44	29.6 M	26.9 M	$101.9 M	$96.8 M	5.3%	$90.6 M	($13.6 M)	$77.0 M
2018	$3.57	30.0 M	27.3 M	$107.3 M	$102.0 M	5.3%	$93.3 M	($13.9 M)	$79.4 M
2019	$3.71	30.4 M	27.6 M	$113.0 M	$107.4 M	5.3%	$96.1 M	($14.3 M)	$81.8 M
2020	$3.86	30.9 M	28.0 M	$119.0 M	$113.1 M	5.3%	$99.0 M	($14.6 M)	$84.4 M
2021	$4.03	31.3 M	28.4 M	$125.9 M	$119.6 M	5.8%	$101.9 M	($14.9 M)	$87.0 M
2022	$4.20	31.7 M	28.8 M	$133.1 M	$126.5 M	5.8%	$105.0 M	($15.3 M)	$89.7 M
2023	$4.38	32.1 M	29.2 M	$140.8 M	$133.8 M	5.8%	$108.2 M	($15.7 M)	$92.4 M
2024	$4.57	32.6 M	29.6 M	$148.9 M	$141.5 M	5.8%	$111.4 M	($16.2 M)	$95.2 M
2025	$4.77	33.0 M	30.0 M	$157.5 M	$149.6 M	5.8%	$114.7 M	($16.7 M)	$98.1 M
2026	$4.97	33.5 M	30.4 M	$166.5 M	$158.1 M	5.7%	$118.2 M	($17.2 M)	$101.0 M
2027	$5.19	33.9 M	30.8 M	$176.0 M	$167.2 M	5.7%	$121.7 M	($17.8 M)	$104.0 M
2028	$5.41	34.4 M	31.2 M	$186.0 M	$176.7 M	5.7%	$125.4 M	($18.2 M)	$107.2 M
2029	$5.64	34.8 M	31.6 M	$196.6 M	$186.8 M	5.7%	$129.1 M	($18.7 M)	$110.5 M
2030	$5.88	35.3 M	32.1 M	$207.8 M	$197.4 M	5.7%	$133.0 M	($19.1 M)	$113.9 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Table A-3
Toll Revenue Detail — Traffic Management Objective — Four-Lane Alternative

Year	Traffic Management Objective*								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$1.70	31.9 M	28.8 M	$54.2 M	$51.5 M	5.6%	$43.7 M	($12.8 M)	$31.0 M
2015	$1.77	32.1 M	28.9 M	$56.9 M	$54.0 M	5.0%	$50.3 M	($13.0 M)	$37.3 M
2016	$1.85	32.3 M	29.1 M	$59.7 M	$56.7 M	5.0%	$54.6 M	($13.3 M)	$41.3 M
2017	$1.93	32.5 M	29.3 M	$62.6 M	$59.5 M	5.0%	$56.2 M	($13.6 M)	$42.6 M
2018	$2.01	32.7 M	29.5 M	$65.8 M	$62.5 M	5.0%	$57.9 M	($13.9 M)	$44.0 M
2019	$2.10	32.9 M	29.7 M	$69.0 M	$65.6 M	5.0%	$59.7 M	($14.3 M)	$45.4 M
2020	$2.19	33.1 M	29.9 M	$72.4 M	$68.8 M	5.0%	$61.4 M	($14.6 M)	$46.8 M
2021	$2.28	33.3 M	30.1 M	$75.9 M	$72.1 M	4.8%	$63.3 M	($14.9 M)	$48.3 M
2022	$2.37	33.5 M	30.3 M	$79.5 M	$75.5 M	4.8%	$65.2 M	($15.3 M)	$49.9 M
2023	$2.47	33.7 M	30.5 M	$83.3 M	$79.1 M	4.8%	$67.1 M	($15.7 M)	$51.4 M
2024	$2.57	34.0 M	30.7 M	$87.2 M	$82.9 M	4.8%	$69.2 M	($16.2 M)	$53.0 M
2025	$2.67	34.2 M	30.9 M	$91.4 M	$86.8 M	4.8%	$71.2 M	($16.7 M)	$54.6 M
2026	$2.77	34.4 M	31.1 M	$95.2 M	$90.4 M	4.1%	$73.4 M	($17.2 M)	$56.2 M
2027	$2.86	34.6 M	31.3 M	$99.1 M	$94.1 M	4.1%	$75.6 M	($17.8 M)	$57.8 M
2028	$2.96	34.9 M	31.5 M	$103.2 M	$98.0 M	4.1%	$77.8 M	($18.2 M)	$59.6 M
2029	$3.06	35.1 M	31.7 M	$107.5 M	$102.1 M	4.1%	$80.2 M	($18.7 M)	$61.5 M
2030	$3.17	35.3 M	31.9 M	$111.9 M	$106.3 M	4.1%	$82.6 M	($19.1 M)	$63.4 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

** VOT = value of time; 1% real growth implies that wage & salary earnings, and thus, VOT grow faster than general inflation.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Table A-4
Toll Revenue Detail — Maximum Funding Objective — Four-Lane Alternative

Year	Maximum Funding Objective*								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$3.03	26.9 M	24.4 M	$81.6 M	$77.5 M	6.0%	$65.9 M	($12.8 M)	$53.1 M
2015	$3.17	27.2 M	24.7 M	$86.2 M	$81.9 M	5.7%	$75.9 M	($13.0 M)	$62.8 M
2016	$3.30	27.6 M	25.0 M	$91.1 M	$86.6 M	5.7%	$82.3 M	($13.3 M)	$69.0 M
2017	$3.45	27.9 M	25.4 M	$96.3 M	$91.4 M	5.7%	$84.7 M	($13.6 M)	$71.1 M
2018	$3.60	28.3 M	25.7 M	$101.7 M	$96.6 M	5.7%	$87.3 M	($13.9 M)	$73.3 M
2019	$3.75	28.6 M	26.0 M	$107.4 M	$102.1 M	5.7%	$89.9 M	($14.3 M)	$75.6 M
2020	$3.92	29.0 M	26.3 M	$113.5 M	$107.8 M	5.7%	$92.6 M	($14.6 M)	$78.0 M
2021	$4.10	29.3 M	26.6 M	$120.4 M	$114.4 M	6.1%	$95.4 M	($14.9 M)	$80.4 M
2022	$4.30	29.7 M	27.0 M	$127.8 M	$121.4 M	6.1%	$98.2 M	($15.3 M)	$82.9 M
2023	$4.51	30.1 M	27.3 M	$135.5 M	$128.8 M	6.1%	$101.2 M	($15.7 M)	$85.5 M
2024	$4.72	30.5 M	27.7 M	$143.8 M	$136.6 M	6.1%	$104.2 M	($16.2 M)	$88.0 M
2025	$4.95	30.8 M	28.0 M	$152.5 M	$144.9 M	6.1%	$107.3 M	($16.7 M)	$90.7 M
2026	$5.15	31.2 M	28.4 M	$160.8 M	$152.8 M	5.4%	$110.6 M	($17.2 M)	$93.4 M
2027	$5.36	31.6 M	28.7 M	$169.6 M	$161.1 M	5.4%	$113.9 M	($17.8 M)	$96.1 M
2028	$5.58	32.0 M	29.1 M	$178.8 M	$169.9 M	5.4%	$117.3 M	($18.2 M)	$99.1 M
2029	$5.82	32.4 M	29.4 M	$188.5 M	$179.1 M	5.4%	$120.8 M	($18.7 M)	$102.1 M
2030	$6.06	32.8 M	29.8 M	$198.8 M	$188.8 M	5.4%	$124.4 M	($19.1 M)	$105.3 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

** VOT = value of time; 1% real growth implies that wage & salary earnings, and thus, VOT grow faster than general inflation.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Table A-5
2014 Toll Schedule for the Six-Lane Alternative — Current and 2014 Dollars

	2014 Toll Rates in Current Dollars* – 6 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$1.67	$1.93	$0.46	$0.46	$2.41	$2.41	$0.57	$0.57
7-8 AM					$2.83	$2.83		
8-9 AM							$1.13	$1.13
9-10 AM					$2.41	$2.41		
10-11 AM								
11 AM-12 PM	$0.46	$0.46			$2.31	$2.22	$1.70	$1.70
12-1 PM								
1-2 PM								
2-3 PM	$2.23	$2.25			$3.10	$3.10		
3-4 PM					$3.45	$3.45		
4-5 PM								
5-6 PM								
6-7 PM					$3.10	$3.10	$1.13	$1.13
7-8 PM	$0.46	$0.46			$2.31	$2.22		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$0.57	$0.57	$0.57	$0.57

* Year-end 2002 dollars.

	2014 Toll Rates in Inflated Dollars — 6 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$2.22	$2.56	$0.62	$0.62	$3.20	$3.20	$0.75	$0.75
7-8 AM					$3.77	$3.77		
8-9 AM							$1.51	$1.51
9-10 AM					$3.20	$3.20		
10-11 AM								
11 AM-12 PM	$0.62	$0.62			$3.08	$2.95	$2.26	$2.26
12-1 PM								
1-2 PM								
2-3 PM	$2.97	$2.99			$4.13	$4.13		
3-4 PM					$4.59	$4.59		
4-5 PM								
5-6 PM								
6-7 PM					$4.13	$4.13	$1.51	$1.51
7-8 PM	$0.62	$0.62			$3.08	$2.95		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$0.75	$0.75	$0.75	$0.75

Table A-6
2014 Toll Schedule for the Four-Lane Alternative — Current and 2014 Dollars

	2014 Toll Rates in 2002 Dollars — 4 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$1.57	$1.89	$0.46	$0.46	$2.36	$2.36	$0.57	$0.57
7-8 AM					$2.78	$2.78		
8-9 AM							$1.13	$1.13
9-10 AM					$2.36	$2.36		
10-11 AM								
11 AM-12 PM	$0.46	$0.46			$2.22	$2.31	$1.70	$1.70
12-1 PM								
1-2 PM								
2-3 PM	$2.27	$2.12			$2.86	$3.20		
3-4 PM					$3.18	$3.56		
4-5 PM								
5-6 PM								
6-7 PM					$2.86	$3.20	$1.13	$1.13
7-8 PM	$0.46	$0.46			$2.22	$2.31		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$0.57	$0.57	$0.57	$0.57

* Year-end 2002 dollars.

	2014 Toll Rates in Inflated Dollars — 4 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$2.09	$2.51	$0.62	$0.62	$3.14	$3.14	$0.75	$0.75
7-8 AM					$3.70	$3.70		
8-9 AM							$1.51	$1.51
9-10 AM					$3.14	$3.14		
10-11 AM								
11 AM-12 PM	$0.62	$0.62			$2.95	$3.08	$2.26	$2.26
12-1 PM								
1-2 PM								
2-3 PM	$3.02	$2.81			$3.81	$4.25		
3-4 PM					$4.23	$4.73		
4-5 PM								
5-6 PM								
6-7 PM					$3.81	$4.25	$1.51	$1.51
7-8 PM	$0.62	$0.62			$2.95	$3.08		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$0.75	$0.75	$0.75	$0.75

Table A-7
2030 Toll Schedule for the Six-Lane Alternative — Current and 2030 Dollars

	2030 Toll Rates in Current Dollars* – 6 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$2.09	$2.62	$0.46	$0.52	$2.78	$2.78	$0.78	$0.78
7-8 AM					$3.27	$3.27		
8-9 AM							$1.57	$1.57
9-10 AM					$2.78	$2.78		
10-11 AM								
11 AM-12 PM	$0.46	$0.52			$3.27	$3.00	$2.35	$2.35
12-1 PM								
1-2 PM								
2-3 PM	$2.64	$2.60			$3.93	$3.93		
3-4 PM					$4.36	$4.36		
4-5 PM								
5-6 PM								
6-7 PM					$3.93	$3.93	$1.57	$1.57
7-8 PM	$0.46	$0.52			$3.27	$3.00		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$0.78	$0.78	$0.78	$0.78

* Year-end 2002 dollars.

	2030 Toll Rates in Inflated Dollars — 6 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$4.17	$5.22	$0.92	$1.03	$5.54	$5.54	$1.56	$1.56
7-8 AM					$6.52	$6.52		
8-9 AM							$3.12	$3.12
9-10 AM					$5.54	$5.54		
10-11 AM								
11 AM-12 PM	$0.92	$1.03			$6.52	$5.98	$4.69	$4.69
12-1 PM								
1-2 PM								
2-3 PM	$5.27	$5.17			$7.82	$7.82		
3-4 PM					$8.69	$8.69		
4-5 PM								
5-6 PM								
6-7 PM					$7.82	$7.82	$3.12	$3.12
7-8 PM	$0.92	$1.03			$6.52	$5.98		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$1.56	$1.56	$1.56	$1.56

Table A-8
2030 Toll Schedule for the Four-Lane Alternative — Current and 2030 Dollars

	2030 Toll Rates in Current Dollars* – 4 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$2.04	$2.65	$0.46	$0.47	$3.01	$3.01	$0.78	$0.78
7-8 AM					$3.55	$3.55		
8-9 AM							$1.57	$1.57
9-10 AM					$3.01	$3.01		
10-11 AM								
11 AM-12 PM	$0.46	$0.47			$3.00	$3.27	$2.35	$2.35
12-1 PM								
1-2 PM								
2-3 PM	$2.78	$2.63			$4.17	$4.17		
3-4 PM					$4.64	$4.64		
4-5 PM								
5-6 PM								
6-7 PM					$4.17	$4.17	$1.57	$1.57
7-8 PM	$0.46	$0.47			$3.00	$3.27		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$0.78	$0.78	$0.78	$0.78

* Year-end 2002 dollars.

	2030 Toll Rates in Inflated Dollars — 4 Lane							
	Toll Operating Objective							
	Traffic Management				*Maximum Funding*			
	Weekdays		*Weekends*		*Weekdays*		*Weekends*	
	WB	*EB*	*WB*	*EB*	*WB*	*EB*	*WB*	*EB*
6-7 AM	$4.06	$5.29	$0.92	$0.94	$6.00	$6.00	$1.56	$1.56
7-8 AM					$7.06	$7.06		
8-9 AM							$3.12	$3.12
9-10 AM					$6.00	$6.00		
10-11 AM								
11 AM-12 PM	$0.92	$0.94			$5.98	$6.52	$4.69	$4.69
12-1 PM								
1-2 PM								
2-3 PM	$5.54	$5.23			$8.31	$8.31		
3-4 PM					$9.24	$9.24		
4-5 PM								
5-6 PM								
6-7 PM					$8.31	$8.31	$3.12	$3.12
7-8 PM	$0.92	$0.94			$5.98	$6.52		
8-9 PM								
9 PM-6 AM	Toll-Free	Toll-Free			$1.56	$1.56	$1.56	$1.56

APPENDIX B — SENSITIVITY ANALYSES

Alternative Future Network Assumptions

All of the toll travel demand modeling that was performed for the four and six-lane alternatives under the "Nickel Package" future network assumptions were also performed under a more expansive future network based on the Regional Transportation Investment District's (RTID's) proposed set of improvements as of the fall of 2002. The RTID future network assumptions included price-managed lanes on I-405 (four general-purpose lanes plus one HOT 3+ lane) in each direction between Tukwila and SR-522, as well as one additional HOV lane on I-90 between I-5 and I-405 (R8-A).

In general, these improvements have a relatively minor effect on the toll demand and revenue projections for SR-520. Optimal toll rates under the Maximum Funding objective with the RTID future network are a bit higher, toll diversion is a bit higher, and revenues are a bit lower, than for the comparable results under the Nickel Package network. The results between the two future networks appear to be better matched for the Traffic Management tolling objective.

Weighted average daily toll rates, toll traffic demand, and various revenue measures by year are presented in the following tables for the Maximum Funding tolling objective by the four- and six-lane SR-520 replacement alternatives. These tables for the RTID future network results may be compared to Tables A-2 and A-4, which present the same information for the Nickel Package future network.

Table B-1
Toll Revenue Detail — Maximum Funding Objective — Six-Lane Alternative (RTID Future Network)

Year	Maximum Funding Objective*								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$3.19	21.5 M	19.5 M	$68.5 M	$65.0 M	6.0%	$55.3 M	($12.8 M)	$42.5 M
2015	$3.32	21.8 M	19.8 M	$72.3 M	$68.7 M	5.7%	$63.6 M	($13.0 M)	$50.6 M
2016	$3.46	22.1 M	20.1 M	$76.4 M	$72.6 M	5.7%	$69.0 M	($13.3 M)	$55.7 M
2017	$3.60	22.4 M	20.4 M	$80.7 M	$76.7 M	5.7%	$71.1 M	($13.6 M)	$57.5 M
2018	$3.75	22.7 M	20.7 M	$85.3 M	$81.0 M	5.7%	$73.2 M	($13.9 M)	$59.3 M
2019	$3.91	23.1 M	21.0 M	$90.1 M	$85.6 M	5.7%	$75.4 M	($14.3 M)	$61.1 M
2020	$4.07	23.4 M	21.3 M	$95.2 M	$90.5 M	5.7%	$77.7 M	($14.6 M)	$63.1 M
2021	$4.26	23.7 M	21.6 M	$101.0 M	$96.0 M	6.1%	$80.0 M	($14.9 M)	$65.0 M
2022	$4.45	24.1 M	21.9 M	$107.2 M	$101.8 M	6.1%	$82.4 M	($15.3 M)	$67.1 M
2023	$4.66	24.4 M	22.2 M	$113.7 M	$108.0 M	6.1%	$84.9 M	($15.7 M)	$69.1 M
2024	$4.87	24.8 M	22.5 M	$120.6 M	$114.6 M	6.1%	$87.4 M	($16.2 M)	$71.2 M
2025	$5.10	25.1 M	22.8 M	$128.0 M	$121.6 M	6.1%	$90.0 M	($16.7 M)	$73.4 M
2026	$5.33	25.5 M	23.2 M	$135.7 M	$128.9 M	6.0%	$92.7 M	($17.2 M)	$75.5 M
2027	$5.57	25.8 M	23.5 M	$143.9 M	$136.7 M	6.0%	$95.5 M	($17.8 M)	$77.7 M
2028	$5.82	26.2 M	23.8 M	$152.6 M	$145.0 M	6.0%	$98.4 M	($18.2 M)	$80.2 M
2029	$6.08	26.6 M	24.2 M	$161.8 M	$153.7 M	6.0%	$101.3 M	($18.7 M)	$82.7 M
2030	$6.36	27.0 M	24.5 M	$171.6 M	$163.0 M	6.0%	$104.4 M	($19.1 M)	$85.2 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Table B-2
Toll Revenue Detail — Maximum Funding Objective — Four-Lane Alternative (RTID Future Network)

Year	Revenue Maximizing Objective*								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$3.18	20.3 M	18.5 M	$64.5 M	$61.3 M	6.8%	$52.1 M	($12.8 M)	$39.3 M
2015	$3.33	20.7 M	18.8 M	$68.7 M	$65.3 M	6.4%	$60.0 M	($13.0 M)	$47.0 M
2016	$3.48	21.0 M	19.1 M	$73.1 M	$69.5 M	6.4%	$65.0 M	($13.3 M)	$51.7 M
2017	$3.64	21.4 M	19.5 M	$77.8 M	$73.9 M	6.4%	$67.0 M	($13.6 M)	$53.4 M
2018	$3.80	21.8 M	19.8 M	$82.9 M	$78.7 M	6.4%	$69.0 M	($13.9 M)	$55.1 M
2019	$3.98	22.2 M	20.2 M	$88.2 M	$83.8 M	6.4%	$71.1 M	($14.3 M)	$56.8 M
2020	$4.16	22.6 M	20.5 M	$93.9 M	$89.2 M	6.4%	$73.2 M	($14.6 M)	$58.6 M
2021	$4.37	23.0 M	20.9 M	$100.3 M	$95.3 M	6.9%	$75.4 M	($14.9 M)	$60.5 M
2022	$4.59	23.4 M	21.3 M	$107.3 M	$101.9 M	6.9%	$77.7 M	($15.3 M)	$62.4 M
2023	$4.82	23.8 M	21.6 M	$114.7 M	$108.9 M	6.9%	$80.0 M	($15.7 M)	$64.3 M
2024	$5.06	24.2 M	22.0 M	$122.6 M	$116.4 M	6.9%	$82.4 M	($16.2 M)	$66.2 M
2025	$5.31	24.7 M	22.4 M	$131.0 M	$124.5 M	6.9%	$84.9 M	($16.7 M)	$68.2 M
2026	$5.57	25.1 M	22.8 M	$139.9 M	$132.9 M	6.8%	$87.4 M	($17.2 M)	$70.2 M
2027	$5.84	25.6 M	23.2 M	$149.4 M	$141.9 M	6.8%	$90.0 M	($17.8 M)	$72.3 M
2028	$6.13	26.0 M	23.7 M	$159.5 M	$151.5 M	6.8%	$92.7 M	($18.2 M)	$74.5 M
2029	$6.43	26.5 M	24.1 M	$170.3 M	$161.8 M	6.8%	$95.5 M	($18.7 M)	$76.9 M
2030	$6.74	27.0 M	24.5 M	$181.9 M	$172.8 M	6.8%	$98.4 M	($19.1 M)	$79.3 M

* Economic Efficiency Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Revenue Maximizing Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

** VOT = value of time; 1% real growth implies that wage & salary earnings, and thus, VOT grow faster than general inflation.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Alternative Value of Time Real Growth Assumption

The baseline assumption for growth in the value of travel time is that it keeps pace with inflation, but exhibits no real growth above inflation over time. Value of time is a key determinant in roadway users' willingness to pay tolls. Because the value of time is related to prevailing wage rates, zero real growth assumes that wages just keep up with inflation. The alternative assumption would be that labor productivity gains lead to real increases in labor wages, and thus, values of time.

The Traffic Management and Maximum Funding tolling objectives for the six-lane alternative were also tested using the assumption of 1 percent real growth in the value of time, compounded from year end 2002, which corresponds to the year's dollars in which values of time were estimated via the stated-preference survey of bridge users. By way of comparison, real wages and salaries in King County have grown at an average rate of 1.25% per year over the last 30 years.

Applying this real growth rate results in values of time that are 12.7% higher in 2014, and 32.1% higher in 2030. The general effects on toll rates and revenues are similar, though there are some subtle differences in the traffic and revenue results between the Traffic Management and Maximum Funding tolling objectives, due to differences in the way these two bookend objectives are modeled.

While this more optimistic value of time growth assumption would imply a higher "optimal" toll schedule when the replacement bridge opens in 2014, the challenges in maintaining the optimality of this toll structure discussed in Chapter 5 still apply, perhaps even more so. To maintain the toll schedule optimality, tolls would need to increase annually due to the compound effects of (1) growth in demand, (2) general price inflation, and (3) real growth in the value of time. If this could be achieved, 2014 revenues under either tolling objective would be approximately 13% higher than the base case for the six-lane alternative, with the spread widening to nearly 33% higher by 2030.

However, it is unlikely that the toll operator will have the full authority to perpetuate the required super-inflationary toll increases, and the more realistic 3% annual revenue growth limit assumption, imposed as a proxy for less frequent and/or smaller toll increases for purposes of the financial capacity analysis, would still apply. Therefore, the assumption of 1% annual real growth in the value of time, if realized, could potentially increase the upper end of the range of project funds generated from tolls by a maximum of perhaps 12 to 15%.

The following tables present daily weighted average toll rates, toll traffic demand, and various revenue measures by year for the six-lane alternative with both tolling objectives, under the assumption of 1% annual real growth in the value of time.

Table B-3
Toll Revenue Detail — Traffic Management Objective — Six-Lane Alternative
(1% Real Growth in the Value of Time)

Year	Traffic Management Objective* — 1% Real Growth in Value of Time								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$1.96	32.2 M	29.0 M	$63.1 M	$59.9 M	6.7%	$50.9 M	($12.8 M)	$38.2 M
2015	$2.06	32.4 M	29.2 M	$66.8 M	$63.5 M	5.9%	$58.7 M	($13.0 M)	$45.6 M
2016	$2.17	32.6 M	29.4 M	$70.7 M	$67.2 M	5.9%	$63.6 M	($13.3 M)	$50.3 M
2017	$2.28	32.8 M	29.6 M	$74.9 M	$71.2 M	5.9%	$65.5 M	($13.6 M)	$51.9 M
2018	$2.40	33.0 M	29.8 M	$79.3 M	$75.4 M	5.9%	$67.5 M	($13.9 M)	$53.5 M
2019	$2.52	33.3 M	30.0 M	$84.0 M	$79.8 M	5.9%	$69.5 M	($14.3 M)	$55.2 M
2020	$2.66	33.5 M	30.2 M	$88.9 M	$84.5 M	5.9%	$71.6 M	($14.6 M)	$57.0 M
2021	$2.79	33.7 M	30.4 M	$93.9 M	$89.2 M	5.6%	$73.7 M	($14.9 M)	$58.8 M
2022	$2.92	33.9 M	30.6 M	$99.2 M	$94.2 M	5.6%	$75.9 M	($15.3 M)	$60.6 M
2023	$3.06	34.2 M	30.9 M	$104.7 M	$99.5 M	5.6%	$78.2 M	($15.7 M)	$62.5 M
2024	$3.21	34.4 M	31.1 M	$110.6 M	$105.1 M	5.6%	$80.6 M	($16.2 M)	$64.4 M
2025	$3.37	34.6 M	31.3 M	$116.8 M	$110.9 M	5.6%	$83.0 M	($16.7 M)	$66.3 M
2026	$3.52	34.9 M	31.5 M	$122.6 M	$116.5 M	5.0%	$85.5 M	($17.2 M)	$68.3 M
2027	$3.66	35.1 M	31.7 M	$128.7 M	$122.2 M	5.0%	$88.0 M	($17.8 M)	$70.3 M
2028	$3.82	35.3 M	31.9 M	$135.1 M	$128.3 M	5.0%	$90.7 M	($18.2 M)	$72.5 M
2029	$3.98	35.6 M	32.1 M	$141.8 M	$134.7 M	5.0%	$93.4 M	($18.7 M)	$74.7 M
2030	$4.15	35.8 M	32.3 M	$148.8 M	$141.4 M	5.0%	$96.2 M	($19.1 M)	$77.1 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

Table B-4
Toll Revenue Detail — Maximum Funding Objective — Six-Lane Alternative
(1% Real Growth in the Value of Time)

Year	Maximum Revenue Objective* — 1% Real Growth in Value of Time								
	Wt. Avg. Auto Toll Rate[1]	Annual PCE Toll Trans-actions[2]	Annual Toll Trans-actions[2]	Gross Annual Revenue	ETC Adj. Gross Revenue[3]	Revenue Growth Rate	Operating Revenue w/ Ramp-up	Operations & Maint. Cost[4]	Net Annual Revenue
2014	$3.62	28.1 M	25.5 M	$101.9 M	$96.8 M	6.7%	$82.3 M	($12.8 M)	$69.5 M
2015	$3.81	28.5 M	25.9 M	$108.4 M	$103.0 M	6.4%	$94.7 M	($13.0 M)	$81.7 M
2016	$4.00	28.8 M	26.2 M	$115.3 M	$109.5 M	6.4%	$102.7 M	($13.3 M)	$89.4 M
2017	$4.20	29.2 M	26.5 M	$122.6 M	$116.5 M	6.4%	$105.8 M	($13.6 M)	$92.2 M
2018	$4.41	29.6 M	26.9 M	$130.4 M	$123.9 M	6.4%	$109.0 M	($13.9 M)	$95.0 M
2019	$4.63	30.0 M	27.2 M	$138.7 M	$131.7 M	6.4%	$112.2 M	($14.3 M)	$98.0 M
2020	$4.86	30.3 M	27.6 M	$147.5 M	$140.1 M	6.4%	$115.6 M	($14.6 M)	$101.0 M
2021	$5.13	30.7 M	27.9 M	$157.5 M	$149.6 M	6.8%	$119.1 M	($14.9 M)	$104.1 M
2022	$5.40	31.1 M	28.3 M	$168.2 M	$159.8 M	6.8%	$122.6 M	($15.3 M)	$107.3 M
2023	$5.70	31.5 M	28.6 M	$179.7 M	$170.7 M	6.8%	$126.3 M	($15.7 M)	$110.6 M
2024	$6.01	31.9 M	29.0 M	$191.9 M	$182.3 M	6.8%	$130.1 M	($16.2 M)	$113.9 M
2025	$6.34	32.3 M	29.4 M	$205.0 M	$194.7 M	6.8%	$134.0 M	($16.7 M)	$117.3 M
2026	$6.64	32.8 M	29.7 M	$217.4 M	$206.6 M	6.1%	$138.0 M	($17.2 M)	$120.8 M
2027	$6.95	33.2 M	30.1 M	$230.6 M	$219.1 M	6.1%	$142.2 M	($17.8 M)	$124.4 M
2028	$7.28	33.6 M	30.5 M	$244.6 M	$232.4 M	6.1%	$146.4 M	($18.2 M)	$128.2 M
2029	$7.63	34.0 M	30.9 M	$259.5 M	$246.5 M	6.1%	$150.8 M	($18.7 M)	$132.2 M
2030	$7.99	34.5 M	31.3 M	$275.3 M	$261.5 M	6.1%	$155.4 M	($19.1 M)	$136.2 M

* Traffic Management Objective = 15 hour toll period with a variable congestion pricing toll schedule designed to maintain reasonable flow conditions; Maximum Funding Objective = 24 hour toll period with a variable toll schedule designed to maximize revenue collection.

[1] Weighted average auto (SOV & HOV2) toll rate across time periods and days of the week in year of collection dollars; toll rates escalate due to growing demand, general inflation, and where applicable, real growth in the value of time (VOT). Upon implementation, actual toll rate escalation will depend on a variety of policy, statutory and/or technical factors, and would likely be less than those shown in the table from that point forward.

[2] Annual Toll Transactions = # vehicles subject to tolls, including SOVs, HOV2s & Trucks; PCE Transactions = passenger car equivalent transactions (converts trucks at higher toll rates into the equivalent number of cars).

[3] Electronic Toll Collection (ETC) Adjusted Gross Revenue reflects a 5% reduction to gross revenue due to ETC errors/violations/uncollectable accounts.

[4] Assumes a standalone Customer Service Center (CSC) at a higher cost than a shared CSC.

APPENDIX C — TOLL COLLECTION AND OPERATING COST DETAIL

The following provides more detailed toll collection and operating cost information by type, in today's dollars. The escalation factor to 2014 is approximately 130%. Tables C-1 through C-3 apply to a stand-alone SR-520 toll operation. Tables C-4 through C-6 apply to the case of a regional toll operation, which shares functions and resources between more than one facility, such as the Tacoma Narrows Bridge.

Table C-1
Toll Collection Maintenance Services Costs — Full Operations (Today's $)

MAINTENANCE SERVICES COST (Year End 2002 Dollars)

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.30	2,000	0.40	
	Proposed VPC Staffing			Cost Per	Prime	Prime	Contractor	Contractor	Total Pay
	Prime	Contractor	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
Maintenance Management:									
Maintenance Manager	0.5		0.5	$45.00	$3,600.00	$4,680.00	$0.00	$0.00	$8,280.00
Maintenance Assistant Manager			0	$30.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$8,280.00
Maintenance Field Technicians									
Supervisor Technician	1		1	$25.00	$4,000.00	$5,200.00	$0.00	$0.00	$9,200.00
Lead Technician	1		1	$22.00	$3,520.00	$4,576.00	$0.00	$0.00	$8,096.00
Technician			0	$18.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$17,296.00
Tech Center Support:									
Hardware	0.25		0.25	$40.00	$1,600.00	$2,080.00	$0.00	$0.00	$3,680.00
Software	0.25		0.25	$40.00	$1,600.00	$2,080.00	$0.00	$0.00	$3,680.00
Warranty/Spares/Purchasing			0	$20.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$7,360.00
Total Payroll/Fringe Costs:	3	0	3		$14,320.00	$18,616.00	$0.00	$0.00	$32,936.00
Direct Costs (Monthly Cost):									
Supplies/Consumables									$1,000.00
Equipment Lease/Maint. Agreements									$1,000.00
Leased Facilities									$0.00
Janitorial Services									$0.00
Training/Recruitment/Misc. HR									$0.00
3rd Party Software Licenses									$200.00
Support Contracts									$200.00
Total Direct Costs:									$2,400.00
Total Monthly Costs (Payroll & Direct):									**$35,336.00**
Prime/Contractor Profit:	Base:	10%	*10% base profit.*						**$3,534.00**
Total Monthly Cost:									**$38,870.00**
Total Annual Cost:									**$466,440.00**

Table C-2
Toll Collection Customer Service Center Costs — Full Operations (Today's $)

CUSTOMER SERVICE CENTER (CSC) OPERATING COST (Year End 2002 Dollars)

	Hours/Year	Fringe/OH	Hours/Year	Fringe/OH
Assumptions:	1,920	1.30	2,000	0.40

	Proposed VPC Staffing			Cost Per	Prime	Prime	Contractor	Contractor	Total Pay
	Prime	Contractor	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
CSC Management:									
CSC Manager	1		1	$45.00	$7,200.00	$9,360.00	$0.00	$0.00	$16,560.00
CSC Assistant Manager	1		1	$35.00	$5,600.00	$7,280.00	$0.00	$0.00	$12,880.00
									$29,440.00
Transponder Management:									
Inventory Supervisor	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Inventory Clerk		1	1	$10.00	$0.00	$0.00	$1,666.67	$666.67	$2,333.33
									$7,853.33
Application/Account Processing:									
Processing Supervisor	1		1	$17.00	$2,720.00	$3,536.00	$0.00	$0.00	$6,256.00
Mail/Fax Application Clerk	2	4	6	$10.00	$3,200.00	$4,160.00	$6,666.67	$2,666.67	$16,693.33
Web Application Clerk	2		2	$12.00	$3,840.00	$4,992.00	$0.00	$0.00	$8,832.00
									$31,781.33
Commercial Account Processing:									
Commercial Supervisor	1		1	$20.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Commercial Clerk	2	2	4	$12.00	$3,840.00	$4,992.00	$4,000.00	$1,600.00	$14,432.00
Commercial Phone Support	1	1	2	$12.00	$1,920.00	$2,496.00	$2,000.00	$800.00	$7,216.00
									$29,008.00
QA/Customer Service									
QA Supervisor	1		1	$23.00	$3,680.00	$4,784.00	$0.00	$0.00	$8,464.00
Customer Service Specialists	2		2	$18.00	$5,760.00	$7,488.00	$0.00	$0.00	$13,248.00
System Analyst/Reporting	2		2	$18.00	$5,760.00	$7,488.00	$0.00	$0.00	$13,248.00
									$34,960.00
Payment Processing:									
Accounting Supervisor	2		2	$25.00	$8,000.00	$10,400.00	$0.00	$0.00	$18,400.00
Payment Processing Lead	2		2	$12.00	$3,840.00	$4,992.00	$0.00	$0.00	$8,832.00
Payment Processing Clerk	2	2	4	$10.50	$3,360.00	$4,368.00	$3,500.00	$1,400.00	$12,628.00
									$39,860.00
Call Center/Phone Support:									
Call Center Supervisor	1		1	$20.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Call Center Operator	5	3	8	$14.00	$11,200.00	$14,560.00	$7,000.00	$2,800.00	$35,560.00
Phone Support		5	5	$10.00	$0.00	$0.00	$8,333.33	$3,333.33	$11,666.67
									$54,586.67
Statement Production:									
Production Lead	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Production Clerk		5	5	$10.00	$0.00	$0.00	$8,333.33	$3,333.33	$11,666.67
									$17,186.67
Mail Room Support:									
Mail Lead	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Mail Clerk	4	2	6	$10.00	$6,400.00	$8,320.00	$3,333.33	$1,333.33	$19,386.67
									$24,906.67
CSC Support:									
Tech Center Support	1		1	$40.00	$6,400.00	$8,320.00	$0.00	$0.00	$14,720.00
Hardware/Software Maintenance	1		1	$25.00	$4,000.00	$5,200.00	$0.00	$0.00	$9,200.00
									$23,920.00
Total Payroll/Fringe Costs:	37	25	62		$100,320.00	$130,416.00	$44,833.33	$17,933.33	$293,503.00
Direct Costs (Monthly Cost):									
Office Supplies									$15,000.00
Equipment Lease/Maint. Agreements									$8,000.00
Leased Facilities									$20,000.00
Janitorial Services									$1,500.00
Training/Recruitment/MiCSC. HR									$4,000.00
3rd Party Software Licenses									$300.00
Support Contracts									$300.00
Banking Fees									$15,000.00
Credit Card Fees									$45,000.00
Total Direct Costs:									$109,100.00
Total Monthly Costs (Payroll & Direct):									$402,603.00

Table C-3
Violations Center Costs — Full Operations (Today's $)

VIOLATION CENTER (VC) OPERATING COST (Year End 2002 Dollars)

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.30	2,000	0.40	
	Proposed VPC Staffing			Cost Per	Prime	Prime	Contractor	Contractor	Total Pay
	Prime	Contractor	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
VC Management:									
VC Manager	1		1	$40.00	$6,400.00	$8,320.00	$0.00	$0.00	$14,720.00
VC Assistant Manager	1		1	$25.00	$4,000.00	$5,200.00	$0.00	$0.00	$9,200.00
									$23,920.00
Violation Image Review:									
QA Supervisor	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Violation Clerk Lead	1		1	$12.00	$1,920.00	$2,496.00	$0.00	$0.00	$4,416.00
Violation Clerk		2	2	$10.00	$0.00	$0.00	$3,333.33	$1,333.33	$4,666.67
									$14,602.67
Appeals/Phone Support:									
Appeal/Phone Supervisor	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Phone Clerk	2		2	$10.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Appeals/Hearing Support	1	1	2	$10.00	$1,600.00	$2,080.00	$1,666.67	$666.67	$6,013.33
									$18,893.33
Payment Processing:									
Accounting Supervisor	1		1	$20.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Payment Processing Lead	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Payment Processing Clerk	1	1	2	$10.00	$1,600.00	$2,080.00	$1,666.67	$666.67	$6,013.33
									$18,893.33
Mail Room Support:									
Mail Lead	1		1	$12.00	$1,920.00	$2,496.00	$0.00	$0.00	$4,416.00
Mail Clerk		2	2	$10.00	$0.00	$0.00	$3,333.33	$1,333.33	$4,666.67
									$9,082.67
VC Support:									
Tech Center Support	0.5		0.5	$40.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Hardware/Software Maintenance	0.5		0.5	$25.00	$2,000.00	$2,600.00	$0.00	$0.00	$4,600.00
									$11,960.00
Total Payroll/Fringe Costs:	13	6	19		$36,240.00	$47,112.00	$10,000.00	$4,000.00	$97,352.00

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.60	1,920	2.00	
	Proposed Staffing (FTE)			Cost Per	WashDOT	WashDOT	State Patrol	State Patrol	Total Pay
	WashDOT	State Patrol	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
Appeals/On-Site Enforcement									
Hearing Examiners	1		1	$30.00	$4,800.00	$7,680.00	$0.00	$0.00	$12,480.00
State Patrol		2	2	$40.00	$0.00	$0.00	$12,800.00	$25,600.00	$38,400.00
Total Non-Contractor Payroll:	1	2	3		$ 4,800.00	$ 7,680.00	$12,800.00	$25,600.00	$50,880.00

Direct Costs (Monthly Cost):				
Office Supplies				$4,500.00
Equipment Lease/Maint. Agreements				$2,000.00
Leased Facilities				$0.00
Janitorial Services				$0.00
Training/Recruitment/Misc. HR				$2,500.00
3rd Party Software Licenses				$150.00
Support Contracts				$200.00
Total Direct Costs:				$9,350.00
Total Monthly Costs (Payroll & Direct):				$106,702.00
Prime/Contractor Profit:	Base:	10%	*10% base profit.*	**$10,670.00**
Total Monthly Cost:				**$117,372.00**
Total Monthly Non-Contractor Payroll:				**$50,880.00**
Total Annual Cost:				**$2,019,024.00**

Table C-4
Toll Collection Maintenance Services Costs — Shared Operations (Today's $)

MAINTENANCE SERVICES COST (Year End 2002 Dollars) - REDUCED/SHARED OPERATIONS

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.30	2,000	0.40	
	Proposed VPC Staffing			Cost Per	Prime	Prime	Contractor	Contractor	Total Pay
	Prime	Contractor	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
Maintenance Management:									
Maintenance Manager	0.2		0.2	$45.00	$1,440.00	$1,872.00	$0.00	$0.00	$3,312.00
Maintenance Assistant Manager			0	$30.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$3,312.00
Maintenance Field Technicians									
Supervisor Technician			0	$25.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lead Technician	1		1	$22.00	$3,520.00	$4,576.00	$0.00	$0.00	$8,096.00
Technician			0	$18.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$8,096.00
Tech Center Support:									
Hardware	0.25		0.25	$40.00	$1,600.00	$2,080.00	$0.00	$0.00	$3,680.00
Software	0.25		0.25	$40.00	$1,600.00	$2,080.00	$0.00	$0.00	$3,680.00
Warranty/Spares/Purchasing			0	$20.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$7,360.00
Total Payroll/Fringe Costs:	1.7	0	1.7		$8,160.00	$10,608.00	$0.00	$0.00	$18,768.00
Direct Costs (Monthly Cost):									
Supplies/Consumables									$1,000.00
Equipment Lease/Maint. Agreements									$1,000.00
Leased Facilities									$0.00
Janitorial Services									$0.00
Training/Recruitment/Misc. HR									$0.00
3rd Party Software Licenses									$200.00
Support Contracts									$200.00
Total Direct Costs:									$2,400.00
Total Monthly Costs (Payroll & Direct):									**$21,168.00**
Prime/Contractor Profit:	Base:	10%	*10% base profit.*						**$2,117.00**
Total Monthly Cost:									**$23,285.00**
Total Annual Cost:									**$279,420.00**

Table C-5
Toll Collection Customer Service Center Costs — Shared Operations (Today's $)

CUSTOMER SERVICE CENTER (CSC) OPERATING COST (Year End 2002 Dollars) - REDUCED/SHARED OPERATIONS

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.30	2,000	0.40	
	Proposed VPC Staffing			Cost Per	Prime	Prime	Contractor	Contractor	Total Pay
	Prime	Contractor	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
CSC Management:									
CSC Manager	1		1	$45.00	$7,200.00	$9,360.00	$0.00	$0.00	$16,560.00
CSC Assistant Manager	1		1	$35.00	$5,600.00	$7,280.00	$0.00	$0.00	$12,880.00
									$29,440.00
Transponder Management:									
Inventory Supervisor	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Inventory Clerk		1	1	$10.00	$0.00	$0.00	$1,666.67	$666.67	$2,333.33
									$7,853.33
Application/Account Processing:									
Processing Supervisor	1		1	$17.00	$2,720.00	$3,536.00	$0.00	$0.00	$6,256.00
Mail/Fax Application Clerk	2	4	6	$10.00	$3,200.00	$4,160.00	$6,666.67	$2,666.67	$16,693.33
Web Application Clerk	2		2	$12.00	$3,840.00	$4,992.00	$0.00	$0.00	$8,832.00
									$31,781.33
Commercial Account Processing:									
Commercial Supervisor	1		1	$20.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Commercial Clerk	2	2	4	$12.00	$3,840.00	$4,992.00	$4,000.00	$1,600.00	$14,432.00
Commercial Phone Support	1	1	2	$12.00	$1,920.00	$2,496.00	$2,000.00	$800.00	$7,216.00
									$29,008.00
QA/Customer Service									
QA Supervisor	1		1	$23.00	$3,680.00	$4,784.00	$0.00	$0.00	$8,464.00
Customer Service Specialists	2		2	$18.00	$5,760.00	$7,488.00	$0.00	$0.00	$13,248.00
System Analyst/Reporting	1		1	$18.00	$2,880.00	$3,744.00	$0.00	$0.00	$6,624.00
									$28,336.00
Payment Processing:									
Accounting Supervisor	1		1	$25.00	$4,000.00	$5,200.00	$0.00	$0.00	$9,200.00
Payment Processing Lead	2		2	$12.00	$3,840.00	$4,992.00	$0.00	$0.00	$8,832.00
Payment Processing Clerk			0	$10.50	$0.00	$0.00	$0.00	$0.00	$0.00
									$18,032.00
Call Center/Phone Support:									
Call Center Supervisor	1		1	$20.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Call Center Operator	1		1	$14.00	$2,240.00	$2,912.00	$0.00	$0.00	$5,152.00
Phone Support			0	$10.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$12,512.00
Statement Production:									
Production Lead	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Production Clerk		1	1	$10.00	$0.00	$0.00	$1,666.67	$666.67	$2,333.33
									$7,853.33
Mail Room Support:									
Mail Lead	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Mail Clerk	1	1	2	$10.00	$1,600.00	$2,080.00	$1,666.67	$666.67	$6,013.33
									$11,533.33
CSC Support:									
Tech Center Support	0.5		0.5	$40.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Hardware/Software Maintenance	0.5		0.5	$25.00	$2,000.00	$2,600.00	$0.00	$0.00	$4,600.00
									$11,960.00
Total Payroll/Fringe Costs:	25	10	35		$71,120.00	$92,456.00	$17,666.67	$7,066.67	$188,309.00
Direct Costs (Monthly Cost):									
Office Supplies									$15,000.00
Equipment Lease/Maint. Agreements									$8,000.00
Leased Facilities									$15,000.00
Janitorial Services									$1,500.00
Training/Recruitment/MiCSC. HR									$3,000.00
3rd Party Software Licenses									$300.00
Support Contracts									$300.00
Banking Fees									$7,500.00
Credit Card Fees									$22,500.00
Total Direct Costs:									$73,100.00
Total Monthly Costs (Payroll & Direct):									$261,409.00

Table C-6
Violations Center Costs — Shared Operations (Today's $)

VIOLATION CENTER (VC) OPERATING COST (Year End 2002 Dollars) - REDUCED/SHARED OPERATIONS

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.30	2,000	0.40	
	Proposed VPC Staffing			Cost Per	Prime	Prime	Contractor	Contractor	Total Pay
	Prime	Contractor	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
VC Management:									
VC Manager	1		1	$40.00	$6,400.00	$8,320.00	$0.00	$0.00	$14,720.00
VC Assistant Manager	1		1	$25.00	$4,000.00	$5,200.00	$0.00	$0.00	$9,200.00
									$23,920.00
Violation Image Review:									
QA Supervisor	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Violation Clerk Lead	1		1	$12.00	$1,920.00	$2,496.00	$0.00	$0.00	$4,416.00
Violation Clerk		2	2	$10.00	$0.00	$0.00	$3,333.33	$1,333.33	$4,666.67
									$14,602.67
Appeals/Phone Support:									
Appeal/Phone Supervisor	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Phone Clerk			0	$10.00	$0.00	$0.00	$0.00	$0.00	$0.00
Appeals/Hearing Support	1	1	2	$10.00	$1,600.00	$2,080.00	$1,666.67	$666.67	$6,013.33
									$11,533.33
Payment Processing:									
Accounting Supervisor	1		1	$20.00	$3,200.00	$4,160.00	$0.00	$0.00	$7,360.00
Payment Processing Lead	1		1	$15.00	$2,400.00	$3,120.00	$0.00	$0.00	$5,520.00
Payment Processing Clerk			0	$10.00	$0.00	$0.00	$0.00	$0.00	$0.00
									$12,880.00
Mail Room Support:									
Mail Lead	1		1	$12.00	$1,920.00	$2,496.00	$0.00	$0.00	$4,416.00
Mail Clerk		2	2	$10.00	$0.00	$0.00	$3,333.33	$1,333.33	$4,666.67
									$9,082.67
VC Support:									
Tech Center Support	0.25		0.25	$40.00	$1,600.00	$2,080.00	$0.00	$0.00	$3,680.00
Hardware/Software Maintenance	0.25		0.25	$25.00	$1,000.00	$1,300.00	$0.00	$0.00	$2,300.00
									$5,980.00
Total Payroll/Fringe Costs:	9.5	5	14.5		$28,840.00	$37,492.00	$8,333.33	$3,333.33	$77,999.00

					Hours/Year	Fringe/OH	Hours/Year	Fringe/OH	
				Assumptions:	1,920	1.60	1,920	2.00	
	Proposed Staffing (FTE)			Cost Per	WashDOT	WashDOT	State Patrol	State Patrol	Total Pay
	WashDOT	State Patrol	Total	Hour	Payroll	Fringe/OH	Payroll	Fringe/OH	& Fringe
Appeals/On-Site Enforcement									
Hearing Examiners	1		1	$30.00	$4,800.00	$7,680.00	$0.00	$0.00	$12,480.00
State Patrol		2	2	$40.00	$0.00	$0.00	$12,800.00	$25,600.00	$38,400.00
Total Non-Contractor Payroll:	1	2	3		$ 4,800.00	$ 7,680.00	$12,800.00	$25,600.00	$50,880.00

Direct Costs (Monthly Cost):				
Office Supplies				$4,500.00
Equipment Lease/Maint. Agreements				$2,000.00
Leased Facilities				$0.00
Janitorial Services				$0.00
Training/Recruitment/Misc. HR				$2,000.00
3rd Party Software Licenses				$150.00
Support Contracts				$200.00
Total Direct Costs:				$8,850.00
Total Monthly Costs (Payroll & Direct):				$86,849.00
Prime/Contractor Profit:	Base:	10%	*10% base profit.*	**$8,685.00**
Total Monthly Cost:				**$95,534.00**
Total Monthly Non-Contractor Payroll:				**$50,880.00**
Total Annual Cost:				**$1,756,968.00**

APPENDIX D — SR-520 STATED PREFERENCE SURVEY

The separate SR-520 Stated Preference Survey Report prepared by Resource Systems Group follows this page.

RESOURCE SYSTEMS GROUP INCORPORATED

- **Documentation for:**

SR-520 Stated Preference Survey

Seattle, Washington

- **Prepared for:**

Parsons Brinckerhoff

21 July 2003 (minor revision 14 October 2003)

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RESOURCE SYSTEMS GROUP INCORPORATED

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RESOURCE SYSTEMS GROUP INCORPORATED

EXECUTIVE SUMMARY

Resource Systems Group, Inc. undertook this stated preference study for Parsons Brinkerhoff to forecast customers' willingness to shift travel behavior in response to new tolls on an improved SR-520 Bridge across Lake Washington in Seattle, Washington and to obtain information on travelers' values of time for forecasting potential traffic and revenue on the new bridge.

Current travelers across the SR-520 Bridge completed a computer-based survey questionnaire that consisted of five sections: Trip Description, such as purpose, travel mode, and time; Scenario Definitions of potential future changes; Stated Preference Experiments testing sensitivity to attributes such as time and cost across a set of travel options; Debrief questions regarding why a travel option was or was not chosen as well as opinion of the new SR-520 bridge; and Demographics to assist in comparing the survey sample to the full population of interest.

A total of 927 work and non-work travelers were intercepted at employment, shopping, recreation, drivers' licensing, hospital, and university sites throughout the greater Seattle area and recruited through employers to participate in the survey over the Internet. Stated preference modeling was based on data from the 690 respondents who drove alone or with one other person. The data included a mix of work and non-work trips, peak period as well as off-peak period trips, and a range of travel times and demographic representation. Across most trip purposes and income categories respondents favored the project.

The stated preference section of the survey presented hypothetical future travel scenarios with various route, time of day, toll, and mode options. The data from the choice experiments were used to develop a multinomial logit-based choice model with a simple specification, and the model coefficients were used to estimate travelers' values of time for six market segments based on time of day of travel, trip purpose, and travel frequency. For all market segments, sensitivity to trip cost and therefore value of time was found to vary with annual household income. A bias-correction travel time coefficient was included to adjust for the route choice bias of strongly opposed individuals that would otherwise inflate overall values of time.

During the peak travel period, travelers making work, school, and business trips have a higher value of time than those making social, personal business, shopping and other types of trips. Frequent peak-period work travelers have the highest overall value of time. Estimates of values of time among segments vary by about $9 per hour (from about $5 per hour to about $14 per hour, however the statistical confidence intervals for the values of time overlap for some of the segments.). The estimates of values of time reflect the differences among the market segments that will be used to model a variety of toll scenarios and to assess revenue projections under various scenarios.

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INTRODUCTION

This report summarizes the results of a stated preference study conducted by Resource Systems Group, Inc. (RSG) in Seattle, Washington for the Washington Department of Transportation with RSG serving as a subconsultant to Parsons Brinckerhoff. This study was undertaken to forecast customers' willingness to shift travel behavior in response to new tolls on an improved SR-520 Bridge across Lake Washington and to obtain information on travelers' values of time for forecasting potential traffic and revenue on the new bridge.

This report describes the design, administration and analysis of the stated preference survey. The analysis includes tabulations of the survey questions as well as the mode choice models estimated from the survey data and the implied values of time obtained from the model coefficients. Appendix A contains the survey questionnaire script and tabulations for each of the questions.

QUESTIONNAIRE DESIGN

The survey questionnaire consisted of five sections: trip Description, Scenario Definitions, Stated Preference Experiments, Debrief, and Demographics.

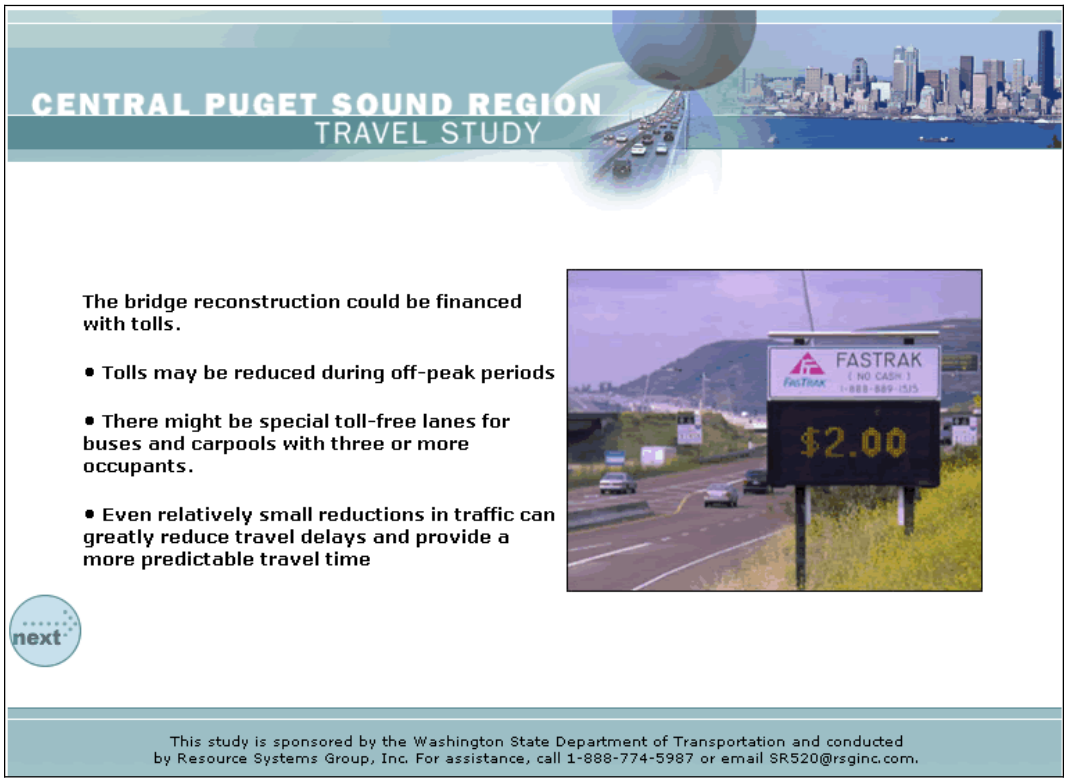
TRIP DESCRIPTION

Each respondent who reported making a trip across the SR-520 floating bridge within a seven-day period prior to taking the survey was asked to describe the most recent trip in detail. Questions included purpose, travel mode and time, origin and destination, frequency, and other details. Questions regarding the respondents' flexibility to travel earlier and later as well as the amount of time they typically allow for congestion were incorporated into this section.

SCENARIO DEFINITIONS

The second section consists of a description of transportation-related changes that are planned for the future. Text and pictures were used to not only identify the current traffic congestion problem in the Central Puget Sound region but to also bring to light the plans for the future (Figure 1).

Figure 1: Example Scenario Definition



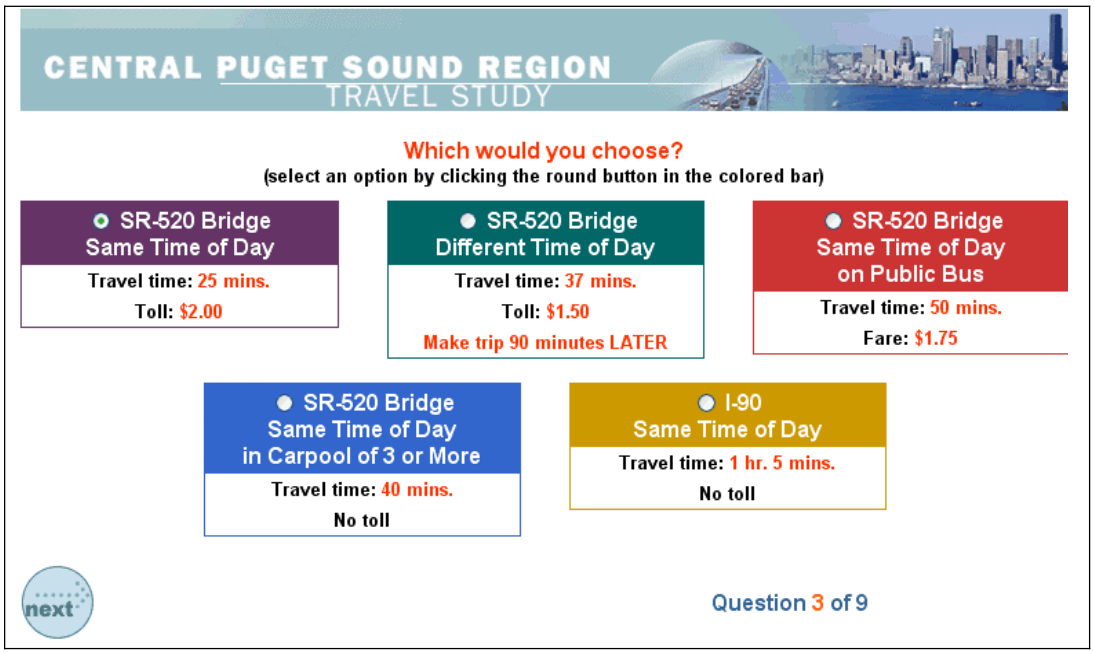
STATED PREFERENCE EXPERIMENTS

Those respondents whose trip qualified them were presented with a set of hypothetical on-screen travel scenarios. To qualify, the respondent had to have traveled either as a driver or a passenger in a vehicle with no more than a total of two occupants. Each screen included four or five distinct future travel options for a trip like the one they described. The options included a description of:

1. The respondent's trip using the SR-520 at the same time of day with varied travel times and tolls,
2. The respondent's trip, again using the SR-520, but at a different time of day with varied travel times and tolls, for those traveling during morning and afternoon peak time,
3. The respondent's trip using the SR-520 at the same time of day but using a bus with varied travel times and bus fares,
4. The respondent's trip using the SR-520 at the same time of day but traveling in a carpool of three or more persons, with varied travel times but no tolls; and
5. The respondent's trip using their most preferred alternative route at the same time of day with varied travel times but no tolls.

Respondents were asked to choose their most preferred option from among the options presented (Figure 2). Each respondent was presented with a total of nine such scenarios.

Figure 2: Example Stated Preference Experiment



Customized sets of options and attribute levels were developed for each of the different travel alternatives presented. The travel times, toll costs, and certain other attributes of the travel options were varied over three different levels (such as $1.50, $2.00, and $2.50) in the experiment and were derived from the fractional factorial design method commonly used in constructing these experimental plans. Each of the scenarios was designed in a manner that allowed for later estimation of the respondents' relative preferences for each of the tested variables (time, cost, time shift, and route). The attributes and levels that were presented to people who qualified for this section and the calculations used for setting each of the variables' levels are listed in Table 1.

Table 1: Stated Preference Attributes and Levels

#	Option	Travel Time Rule (CTT = current travel time today w/o toll and before improvements)	Toll/ Fare	Time Shift	New Travel Time	Rule Threshold	Time Savings Mult Factor	Time Savings Add Factor
Respondents Currently Traveling in Weekday Peak Periods								
1.1	**Auto—peak at same time of day**	If CTT < 40 then CTT * 0.8 else CTT - 8 min	$1.50		32	40	0.8	8
1.2	SOVs & HOV2s traveling in peak only	If CTT < 40 then CTT * 0.65 else CTT - 14 min	$2.00	N/A	26	40	0.65	14
1.3	(no longer than current travel time)	If CTT < 40 then CTT * 0.5 else CTT - 20 min	$2.50		20	40	0.5	20
2.1	**Auto—peak with time shift**	If CTT < 40 then CTT * 0.8 else CTT - 8 min	$0.50	± 30 minutes	32	40	0.8	8
2.2	SOVs & HOV2s traveling in peak only	If CTT < 40 then CTT * 0.65 else CTT - 14 min	$1.00	± 60 minutes	26	40	0.65	14
2.3	(no longer than Option 1 time)	If CTT < 40 then CTT * 0.5 else CTT - 20 min	$1.50	± 90 minutes	20	40	0.5	20
3.1	**Mode shift to 3+HOV—peak at same time**	CTT * 1			40		1.0	
3.2	SOVs & HOV2s traveling in peak only	CTT * 0.9	No toll	N/A	36		0.9	
3.3	(no longer than current travel time)	CTT * 0.8			32		0.8	
4.1	**Mode shift to bus—peak at same time**	CTT * 1.1	$1.75		44		1.1	
4.2	SOVs & HOV2s traveling in peak only	CTT * 1	$2.00	N/A	40		1.0	
4.3	(always longer than current travel time)	CTT * 0.9	$2.25		36		0.9	
5.1	**I-90 Bridge or SR-522 at same time of day**	(CTT + 20 min) * 1.1			66	20	1.1	
5.2	SOVs & HOV2s traveling in peak only	(CTT + 20 min) * 1	No toll	N/A	60	20	1.0	
5.3	(always longer than current travel time)	(CTT + 20 min) * 0.9			54	20	0.9	
Respondents Currently Traveling in Weekday Off-Peak Periods or Weekends								
6.1	**Auto—off-peak at same time**	If CTT < 20 then CTT * 0.8 else CTT - 4 min	$0.50		36	20	0.8	4
6.2	SOVs & HOV2s traveling in off-peak only	If CTT < 20 then CTT * 0.65 else CTT - 7 min	$1.00	N/A	33	20	0.65	7
6.3	(including all day on weekends)	If CTT < 20 then CTT * 0.5 else CTT - 10 min	$1.50		30	20	0.5	10
7.1	**Mode shift to 3+HOV—off-peak at same time**	CTT * 1.1			44		1.1	
7.2	SOVs & HOV2s traveling in off-peak only	CTT * 1	No toll	N/A	40		1.0	
7.3		CTT * 0.9			36		0.9	
8.1	**Mode shift to bus—peak at same time**	CTT * 1.1	$1.75		44		1.1	
8.2	SOVs & HOV2s traveling in peak only	CTT * 1	$2.00	N/A	40		1.0	
8.3	(always longer than current travel time)	CTT * 0.9	$2.25		36		0.9	
9.1	**I-90 Bridge or SR-522 at same time of day**	(CTT + 15 min) * 1.1			61	15	1.1	
9.2	SOVs & HOV2s traveling in peak only	(CTT + 15 min) * 1	No toll	N/A	55	15	1.0	
9.3	(always longer than current travel time)	(CTT + 15 min) * 0.9			50	15	0.9	

DEBRIEF

Anyone who chose an option in the stated preference section that included tolls on any of the nine screens received a follow-up question regarding their reasons for selecting a toll option. Anyone who chose options on all nine screens that never included tolls saw a follow-up question regarding their reasons for never selecting a toll option.

All respondents (including the non-qualified respondents) were asked their opinions regarding the possibility of a new SR-520 bridge crossing of Lake Washington with a toll.

DEMOGRAHPICS

The questionnaire concluded with a set of standard background and demographic questions, including household size, gender, age, employment status and income, to assist in comparing the survey sample to the full population of interest.

Respondents who did not make a qualifying trip did not see the stated preference experiments and went through the Trip Description, the Scenario Definitions, Debrief and Background Information portions of the survey only.

SURVEY ADMINISTRATION

Travelers making trips across Lake Washington using the SR-520 Floating Bridge were intercepted at various sites throughout the greater Seattle area. Emphasis was placed on selecting sites that were both in proximity to the SR-520 corridor and would allow collection of responses for both work and non-work purposes. The following general areas were targeted:

1) Downtown office buildings and other area employment sites,
2) Shopping and recreational centers, and
3) Other heavily trafficked sites including drivers' licensing locations, area hospitals and the University of Washington.

In total, the stated preference survey administration setup comprised up to twelve laptop computer interview stations set up each day. Each survey site was staffed by two to three survey attendants who were responsible for soliciting and screening potential respondents, escorting the participants to survey stations, and, if necessary, assisting them with questions. Potential respondents were questioned to be sure that they met the screening criteria (Table 2). Two framed posters mounted on easels were positioned near the interview stations to assist in attracting respondents.

Table 2: Screening Criteria

General	Trips must cross Lake Washington using the SR-520 Floating Bridge.
Work Trips	Seattle area residents who make trips to or from work using the SR-520 Floating Bridge.
Non-Work Trips	Seattle area residents who make trips using the SR-520 Floating Bridge for purposes other than traveling to or from work and that are not for air travel.
Transit	Seattle area residents who make bus trips using the SR-520 Floating Bridge.

When taking the stated preference survey, respondents sat in front of a laptop computer and used a mouse to record answers and navigate through the survey. Most respondents took between seven and ten minutes to complete the survey. When respondents finished the survey, the data for that individual were automatically saved to the computer for later analysis. People were generally enthusiastic about taking the survey and seemed to enjoy the survey's interactive technology.

The survey was administered over an eight-day period between Monday, March 24th and Tuesday, March 31st to 635 current SR-520 Bridge users. Surveys for both the work and non-work segments

were collected at various sites east and west of the SR-520 Bridge. Table 3 lists the survey administration schedule and specific site locations.

In addition, a total of 293 surveys (over one-third of total respondents), representing all market segments, were collected via invitation over the Internet at SuveyCafe.com from March 24th through April 2nd. Six employers covering a range of industries and including locations in Seattle, Bellevue and Redmond participated. Two hundred seventy-one of these respondents logged on in response to e-mail invitations issued through their employer. Finally, an additional twenty-two individuals participated via the web site in response to fliers handed out at survey sites as well as at business locations in the downtown Seattle area.

Table 3: Survey Schedule

Date	Day	Location	Time
3/24	Monday	Bank of America Tower, Downtown Seattle Overlake Hospital, Bellevue	9:30 am to 4 pm 7:30 am to 4 pm
3/25	Tuesday	Safeco Center, Downtown Seattle Seattle North Drivers' Licensing Office	10:30 am to 2 pm 8:30 am to 5 pm
3/26	Wednesday	Kirkland Drivers' Licensing Office Bellevue Drivers' Licensing Office	8:30 am to 5 pm 8:30 am to 5 pm
3/27	Thursday	Safeco Tower, Seattle University District	11 am to 1:30 pm
3/28	Friday	Westlake Shopping Center, Downtown Seattle University Village Shopping Center, Seattle Plaza Café – University of Washington Hospital & Health Sciences Center, Seattle	10 am to 7 pm 10 am to 6:30 pm 7 am to 3 pm
3/29	Saturday	Westlake Shopping Center, Downtown Seattle Bellevue Drivers' Licensing Office Factoria Mall, Bellevue	10 am to 6:30 pm 8:30 am to 2:30 pm 10 am to 4 pm
3/31	Monday	Husky Union Building, University of Washington	9:00 am to 2 pm

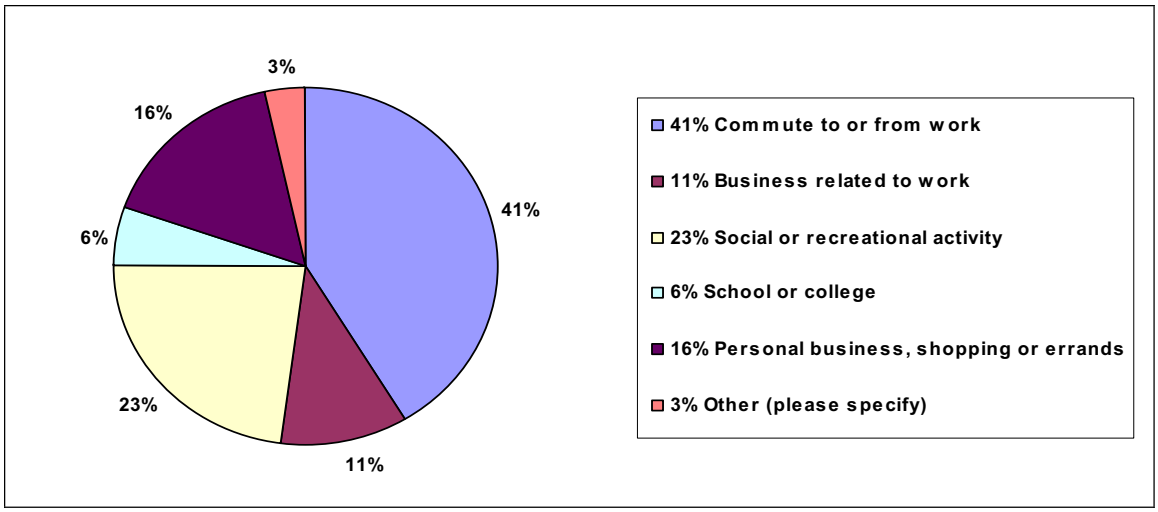
SURVEY RESULTS

A total of 927 surveys were processed for analysis with 690 of those respondents qualifying for the stated preference portion of the survey. The survey results section of this report reflects the 690 respondents who qualified for the stated preference experiments. Data from 673 of these respondents were used in the stated preference modeling described in a later section. Respondents with very long (more than three hours) or very short (less than five minutes) travel times for current or alternative options that were considered to be outliers and were excluded from the modeling. Appendix A contains tabulations of the survey questions for the 690 respondents who completed the stated preference section.

TRIP DESCRIPTION

In the SR-520 Travel Study, as a pre-qualifying screener, potential respondents were asked whether they had made a trip across Lake Washington using the SR-520 within the past week. Qualifying respondents of the survey were asked to think about the most recent trip they made using the bridge and were then instructed to keep this particular trip in mind as they completed the survey. The majority of the respondents indicated that the purpose of their trip was to commute to or from work. The table below summarizes the sampled respondents for each of their trip purposes.

Figure 3: Trip Purpose



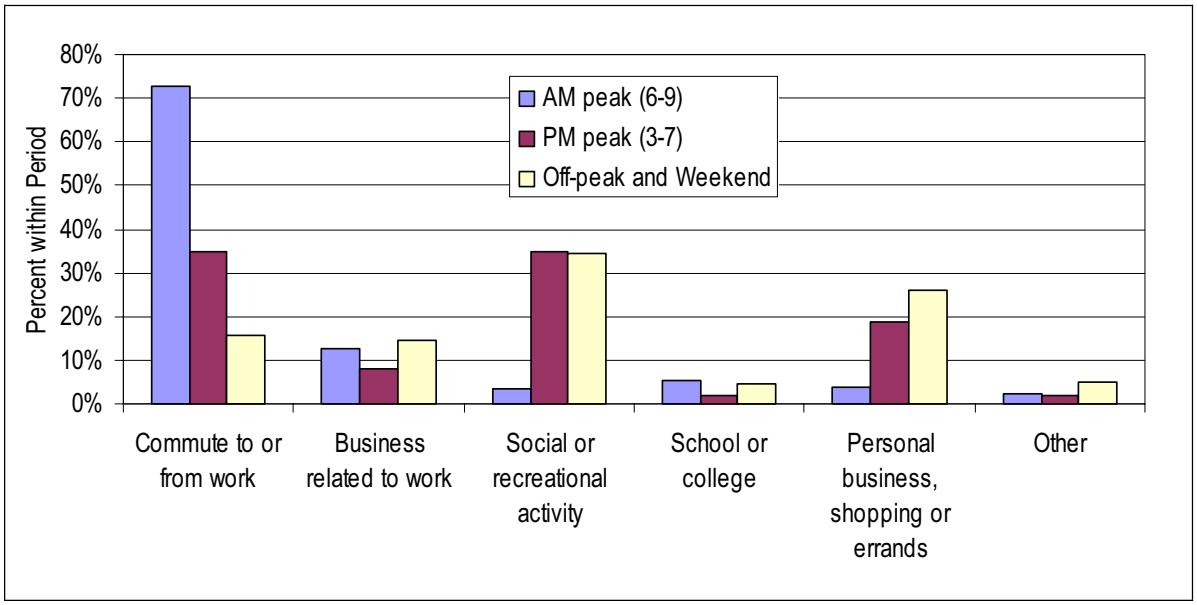
Respondents were able to identify their origins and destinations using provided maps that were linked to a geocoding engine. Zone-to-zone travel times were used to validate user-defined travel times and construct the stated preference scenarios. Once the origin and destination were geocoded, the travel time that was input by the respondent was validated against the model travel times. When large discrepancies were detected, respondents were asked to check and confirm their travel times. It should be noted that reported travel times for the entire sample ranged from five minutes to 14 hours with an average of 50 minutes. Reported travel times are summarized in the table below (Table 4). Over 75 percent of the respondents reported on trips that were 45 minutes or less and most of the remainder were 60 minutes or less.

Table 4: Travel Time

	Frequency	Percent
5 to 15 minutes	30	4.3%
16 to 30 minutes	302	43.8%
31 to 45 minutes	176	25.5%
46 to 60 minutes	114	16.5%
1 to 2 hours	50	7.2%
More than 2 hours	18	2.6%
Total	**690**	**100.0%**

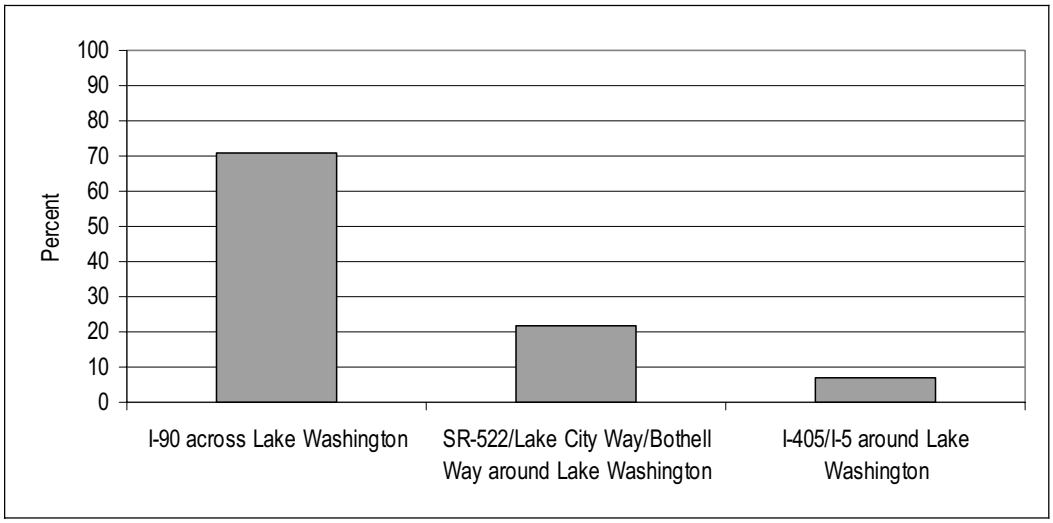
Figure 4 provides a breakdown of the respondent's trip purpose by peak and off-peak travel periods. Among respondents' most recent trips, there were more than twice the number of morning peak travelers than evening peak travelers, though this was not unexpected given that a majority of the surveys were fielded during typical business hours of the day. Overall, there was a fairly even split between the peak and off-peak respondents.

Figure 4: Trip Purpose by Travel Period



Survey respondents were also asked if they take an alternative route to avoid traffic congestion on the SR-520, and if so, which route. The majority of those who did take an alternate route at least once a week selected I-90 as their main alternate choice (Figure 5).

Figure 5: Alternate Route



DEBRIEF AND DEMOGRAPHICS

Each of the respondents received one of two questions as a follow-up to the stated preference experiments. Respondents who never chose an option that included a toll in the stated preference section were asked an additional question regarding their primary reasons for not selecting an option with a toll. Over one-half of those who never chose a tolled option said that they did so because they oppose the idea of tolls.

Table 5: Reasons For Never Selecting An Option That Included Tolls

	Frequency	Percent
Tolls shown were too high	23	15.9%
Do not want to use electronic toll collection	16	11.0%
Oppose the idea of toll roads	82	56.6%
Preferred the non-toll options	46	31.7%
Other (please specify)	34	23.4%

145 respondents

Because of multiple-select question format total exceeds 100%

Table 6: Reason For Selecting An Option That Included Tolls

	Frequency	Percent
Lower travel times	360	66.1%
Less congestion	138	25.3%
The other options shown would not serve my needs	207	38.0%
Other (please specify)	80	14.7%

545 respondents

Because of multiple-select question format total exceeds 100%

All respondents were asked a final debriefing question as to their opinion of the new toll bridge option. Of the 690 qualified respondents, almost a quarter of them said they would strongly favor the new option, with 55% stating they would at least somewhat favor the idea compared to only 35% who opposed the idea.

Table 7: Opinion of New SR-520 Toll Bridge Option Across Lake Washington

	Frequency	Percent
Strongly favor it	156	22.6%
Somewhat favor it	226	32.8%
No opinion	63	9.1%
Somewhat opposed to it	128	18.6%
Strongly opposed to it	117	17.0%
Total	**690**	**100.0%**

Table 8: Opinion of New SR-520 Toll Bridge Option Across Lake Washington by Trip Purpose

	In favor	No opinion	Opposed	Total
Commute to or from work	54.5%	8.6%	36.9%	100.0%
Business related to work	59.6%	6.7%	33.7%	100.0%
Social or recreational activity	54.3%	8.6%	37.0%	100.0%
School or college	26.7%	20.0%	53.3%	100.0%
Personal business, shopping or errands	62.4%	12.0%	25.6%	100.0%
Other	58.3%	0.0%	41.7%	100.0%

Nearly 56% of the survey sample was male and 44% was female. About 84% of the sample worked either full or part-time, and 10% were full-time students or part-time students who were also employed at least part-time. Annual household income among survey respondents was nearly evenly

distributed among all categories (Figure 6), with the median household income falling in the $60,000 to $79,999 category. U.S. Census 2000 data indicates that the median 1999 household income for King County as a whole was $53,157. The most current median household income data available through the Economic Development Council of Seattle and King County shows a median 2001 household income for King County of $61.400 (Table 9).

Figure 6: Annual Household Income for Survey Respondents

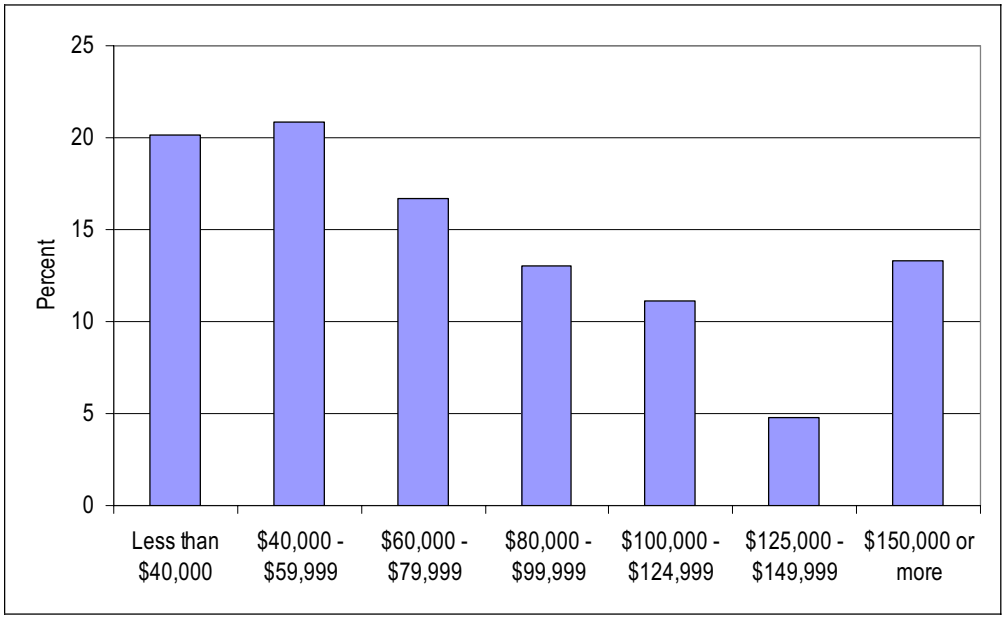


Table 9: Median Income for all King County Households by Year

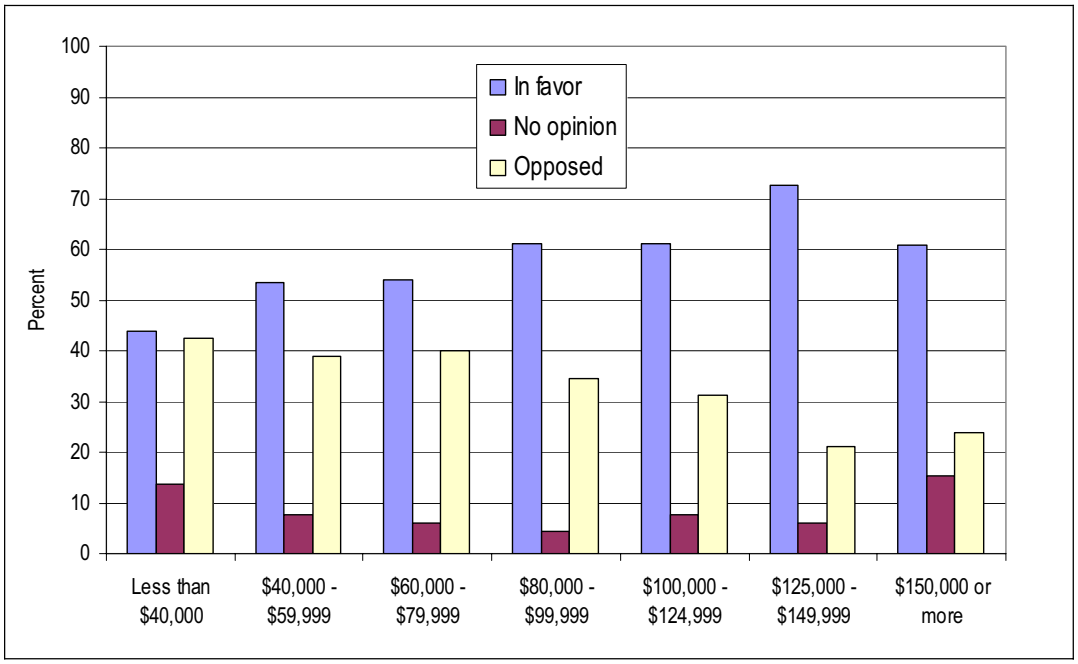
Year	Income
2001	$61,400
2000	$55,900
1999	$53,200
1998	$47,656
1997	$45,300

Seattle/Bellevue/Everett PMSA Median Household Income (In Current Dollars)

From the Economic Development Council of Seattle and King County

Across all income categories, respondents reported that they were in favor of the new toll bridge option (Figure 7). The greatest relative margin of opinions in favor of the new toll bridge option is found in the $125,000 to $149,999 category, though all income categories showed a significant margin in favor of the new toll bridge, with the exception of the less than $40,000 category.

Figure 7: Opinion of Project by Annual Household Income



MODELING

The stated preference data from the survey were compiled into an ALOGIT dataset and used to support estimation of the coefficients of a multinomial logit-based route and mode choice model[1]. Data from the choice experiments were expanded into a dataset that contained the nine stated preference scenarios for each respondent for a total of over 6000 observations. These nine choice observations consist of the data from individual survey screens shown to respondents who currently travel across the SR-520 Bridge by auto with one or two occupants. For current peak period travelers, each survey screen was one experiment of a 27-experiment orthogonal design with five alternatives:

---

[1] The multinomial logit model has the general form, $p(i) = \frac{e^{U_i}}{\sum_{AllModes} e^{U_j}}$, where *p(i)* is the probability that mode i will be chosen and U_i is the "utility" of mode i, a function of service and other variables. See, for example, M. E. Ben-Akiva and S. R. Lerman, *Discrete Choice Analysis*, MIT Press, 1985 for details on the model structure and statistical estimations procedures.

1. SR-520 during the peak period with varied travel times and tolls,
2. SR-520 during the off-peak period with varied travel times, tolls, and change in time of day of travel,
3. SR-520 using a bus with varied travel times and bus fares,
4. SR-520 in a carpool of three or more with varied travel times but no tolls, and
5. Using the most preferred alternative route with varied travel times but no tolls.

For current off-peak period travelers each survey screen was one experiment of an 18-experiment orthogonal design with four alternatives:

1. SR-520 during the off-peak period with varied travel times and tolls,
2. SR-520 using a bus with varied travel times and bus fares,
3. SR-520 in a carpool of three or more with varied travel times but no tolls, and
4. Using the most preferred alternative route with varied travel times but no tolls.

A set of diagnostic model runs was conducted to ensure that the data were consistent with the original stated preference experimental design and to identify data outliers. Ultimately, 6055 observations (data from 673 respondents) were included in model estimation after excluding observations with very long (more than three hours) or very short (less than five minutes) travel times.

GENERAL MODEL STRUCTURE

A simple specification was developed using the variables included in the stated preference experiments and segmented by the period of travel – peak and off-peak. Within these segments the model specification was refined after testing for effects of trip purpose, demographics, and strategic bias. Because the primary purpose of the modeling was to determine values of time for a variety of traveler segments, a relatively simple general model structure was retained. The structure includes up to seven model coefficients related to travel time, trip cost, time shift, and mode constants (Table 10 and Table 11). Some coefficients, such as time and cost, are applicable to all alternatives, while others are alternative-specific and affect the utility of only one alternative. In the mode and route choice model, the coefficients that are applicable to each alternative are multiplied by a relevant value for each alternative (in the indicated units) and contribute to the probability of choice of that option. The values of the coefficients, and therefore the contribution of each of the variables to choice probability, vary by traveler segment. The relative values of the time and cost coefficients provide information about the value of time within each segment. The trip cost coefficient is divided by income, which means that the sensitivity to cost and the value of time of higher income travelers is greater than that for lower income travelers. To estimate the overall value of time for a given traveler segment, the median income of the travelers in that segment is used with the time and cost coefficients.

Table 10: Peak Period Model Variables and Alternatives to Which They Apply

Variable	Units	Alternatives				
		SR-520 during peak period	SR-520 during off-peak period	SR-520 during peak in HOV3+	SR-520 during peak by bus	Alternate route during peak
Travel time	minutes	x	x	x	x	x
Travel time – correction for strategic bias	minutes	x	x	x	x	x
Trip cost* (toll or bus fare)	dollars	x	x	x	x	x
Constant for off-peak period	(0,1)		x			
Time shift into off-peak period	minutes		x			
Constant for bus	(0,1)				x	
Constant for HOV3+	(0,1)			x		

* Trip cost is divided by household income in thousands

Table 11: Off-Peak Period Model Variables and Alternatives to Which They Apply

Variable	Units	Alternatives			
		SR-520 during off-peak period	SR-520 during off-peak in HOV3+	SR-520 during off-peak by bus	Alternate route during off-peak
Travel time	minutes	x	x	x	x
Travel time – correction for strategic bias	minutes	x	x	x	x
Trip cost* (toll or bus fare)	dollars	x	x	x	x
Constant for bus	(0,1)			x	
Constant for HOV3+	(0,1)		x		

* Trip cost is divided by household income in thousands

Mode constants are included for the bus, HOV3+, and off-peak alternatives, which capture the utility or disutility of these options that is not included in the time and cost variables. The alternate route option does not differ along any important dimensions other than those included in the model, so the constant for alternate route is set to zero. An alternate route mode constant was tested and the large negative value of the coefficient was found to remove the travel time effect between the current route and the alternative, causing the implied value of time to be unreasonably low in value and statistical significance.

For peak period travelers, a time shift variable was shown in the stated preference scenarios and tested in the models. The time shift coefficient indicates sensitivity to changing the time of day of travel, by shifting from the peak period to the off-peak period. Morning and afternoon peak period respondents find it more difficult to change to a later time of day than to an earlier time of day. Frequent peak work travelers (traveling five days per week or more) were somewhat sensitive to time shift. Time shift was not statistically significant for infrequent peak work travelers or for non-work travelers and was therefore removed from those models.

Trip cost, which is applicable to all alternatives, represents toll cost for the auto alternatives and fare for the bus alternative. The alternate route alternative was tested as a free option, so the toll cost associated with it is zero. Sensitivity to trip cost was found to vary with income and an income effect was included in the estimation of the trip cost coefficient. After testing several effects such as cost divided by a code representing the income category, log of an income code, income in thousands of dollars, and the log of income in thousands of dollars, cost divided by household income in thousands of dollars was used in the final models. The non-log-linear effects produced models with better statistical significance overall, and income in thousands was selected over an income code for greater flexibility in computing values of time over a continuous range of incomes.

The travel time coefficient is applicable to all alternatives and represents the sensitivity to total travel time in minutes. A variety of tests were performed to determine any potential effects of opposed and or strongly opposed individuals on the models and the resulting values of time. The effects were tested for opposition and for strong opposition in a variety of ways including mode specific constants, segmentation, and finally correction for the coefficients that are most affected by the bias. A second travel time coefficient for travelers who are strongly opposed to the projects was used to adjust for the bias of those respondents that would otherwise affect the magnitude of the primary time coefficient and the related value of time. The time coefficient for strongly opposed respondents is used only as a means to remove bias and can be ignored in model application. Respondents who are opposed to the project were identified through their response to a survey question regarding opinion of a new toll bridge on SR-520. A bias-removing travel time coefficient was the approach chosen over segmentation because it allows for inclusion of all survey respondents in analysis and therefore includes the mode preferences of all travelers while excluding only the route choice bias. In general, values of time were higher when strongly opposed respondents were excluded from the models altogether versus using only a bias-correction coefficient. Also, values of time were higher when travel time was adjusted for both strongly opposed and opposed survey respondents. To be conservative, the correction for strategic bias in the final models is for only strongly opposed individuals.

A few other trip characteristic effects were tested. For example, willingness to switch to carpool (HOV) was found to be related to current vehicle occupancy. HOV constants tended to be larger negative for current single-occupant vehicles than for current two-occupant vehicles, indicating greater difficulty of adding more passengers to create the three-occupant carpool. Using purpose-specific cost and time coefficients, values of time were found to be higher for work-related business trips than for work commute and school/college trips. For peak period trips, business travelers place about $2-$3 per hour additional value on their time compared to work and school travelers. During the off-peak period the difference is much greater—business travelers place a high value on time and a low (and but only marginally significant) value on cost. For simplicity of implementation and limitations on data for applying the models, these additional effects are not included in the final model specification.

SEGMENTATION

The marginal rate of substitution of the travel time and trip cost coefficients provides the implied value that travelers place on their time (value of time). For the aggregate survey sample, the implied value of time represents a composite value using the mix of travelers and trip characteristics as captured in the stated preference surveys. To determine potential differences in values of time among different types of trips and travelers, a variety of segmentation schemes were tested. Statistical measures, such as t-stats, chi-squared tests, and confidence intervals, were used to make decisions about final segmentation schemes and distinct values of time among segments.

A total of four primary traveler segments based on travel period (peak and off-peak) and trip purpose (work and non-work) were selected. Each of the peak period segments were further segmented into frequent and infrequent travelers, resulting in a total of six final model segments:

- Frequent peak period work trips
- Infrequent peak period work trips
- Frequent peak period non-work trips
- Infrequent peak period non-work trips
- Off-peak period work trips
- Off-peak period non-work trips

The work segments include work commute trips, school or college trips, and trips for business related to work. The non-work segments include trips for social or recreational activities, personal business, shopping or errands, and all other purposes.

For peak period work trips, "frequent" users are defined as those making a trip in a specific direction five times per week or more, while travelers who conducted trips for work purposes four times per week or less are considered "infrequent" users. For peak period non-work travelers, trips made in the reported direction one time per week or more are included in the frequent user segment, while those making a trip in the reported direction less than once per week are included in the infrequent segment.

The thresholds for frequent versus infrequent work and non-work peak period travelers were selected after reviewing the results of segmenting at various levels of travel frequency based on statistical significance of the segmentation schemes and sufficiency of data within each segment. For example, for the peak period work travelers, segmentation schemes splitting the travelers into those who reported travel frequency (Figure 8) in the first two categories (five times per week or more) versus the last four categories (four times per week or less) and those who reported travel frequency in the first three categories (two times per week or more) versus the last three categories (one time per week or less) were among the schemes tested. Since both segmentation schemes were statistically significant at a 99.9% confidence interval, the scheme that provided the most data in the infrequent category was selected to support possible further segmentation and customization within segments.

Figure 8: Trip Frequency Question and Answer Categories

How often do you make this trip between these two locations using this route? Again, focus only on the most recent one-way leg of this trip.

- ○ More than five times a week
- ○ Five times a week
- ○ Two to four times a week
- ○ Once a week
- ○ One to three times a month
- ○ Less than once a month

The final market segments for assessing values of time to be applied in the subsequent toll modeling of SR-520 were selected after testing segmentation along a multitude of dimensions (Figure 9). Segments tested included travel period (peak and off-peak), trip purpose (work and non-work), trip frequency (various definitions of frequent and infrequent), vehicle occupancy (SOV and HOV2), day of week (weekday and weekend), and residence location (east and west). Many of the segmentation schemes were tested in combination with one another or within other segments, such as occupancy within frequency within trip purpose and time period, for a total of 16 unique segments in just one set of runs. Over 200 model runs were conducted. In some cases the data were not sufficient to support estimation of statistically significant model coefficients for small traveler segments. For other segments that were not selected, either the segmentation scheme was not statistically significant or values of time were not significantly different from one another.

Figure 9: Segments Tested

- Peak period work trips by frequency (high, medium, and low)
- Peak period work trips by detailed purpose (work/school and business)
- Peak period work trips by vehicle occupancy (1 and 2)
- Peak period work trips by opinion of the new toll bridge (opposed)
- Peak period work trips by frequency (five times per week or more and four times per week or less) within occupancy
- Peak period work trips by residence location (east and west side of the lake)
- Peak period work trips by opinion of the new toll bridge
- Peak period work trips by opinion of the new toll bridge within frequency and occupancy
- Peak period work trips by residence location (east or west side of the lake) within frequency and occupancy

- Peak period work trips by residence location (east or west side of the lake), only possible for trips that start or end at home
- Peak period work trips by frequency
  (five times per week or more and four times per week or less)
- Peak period work trips by opinion of the new toll bridge (strongly opposed) within frequency
- Peak period non-work trips by frequency (high, medium, and low)
- Peak period non-work trips by occupancy (1 and 2)
- Peak period non-work trips by opinion of the new toll bridge (opposed)
- Peak period non-work trips by frequency
  (two times per week or more and one time per week or less) within occupancy
- Peak period non-work trips by frequency
  (one time per week or more and three times per month or less) within occupancy
- Peak period non-work trips by frequency
  (one time per month or more and less than one time per month) within occupancy
- Peak period non-work trips by residence location (east and west side of the lake)
- Off-peak work trips by frequency (high, medium, and low)
- Off-peak work trips by detailed purpose (work/school and business)
- Off-peak work trips by occupancy (1 and 2)
- Off-peak work trips by opinion of the new toll bridge (opposed)
- Off-peak work trips by frequency (five times per week or more and four times per week or less) within occupancy
- Off-peak work trips by frequency
  (more than five times per week and five times per week or less) within occupancy
- Off-peak work trips by residence location (east and west side of the lake)
- Off-peak work trips by frequency
  (more than five times per week and five times per week or less)
- Off-peak work trips by opinion of the new toll bridge (strongly opposed) within frequency
- Off-peak non-work trips by frequency (high, medium, and low)
- Off-peak non-work trips by occupancy (1 and 2)
- Off-peak non-work trips by opinion of the new toll bridge
- Off-peak non-work trips by frequency
  (one time per week or more and one time per month or less) within occupancy
- Off-peak non-work trips by residence location (east and west side of the lake)
- Off-peak non-work trips by day of the week (weekday and weekend)
- Off-peak non-work trips by opinion of the new toll bridge (strongly opposed) within frequency
- Off-peak trips by weekday and weekend
- Off-peak work trips except weekend non-work and off-peak non-work weekend trips

VALUES OF TIME

The primary differences among travelers were identified and isolated in separate model segments and unique model coefficients were estimated for each of six segments. Detailed model specification results intended for technical readers are shown in Appendix B.

The marginal rate of substitution of the travel time and trip cost coefficients provides the implied value that travelers place on their time (value of time). Because sensitivity to trip cost was found to vary with income, the implied values of time within each segment likewise vary directly with income. That is, travelers with higher incomes have higher values of time. The median income of the travelers in each segment is used to estimate the overall value of time for the traveler segment. Within each model segment the implied value of time represents a composite value using the mix of travelers and trip characteristics as captured in the stated preference surveys. For example, values of time in the work model represent the composite values of time of the work commute, business, and school/college trips in proportion to their representation in the stated preference survey sample.

The median income for nearly all traveler segments fell within the third ($60,000 - $79,999) income category shown in the survey (Figure 10). Using the midpoint of that category ($70,000) along with the unique time and cost coefficients for each segment, initial values of time (VOT) for each segment were computed (Table 12). Interpolation within the median income category for each segment allowed estimation of a more refined median income and improved estimates of the overall values of time for travelers in each segment (Table 13). Because the stated preference survey was limited to auto travelers who currently travel alone (single occupant vehicles – SOV) and those who currently travel with one other person (high occupant vehicles with two occupants – HOV2), all median income estimates are for these travelers and do not include current auto travelers with three or more vehicle occupants (HOV3+) or current transit riders.

Table 12 shows how values of time differ by time of day, trip purpose, and trip frequency for an example traveler with an annual household income of $70,000. Table 13 shows the best available estimates of the overall value of time for each traveler segment accounting for differences in median income of SOV and HOV2 travelers among segments. Using the standard errors of the time and cost coefficients along with the degree of correlation between time and cost for each segment, the range of values of time for the 95% confidence interval for each value of time estimate were computed and are also shown in the tables.

Figure 10: Annual Household Income Ranges in the Stated Preference Survey

Which category represents your present annual household income?

- Less than $40,000
- $40,000 - $59,999
- $60,000 - $79,999
- $80,000 - $99,999
- $100,000 - $124,999
- $125,000 - $149,999
- $150,000 or more

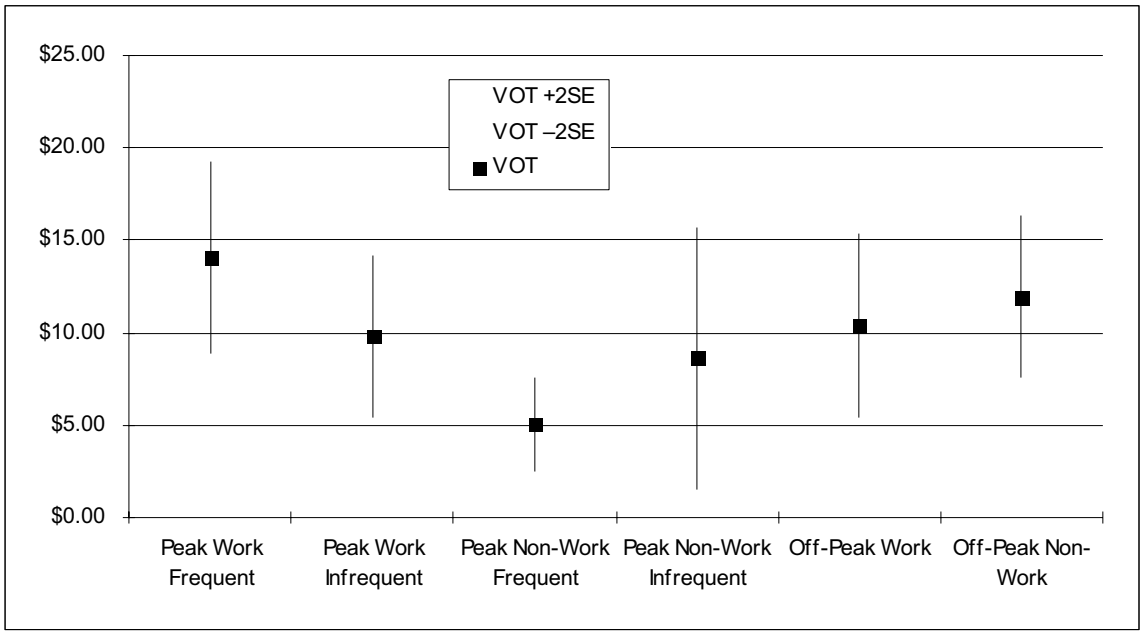
Table 12: Values Of Time (VOT) for SOV/HOV2 Based on the Sample Median Annual Household Income of $70,000

					Exp. Value	95% Confidence Interval	
				Income	VOT	VOT –2SE	VOT +2SE
Peak	Work	Frequent	5+	$70k	$12.15	$7.68	$16.62
		Infrequent	4–	$70k	$9.40	$5.21	$13.58
	Non-Work	Frequent	1+	$70k	$5.03	$2.45	$7.62
		Infrequent	1–	$70k	$8.15	$1.47	$14.84
Off-Peak	Work	-	-	$70k	$11.27	$5.91	$16.63
	Non-Work	-	-	$70k	$12.67	$8.02	$17.31

Table 13:
Values Of Time (VOT) forSOV/HOV2 Using Interpolated Median Annual Household Incomes by Market Segment

					Exp. Value	95% Confidence Interval	
				Income	VOT	VOT –2SE	VOT +2SE
Peak	Work	Frequent	5+	$81k	$14.07	$8.89	$19.24
		Infrequent	4–	$73k	$9.83	$5.46	$14.22
	Non-Work	Frequent	1+	$70k	$5.03	$2.45	$7.62
		Infrequent	1–	$74k	$8.65	$1.56	$15.74
Off-Peak	Work	-	-	$65k	$10.38	$5.44	$15.32
	Non-Work	-	-	$66k	$11.92	$7.55	$16.30

Figure 11:
Values of Time (VOT) for SOV/HOV2 Using Interpolated Median Annual Household Income by Market Segment



Notes of interest include the fact that the values of time for the off-peak trips are not substantially lower than the values of time for the analogous peak period segments. A model segment that combines off-peak work and non-work trips excluding weekend off-peak non-work trips was tested. It produced a higher value of time estimate, but had a wide range of values within the 95% confidence interval. During the peak travel period, travelers making work, school, and business trips have a higher value of time than those making social, personal business, shopping and other types of trips. Frequent peak-period work travelers have the highest overall value of time. Travelers making trips for work purposes during the off-peak period have a similar overall value of time to those making trips for work purposes during the peak period.

SUMMARY

This study was undertaken to estimate customers' willingness to shift travel behavior in response to new tolls on an improved SR-520 Bridge across Lake Washington and to obtain information on travelers' values of time for forecasting potential traffic and revenue on the new bridge.

A stated preference survey of travelers who currently cross the SR-520 Bridge by auto with one or two occupants was conducted. The survey presented hypothetical future travel scenarios with various route, time of day, toll, and mode options. The data from the choice experiments were used to develop a multinomial logit-based choice model with a simple specification, and the model coefficients were used to estimate travelers' values of time for six market segments based on time of

day of travel, trip purpose, and travel frequency. For all market segments, sensitivity to trip cost and therefore value of time was found to vary with annual household income.

During the peak travel period, travelers making work, school, and business trips have a higher value of time than those making social, personal business, shopping and other types of trips. Frequent peak-period work travelers have the highest overall value of time. Travelers making trips for work purposes during the off-peak period have a similar overall value of time to those making trips for work purposes during the peak period. Estimates of values of time among segments vary by about $9 per hour (from about $5 per hour to about $14 per hour, however the statistical confidence intervals for the values of time overlap for some of the segments.). These estimates of values of time reflect the differences among the market segments that will be used to model a variety of toll scenarios and to assess revenue projections under various scenarios.

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APPENDIX A: Sample Breakdown – Qualifying for CBC

Categorization of all respondent types

	Frequency	Percent
HOV 3 or more	106	11.4%
Bus	131	14.1%
Qualifying Trips	690	74.4%
Total	**927**	**100.0%**

Survey Script:

What was the primary purpose of this trip?

	Frequency	Percent
Commute to or from work	269	39.0%
Business related to work	89	12.9%
Social or recreational activity	162	23.5%
School or college	30	4.3%
Personal business, shopping or errands	116	16.8%
Other (please specify)	24	3.5%
Total	**690**	**100.0%**

In what part of the week did you make this trip?

	Frequency	Percent
Weekday	553	80.1%
Weekend	137	19.9%
Total	**690**	**100.0%**

Where did this trip begin?

	Frequency	Percent
My home	523	75.8%
My workplace	134	19.4%
Other (please specify)	33	4.8%
Total	**690**	**100.0%**

331 Olcott Drive, White River Junction, Vermont 05001
TEL 802.295.4999 ▪ FAX 802.295.1006 ▪ www.rsginc.com

Please select the location closest to where this trip BEGAN.

	Frequency	Percent
Downtown Seattle	49	7.1%
Central Seattle	38	5.5%
Queen Anne/Magnolia	27	3.9%
NW Seattle	46	6.7%
NE Seattle	45	6.5%
University District	54	7.8%
South Seattle	6	.9%
Shoreline	12	1.7%
Lynwood/Edmonds	3	.4%
Bothell	11	1.6%
Woodinville	6	.9%
Kirkland/Totem Lake	34	4.9%
Redmond/Overlake	52	7.5%
Downtown/NW Bellevue	56	8.1%
East Bellevue	27	3.9%
South Bellevue	14	2.0%
Mercer Island	1	.1%
Sammamish	17	2.5%
Issaquah	4	.6%
Renton	4	.6%
E King County	116	16.8%
S King County	24	3.5%
W of Puget Sound	8	1.2%
NE Snohomish County	27	3.9%
North of this map	4	.6%
South of this map	1	.1%
East of this map	4	.6%
Total	**690**	**100.0%**

Where did this trip end?

	Frequency	Percent
My home	62	9.0%
My workplace	272	39.4%
Other (please specify)	356	51.6%
Total	**690**	**100.0%**

Please select the location closest to where this trip ENDED.

	Frequency	Percent
Downtown Seattle	110	15.9%
Central Seattle	53	7.7%
Queen Anne/Magnolia	10	1.4%
NW Seattle	31	4.5%
NE Seattle	24	3.5%
University District	102	14.8%
South Seattle	7	1.0%
Shoreline	8	1.2%
Lynwood/Edmonds	1	.1%
Bothell	7	1.0%
Woodinville	3	.4%
Kirkland/Totem Lake	37	5.4%
Redmond/Overlake	44	6.4%
Downtown/NW Bellevue	98	14.2%
East Bellevue	32	4.6%
South Bellevue	7	1.0%
Mercer Island	2	.3%
Sammamish	1	.1%
Issaquah	3	.4%
Renton	4	.6%
E King County	56	8.1%
S King County	13	1.9%
Pierce County	4	.6%
W of Puget Sound	12	1.7%
NE Snohomish County	16	2.3%
North of this map	1	.1%
East of this map	4	.6%
Total	**690**	**100.0%**

Time of day travelling

	Frequency	Percent
AM peak (6-9)	245	35.5%
PM peak (3-7)	112	16.2%
Off-peak and Weekend	333	48.3%
Total	**690**	**100.0%**

Minutes spent travelling

	Frequency	Percent
5	2	.3%
10	3	.4%
15	25	3.6%
20	72	10.4%
25	62	9.0%
30	167	24.2%
35	62	9.0%
40	52	7.5%
45	63	9.1%
50	29	4.2%
55	11	1.6%
60	74	10.7%
65	1	.1%
70	7	1.0%
75	8	1.2%
80	2	.3%
85	2	.3%
90	16	2.3%
95	2	.3%
105	4	.6%
120	8	1.2%
150	3	.4%
180	5	.7%
240	1	.1%
360	1	.1%
420	1	.1%
495	1	.1%
540	1	.1%
590	1	.1%
600	1	.1%
720	2	.3%
840	1	.1%
Total	**690**	**100.0%**

How often do you make this trip between these two locations using this route? Again, focus only on the most recent one-way leg of this trip.

	Frequency	Percent
5 or more per week	59	8.6%
5 per week	168	24.3%
2 to 4 per week	141	20.4%
1 per week	82	11.9%
1 to 3 per month	129	18.7%
Less than 1 per month	111	16.1%
Total	**690**	**100.0%**

Did you budget extra time to allow for traffic congestion?

	Frequency	Percent
Did not budget extra time	224	32.5%
Less than 5 minutes	32	4.6%
5 To 10 minutes	95	13.8%
11 To 15 minutes	131	19.0%
16 To 20 minutes	97	14.1%
21 To 25 minutes	33	4.8%
26 To 30 minutes	41	5.9%
More than 30 minutes	37	5.4%
Total	**690**	**100.0%**

How many times per week do you take an alternate route to avoid traffic congestion on SR-520?

	Frequency	Percent
0	397	57.5%
1	105	15.2%
2	72	10.4%
3	43	6.2%
4	15	2.2%
5 or more	58	8.4%
Total	**690**	**100.0%**

Which route would you choose if you had to avoid congestion on SR-520?

	Frequency	Percent
I-90 across Lake Washington	499	72.3%
SR-522/Lake City Way/Bothell Way around Lake Washington	129	18.7%
I-405/I-5 around Lake Washington	62	9.0%
Total	**690**	**100.0%**

For this trip, did you travel as:

	Frequency	Percent
the driver of the vehicle	621	90.0%
a passenger in a private vehicle	69	10.0%
Total	**690**	**100.0%**

Including the driver, how many people were in the car at the time you crossed Lake Washington?

	Frequency	Percent
1	450	65.2%
2	240	34.8%
Total	**690**	**100.0%**

Have you shifted the activities in your schedule in order to avoid congeste periods?

	Frequency	Percent
NO	381	55.2%
up to 1 hour earlier	149	21.6%
1 to 2 hours earlier	42	6.1%
more than 2 hours earlier	12	1.7%
up to 1 hour later	56	8.1%
1 to 2 hours later	44	6.4%
more than 2 hours later	6	.9%
Total	**690**	**100.0%**

Would it have been possible for you to make this trip using a public bus?

	Frequency	Percent
Yes	255	37.0%
No	313	45.4%
Don't know	122	17.7%
Total	**690**	**100.0%**

Why did you select options that included tolls?

	Frequency	Percent
Lower travel times	360	66.1%
Less congestion	138	25.3%
The other options shown would not serve my needs	207	38.0%
Other (please specify)	80	14.7%
Total	**545**	**100.0%**

Why did you not select options that did not include tolls?

	Frequency	Percent
Tolls shown were too high	23	15.9
Do not want to use electronic toll collection	16	11.0
Oppose the idea of toll roads	82	56.6
Preferred the non-toll options	46	31.7
Other (please specify)	34	23.4
Total	**145**	**100.0**

Which of the following best describes how you feel about this new toll bridge option in the central Puget Sound region?

	Frequency	Percent
Strongly favor it	155	22.5%
Somewhat favor it	226	32.8%
No opinion	63	9.1%
Somewhat opposed to it	128	18.6%
Strongly opposed to it	118	17.1%
Total	**690**	**100.0%**

Sentiment of new toll bridge option

	Frequency	Percent
In favor	381	55.2%
No opinion	63	9.1%
Opposed	246	35.7%
Total	**690**	**100.0%**

How many people live in your household the majority of the time?

	Frequency	Percent
1	118	17.1%
2	272	39.4%
3	134	19.4%
4	108	15.7%
5	39	5.7%
6	11	1.6%
7 or more	8	1.2%
Total	**690**	**100.0%**

How many vehicles are there in your household? (Include cars, motorcycle and pickup trucks.)

	Frequency	Percent
0	5	.7%
1	170	24.6%
2	296	42.9%
3	137	19.9%
4	61	8.8%
5	15	2.2%
6 or more	6	.9%
Total	**690**	**100.0%**

What is your gender?

	Frequency	Percent
Female	306	44.3%
Male	384	55.7%
Total	**690**	**100.0%**

Which category represents your age?

	Frequency	Percent
18 - 24 Years	105	15.2%
25 - 34 Years	176	25.5%
35 - 44 Years	163	23.6%
45 - 54 Years	166	24.1%
55 - 64 Years	64	9.3%
Over 64 Years	16	2.3%
Total	**690**	**100.0%**

What is your employment status?

	Frequency	Percent
Employed full-time	538	78.0%
Employed part-time	39	5.7%
Student	34	4.9%
Student, and employed part-time or more	37	5.4%
Homemaker	8	1.2%
Retired	17	2.5%
Other (please specify)	17	2.5%
Total	**690**	**100.0%**

Which category represents your present annual household income?

	Frequency	Percent
Less than $40,000	139	20.1%
$40,000 - $59,999	143	20.7%
$60,000 - $79,999	115	16.7%
$80,000 - $99,999	90	13.0%
$100,000 - $124,999	78	11.3%
$125,000 - $149,999	33	4.8%
$150,000 or more	92	13.3%
Total	**690**	**100.0%**

Why did you select options that included tolls?

	Frequency	Percent
Lower travel times	360	66.1%
Less congestion	138	25.3%
The other options shown would not serve my needs	207	38.0%
Other (please specify)	80	14.7%
Total	**545**	**100.0%**

Why did you not select options that did not include tolls?

	Frequency	Percent
Tolls shown were too high	23	15.9
Do not want to use electronic toll collection	16	11.0
Oppose the idea of toll roads	82	56.6
Preferred the non-toll options	46	31.7
Other (please specify)	34	23.4
Total	**145**	**100.0**

Crosstabs

What was the primary purpose of this trip? * Sentiment of new toll bridge option

			Sentiment of new toll bridge option			
			In favor	No opinion	Opposed	Total
What was the primary purpose of this trip?	Commute to or from work	Frequency	146	23	100	269
		Percent	54.3%	8.6%	37.2%	100.0%
	Business related to work	Frequency	53	6	30	89
		Percent	59.6%	6.7%	33.7%	100.0%
	Social or recreational activity	Frequency	88	14	60	162
		Percent	54.3%	8.6%	37.0%	100.0%
	School or college	Frequency	8	6	16	30
		Percent	26.7%	20.0%	53.3%	100.0%
	Personal business, shopping or errands	Frequency	72	14	30	116
		Percent	62.1%	12.1%	25.9%	100.0%
	Other (please specify)	Frequency	14	0	10	24
		Percent	58.3%	.0%	41.7%	100.0%
		Frequency	381	63	246	**690**
		Percent				

Which category represents your present annual household income? * Sentiment of new toll bridge option

			Sentiment of new toll bridge option			
			In favor	No opinion	Opposed	Total
Which category represents your present annual household income?	Less than $40,000	Frequency	61	19	59	139
		Percent	43.9%	13.7%	42.4%	100.0%
	$40,000 - $59,999	Frequency	76	11	56	143
		Percent	53.1%	7.7%	39.2%	100.0%
	$60,000 - $79,999	Frequency	62	7	46	115
		Percent	53.9%	6.1%	40.0%	100.0%
	$80,000 - $99,999	Frequency	55	4	31	90
		Percent	61.1%	4.4%	34.4%	100.0%
	$100,000 - $124,999	Frequency	47	6	25	78
		Percent	60.3%	7.7%	32.1%	100.0%
	$125,000 - $149,999	Frequency	24	2	7	33
		Percent	72.7%	6.1%	21.2%	100.0%
	$150,000 or more	Frequency	56	14	22	92
		Percent	60.9%	15.2%	23.9%	100.0%
		Frequency	381	63	246	690
		Percent				

Time of day travelling * Sentiment of new toll bridge option

			Sentiment of new toll bridge option			
			In favor	No opinion	Opposed	Total
Time of day travelling	AM peak (6-9)	Frequency	128	20	97	245
		Percent	52.2%	8.2%	39.6%	100.0%
	PM peak (3-7)	Frequency	65	12	35	112
		Percent	58.0%	10.7%	31.3%	100.0%
	Off-peak and Weekend	Frequency	188	31	114	333
		Percent	56.5%	9.3%	34.2%	100.0%
		Frequency	381	63	246	**690**
		Percent				

How often do you make this trip between these two locations using this route? * Sentiment of new toll bridge option

			Sentiment of new toll bridge option			
			In favor	No opinion	Opposed	Total
How often do you make this trip between these two locations using this route?	5 or more per week	Frequency	29	4	26	59
		Percent	7.6%	6.3%	10.6%	8.6%
	5 per week	Frequency	87	18	63	168
		Percent	22.8%	28.6%	25.6%	24.3%
	2 to 4 per week	Frequency	71	12	58	141
		Percent	18.6%	19.0%	23.6%	20.4%
	1 per week	Frequency	50	7	25	82
		Percent	13.1%	11.1%	10.2%	11.9%
	1 to 3 per month	Frequency	78	9	42	129
		Percent	20.5%	14.3%	17.1%	18.7%
	Less than 1 per month	Frequency	66	13	32	111
		Percent	17.3%	20.6%	13.0%	16.1%
		Frequency	381	63	246	690
		Percent				

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APPENDIX B: Modeling Details

The stated preference data from the survey were compiled into an ALOGIT dataset and used to support estimation of the coefficients of a multinomial logit-based route and mode choice model[1]. The data included 6055 observations made up of nine choice observations per respondent, based on an orthogonal design with five alternatives for peak period travelers or four alternatives for off-peak period travelers.

A simple specification was developed using the variables included in the stated preference experiments and segmented by the period of travel – peak and off-peak. The structure includes up to seven model coefficients related to travel time, trip cost, time shift, and mode constants (Table 1 and Table 2). Explanations of the model coefficients are included in the modeling section of the full report.

Table 1: Peak Period Model Variables and Alternatives to Which They Apply

Variable	**Units**			**Alternatives**		
		SR-520 during peak period	SR-520 during off-peak period	SR-520 during peak in HOV3+	SR-520 during peak by bus	Alternate route during peak
Travel time	minutes	x	x	x	x	x
Travel time – correction for strategic bias	minutes	x	x	x	x	x
Trip cost* (toll or bus fare)	dollars	x	x	x	x	x
Constant for off-peak period	(0,1)		x			
Time shift into off-peak period	minutes		x			
Constant for bus	(0,1)				x	
Constant for HOV3+	(0,1)			x		

* Trip cost is divided by household income in thousands

[1] The multinomial logit model has the general form, $p(i) = \frac{e^{U_i}}{\sum_{AllModes} e^{U_j}}$, where *p(i)* is the probability that mode i will be chosen and U_i is the "utility" of mode i, a function of service and other variables. See, for example, M. E. Ben-Akiva and S. R. Lerman, *Discrete Choice Analysis*, MIT Press, 1985 for details on the model structure and statistical estimations procedures.

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Table 2: Off-Peak Period Model Variables and Alternatives to Which They Apply

Variable	Units	Alternatives			
		SR-520 during off-peak period	SR-520 during off-peak in HOV3+	SR-520 during off-peak by bus	Alternate route during off-peak
Travel time	minutes	x	x	x	x
Travel time – correction for strategic bias	minutes	x	x	x	x
Trip cost* (toll or bus fare)	dollars	x	x	x	x
Constant for bus	(0,1)			x	
Constant for HOV3+	(0,1)		x		

* Trip cost is divided by household income in thousands

A total of four primary traveler segments based on travel period (peak and off-peak) and trip purpose (work and non-work) were selected. Each of the peak period segments were further segmented into frequent and infrequent travelers, resulting in a total of six final model segments:

- Frequent peak period work trips
- Infrequent peak period work trips
- Frequent peak period non-work trips
- Infrequent peak period non-work trips
- Off-peak period work trips
- Off-peak period non-work trips

The work segments include work commute trips, school or college trips, and trips for business related to work. The non-work segments include trips for social or recreational activities, personal business, shopping or errands, and all other purposes.

Unique model coefficients were estimated for each of six segments. The variables included in each model segment, the relevant units, the coefficient estimates, and the associated t-stats are shown in Table 3 through Table 8. The coefficient multiplied by a value for the relevant variable for a given alternative produces the contribution to the utility or disutility of the alternative. The utilities of the alternatives can then be used to predict the probability of choice of each alternative. Each t-stat provides information about whether a variable is making a statistically significant contribution to the model. A rule of thumb is that a t-stat of two or higher means the variable is statistically significant.

Listed below the tables are summary reports for each model segment. The reports include the number of observations, the log likelihood with respect to zero, the final log likelihood, and the rho-squared with respect to constants. The log likelihood values are used to determine the relative quality of one model compared to another model that uses the same data. Final log likelihood values are

used in the chi-squared test to determine the statistical significance of the segmentation schemes (Table 9). Rho-squared provides an indication of the explanatory power of the model. Values typically range anywhere between .05 and .40, depending on the complexity of the model. Values from .05 - .10 can be considered good for some models.

Table 3: Peak Period Work Model for Frequent (Five Days per Week or More) Travelers

Variable	Units	Coefficient	T-Stat
Travel time excluding those strongly opposed to project	minutes	-0.061	-15.9
Travel time when strongly opposed (correction for strategic bias)	minutes	-0.014	-2.7
Trip cost (toll or bus fare) divided by HH income in thousands	dollars	-21.210	-7.2
Constant for off-peak period	(0,1)	-1.156	-12.9
Time shift into off-peak period	minutes	-0.002	-2.1
Constant for bus	(0,1)	-0.734	-7.9
Constant for HOV3+	(0,1)	-1.461	-13.6

1460 observations

Likelihood with Zero Coefficients = -2349.78

Final value of Likelihood = -2058.62

"Rho-Squared" w.r.t. Zero = .124

"Rho-Squared" w.r.t. Constants = .033

Table 4: Peak Period Work Model for Infrequent (Four Times per Week or Less) Travelers

Variable	Units	Coefficient	T-Stat
Travel time excluding those strongly opposed to project	minutes	-0.053	-11.4
Travel time when strongly opposed (correction for strategic bias)	minutes	-0.005	-0.8
Trip cost (toll or bus fare) divided by HH income in thousands	dollars	-23.780	-6.5
Constant for off-peak period	(0,1)	-1.535	-12.8
Constant for bus	(0,1)	-0.794	-6.8
Constant for HOV3+	(0,1)	-1.742	-12.2

909 observations

Likelihood with Zero Coefficients = -1462.98

Final value of Likelihood = -1265.60

"Rho-Squared" w.r.t. Zero = .135

"Rho-Squared" w.r.t. Constants = .039

Table 5: Peak Period Non-Work Model for Frequent (One Time per Week or More) Travelers

Variable	Units	Coefficient	T-Stat
Travel time excluding those strongly opposed to project	minutes	-0.051	-7.4
Travel time when strongly opposed (correction for strategic bias)	minutes	0.004	0.4
Trip cost (toll or bus fare) divided by HH income in thousands	dollars	-42.680	-7.1
Constant for off-peak period	(0,1)	-0.993	-6.2
Constant for bus	(0,1)	-2.234	-6.1
Constant for HOV3+	(0,1)	-2.320	-10

396 observations

Likelihood with Zero Coefficients = -637.34

Final value of Likelihood = -495.49

"Rho-Squared" w.r.t. Zero = .222

"Rho-Squared" w.r.t. Constants = .085

Table 6: Peak Period Non-Work Model for Infrequent (One Time per Month or Less) Travelers

Variable	Units	Coefficient	T-Stat
Travel time excluding those strongly opposed to project	minutes	-0.038	-5.3
Travel time when strongly opposed (correction for strategic bias)	minutes	0.006	0.7
Trip cost (toll or bus fare) divided by HH income in thousands	dollars	-19.630	-3.8
Constant for off-peak period	(0,1)	-0.642	-4.1
Constant for bus	(0,1)	-3.036	-6
Constant for HOV3+	(0,1)	-1.723	-7.5

352 observations

Likelihood with Zero Coefficients = -566.52

Final value of Likelihood = -455.85

"Rho-Squared" w.r.t. Zero = .195

"Rho-Squared" w.r.t. Constants = .041

Table 7: Off-Peak Period Work Model

Variable	Units	Coefficient	T-Stat
Travel time excluding those strongly opposed to project	minutes	-0.066	-12.4
Travel time when strongly opposed (correction for strategic bias)	minutes	0.019	2.4
Trip cost (toll or bus fare) divided by HH income in thousands	dollars	-24.520	-5.5
Constant for bus	(0,1)	-1.565	-9.5
Constant for HOV3+	(0,1)	-1.723	-14.5

1035 observations
Likelihood with Zero Coefficients = -1434.81
Final value of Likelihood = -1044.72
"Rho-Squared" w.r.t. Zero = .272
"Rho-Squared" w.r.t. Constants = .072

Table 8: Off-Peak Period Non-Work Model

Variable	Units	Coefficient	T-Stat
Travel time excluding those strongly opposed to project	minutes	-0.070	-18
Travel time when strongly opposed (correction for strategic bias)	minutes	0.031	4.2
Trip cost (toll or bus fare) divided by HH income in thousands	dollars	-23.240	-6.9
Constant for bus	(0,1)	-1.973	-14.2
Constant for HOV3+	(0,1)	-1.534	-18.5

1903 observations
Likelihood with Zero Coefficients = -2638.12
Final value of Likelihood = -1854.52
"Rho-Squared" w.r.t. Zero = .297
"Rho-Squared" w.r.t. Constants = .075

Table 9: Level of Significance of Segmentation Schemes Using the Chi-Squared Test

	Aggregate Log Likelihood	Segment 1 Log Likelihood	Segment 2 Log Likelihood	Significance Level
Peak Period vs. Off-Peak Period Trips	-7635.51	-4442.26	-3147.18	99.9%
Work vs. Non-Work Peak Period Trips	-4442.26	-3338.69	-958.33	99.9%
Frequent vs. Infrequent Peak Period Work Trips	-3338.69	-2058.62	-1265.60	99.9%
Frequent vs. Infrequent Peak Period Non-Work Trips	-958.33	-495.49	-455.85	97.0%
Work vs. Non-Work Off-Peak Period Trips	-3147.18	-1044.72	-1854.52	99.9%

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