TOLL FEASIBILITY STUDY

Prepared For:

HAMPTON ROADS
PLANNING DISTRICT COMMISSION

and

VDOT Virginia Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

Prepared by:

Baker

801 Cromwell Park Drive, Suite 110
Glen Burnie, Maryland 21061

and

PFM CRA fhi

Public Financial Management
CRA International
Fitzgerald & Halliday

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1 EXECUTIVE SUMMARY

1.1 Introduction

The Hampton Roads region has identified transportation infrastructure projects that hold promise to address future mobility issues and alleviate anticipated congestion:

- Hampton Roads Third Crossing
- Southeastern Parkway & Greenbelt, Dominion Boulevard
- US 460 Alternate
- Midtown Tunnel Expansion
- Martin Luther King Freeway Extension.

Prior to this study, there were several unsuccessful efforts to fund these transportation projects; beginning with the 1999 Regional Transportation Priority Setting completed as a part of the 2021 Regional Transportation Plan development process. This plan recommended funding the construction of these projects through the use of user tolls. Toll revenues were to be supplemented by a regional gas tax. The 2002 Regional Transportation Referendum proposed to build these projects, using a general sales tax to fund project construction. The referendum was not successful.

The 2026 Regional Transportation Plan, released in August 2003, contains some of these projects. The Plan's $30+ billion in candidate transportation projects has an anticipated funding deficit of over $20 billion. With the Virginia Department of Transportation (VDOT) finding "that the reliance on a regional gas tax is not a reasonably foreseeable source of revenue for the current [2026] plan update", and the Federal Highway Administration (FHWA) allowing user tolls for substantial reconstruction of bridge/tunnel facilities; this study was conceived to evaluate the feasibility of using toll-based financing as a means to fully or partially fund these transportation projects.[1]

1.2 Report Context

This document summarizes the feasibility evaluation process and provides a comprehensive discussion of many topics introduced to the Metropolitan Planning Organization during its September, October, and November 2004 meetings. The feasibility evaluation process includes:

- Estimation of travel demand, under tolled conditions
- Projection of toll revenues
- Projection of project costs

1 Correspondence supporting statements to the Hampton Roads Planning District Commission (HRPDC) by VDOT and FHWA are in Technical Appendices "A" and "B" respectively.

- Evaluation of project funding deficit or surplus
- Evaluation of transportation system Impacts

In this study, project funding evaluation uses the maximum toll revenue attainable.

1.3 Project Feasibility Evaluation

This study investigated the feasibility of using toll-based financing as a means to fully fund several transportation improvement projects in the Hampton Roads region. These projects were evaluated as “stand-alone” (individual) and in combination with toll revenues from other roadways. Projects were also evaluated with respect to the impact of tolls on the magnitude of travel demand, and the change in regional travel patterns and roadway “level-of-service” (LOS).

The feasibility of toll implementation for the purposes of funding infrastructure improvements constitutes two (2) primary components:

1. Portion of debt service[2] covered by toll revenues (cash flow analysis)
2. Impact on travel demand

This study provides a comprehensive financial feasibility and travel demand impact analysis for each improvement project. Table 1.3-1 describes the projects.

This study uses a modified version of the Hampton Roads Regional Travel Model as the means to estimate travel demand for the projects under tolled conditions. These travel demand estimates are the basis for generating a schedule of revenues associated with the project over the 30-year study or re-payment period. Projects are tolled on a “per mile” basis and do not consider the physical configuration of a toll collection mechanism, assuming “open road” tolling technology.

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2 Addressing project expenses, including, but not limited to, engineering, right-of-way acquisition, construction, financing, toll collection, and maintenance

Table 1.3-1 Project Descriptions

Project	Improvement	Distance	Tolled Distance
Hampton Roads Crossing	I-564, west of I-64: widen to 8 lanes + 2 lanes (transit)	2.7 mi.	0 mi.
	I-564 to MMMBT (E/W Connector) : new 4-lane highway + 2 lanes (transit)	6.4 mi.	6.4 mi.
	I-664, E/W Conn. to 28th St., 2nd MMMBT tube: 8 lanes + 2 lanes (transit)	2.4 mi.	2.4 mi.
	Craney Island Connector: new 4-lane highway	5.6 mi.	5.6 mi.
	I-664, 28th St. to I-664/I-64 Interchange: widen to 8 lanes	4.7 mi.	4.7 mi.
	I-664, I-64/I-264 Interchange to E/W Conn.: widen to 6 lanes	13.3 mi.	13.3 mi.
Midtown Tunnel & MLK Freeway Extension	Midtown Tunnel, Pinners Point Connector to Brambleton Avenue: new 2-lane tunnel	1.0 mi.	1.0 mi.
	MLK Freeway, I-264 to High Street	0.6 mi.	0.6 mi.
Route 460	I-664 to Suffolk Bypass: widen to 4 lanes	5.7 mi.	0 mi.
	Suffolk Bypass to I-295: new 6-lane highway	47 mi.	47 mi.
Southeastern Parkway & Green Belt	I-264 to Oak Grove Connector: new 4-lane highway	24 mi.	24 mi.
	Oak Grove Connector	1.9 mi.	1.9 mi.
	Dominion Boulevard, George Washington Hwy. To Oak Grove Connector	6.6 mi.	2.7 mi.

1.3.1 Financial Feasibility

“Stand-Alone” Projects

This analysis produced, for each individual project, a revenue-optimized toll rate, a travel demand estimate, and an associated revenue schedule. All project toll revenues start accruing after construction of the facility is complete. Section 3.2.1 of this report lists toll values for the projects.

Table 1.3-2 shows the degree to which individual project costs can be covered using toll-based financing, including some committed State and federal funds for selected projects (NHS, RSTP, and Primary) shown under “additional funding”. Toll revenues from the project leverage funds shown under “total bond/loan funds”. The “funding deficit” column shows a significant funding deficit for each project, indicating that other funding sources or a re-scheduling of funding is necessary to cover project costs if they are to be financed using project tolls.

In the stand-alone analysis, this study assumes that revenue from tolls does not start until the project is completely constructed and opened; creating a substantial delay between the beginning of scheduled expenditures (Construction Start Date) and the toll revenue start date. In the case of the Hampton Roads Third Crossing, the delay is eleven (11) years. During this time financing costs continue to rise with no revenue to offset. With project toll revenues as the only leverage for bonds and loans, project financing is costly and inefficient for start-up toll facilities.

Table 1.3-2 "Stand-Alone" Project Capital Sources & Costs Summary

Project	P/D & E (1)	Net Total Cost (2)	Additional Funding (4)	Total Bond / Loan Funds	Funding Deficit	Const. Start Date	Total Revenue Start Date
HRX, Segment I	53,850,000	1,833,348,300	-	82,670,500	1,750,677,800	2005	2008
HRX	81,000,000	4,152,372,000	-	336,804,100	3,815,567,900	2006	2017
Midtown & MLK	12,630,000	548,827,600	-	83,915,300	464,912,300	2009	2015
Route 460	26,820,000	1,468,264,000	321,000,000	454,236,600	902,375,200	2010	2018
SP&G (3), I-264 to I-64	14,670,000	931,532,800	420,000,000	598,046,400	337,797,000	2010	2017
SP&G (3), Dominion Boulevard	3,270,000	185,180,200	100,000,000			2010	2017

(1) Preliminary design and engineering costs are estimated to be 3% of non-inflated project cost.
(2) Preliminary design and engineering have been subtracted out
(3) SP&G bond/loan amount, and funding deficit shown in aggregate.
(4) NHS, RSTP, and Primary funds. Only part of these funds is scheduled in the construction period; the remainder used to increase bond capacity.
Note: all values are US dollars at year of accrual or expenditure

Toll Financed Projects Using Unimproved Roadway Toll Revenue

Based upon the individual facility results, this Study examines three project scenarios that feature tolling of existing unimproved roadways parallel to the projects under study. Table 1.3-3, below, lists the features of each project scenario.

The introduction of toll revenues from existing roadways at the beginning of the project expenditure schedule (especially where a verifiable traffic history is available) can dramatically increase financial feasibility by:

- Reducing construction cost
- Increasing bonding and loan capacity
- Reducing accrual of interest

Table 1.3-3 Project Scenarios

Features	Project Scenario #1	Project Scenario #2	Project Scenario #3
Projects	• HRX	• Improved HRBT (1)	• Midtown & MLK
Existing/Unimproved, Tolled Roadways	• MMMBT • JRB • HRBT	• MMMBT • JRB • HRBT	• Downtown Tunnel

MMMBT – Monitor Merrimac Bridge Tunnel
JRB – James River Bridge
HRBT – Hampton Roads Bridge Tunnel

(1) Hampton Roads Crossing Study, Alternative #1

Toll values for each project scenario were developed to satisfy three objectives: (1) maximize toll revenues; (2) ensure that roadway patrons are not "tolled-off"[3] of roadways; and (3) employ "value-priced" variable tolls[4]. This study examined value-price tolling for two time periods: peak and off-peak. Section 3.2.2 toll values for the project scenarios in detail. Table 1.3-4, below, shows the degree to which individual project costs can be covered using project tolls <u>and funding provided by unimproved roadways.</u>

Scenario #1 still has a significant funding deficit with the introduction of existing roadway toll revenues. Scenarios #2 and #3 are financially feasible. Scenario #3, in fact, has significant excess financing capacity, which means that it could be feasible at less than the stated toll rates. Only 37% of estimated toll revenue for Scenario #3 is required to cover costs.

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3 Toll value is high enough that the majority of roadway capacity is unused due to travelers avoiding the roadway.

4 Value-priced tolls are tolls that change depending on the level of congestion, such that higher tolls are charged during more congested periods

Table 1.3-4 Project Scenario Capital Sources & Cost Summary

	Net Total Cost (1)	Additional Funding (3)	P/D & E (2)	Total Bond / Loan Funds	Funding Deficit	Const. Start Date	Toll Revenue Start Date
Scenario #1 HRX	4,152,400,000	193,500,000	81,000,000	2,805,000,000	1,153,900,000	2006	2006
Scenario #2 HRBT	1,845,500,000	116,300,000	36,000,000	1,729,200,000	-	2006	2006
Scenario #3 Midtown & MLK	548,800,000	251,100,000	12,600,000	297,700,000	-	2009	2009

(1) Preliminary design and engineering have been subtracted out
(2) Preliminary design and engineering costs are estimated to be 3% of non-inflated project cost.
(3) Toll revenues from unimproved roadways scheduled to offset construction costs (the remainder of toll revenue used to increase bond capacity).
Note: all values are US dollars at year of accrual or expenditure

Financial Risk Assessment

There are a number of risks associated with toll road development. The financing plans for these projects are based upon estimates of costs and revenues. The exact values of these costs and revenues are not truly known and may well change over the lifetime of the project: the construction schedule may slip due to delays caused by environmental or other issues; the construction costs could increase due to poor estimation or unforeseen complications; or the traffic and revenue may not reach forecasted targets due to improvements of competing facilities or changes in travel behavior. Understanding these risks and their financial implications can help make a better-informed decision on whether to proceed with the project.

Table 1.3-5 shows the probable variability in funding or financial feasibility based on a risk analysis performed for this study. A more detailed discussion of results, analysis methods, and assumptions can be found in Section 3.2.3 and in Appendix “F”. Since the Project Scenario #3 is very well funded, an analysis of financial risk was not necessary.

Table 1.3-5 Funding Deficit Uncertainty

Project	Funding Deficit	Probable Deficit Range	Percent Deviation (2)
HRX, Segment I	1,750,677,800	1,668,286,400 to 1,841,708,300	-5% to +5%
HRX	3,815,567,900	3,429,170,500 to 3,971,288,500	-10% to +4%
Midtown & MLK	464,912,300	399,227,800 to 469,173,347	-14% to +1%
Route 460	902,375,200	691,823,400 to 972,789,400	-23% to +8%
Southeastern Parkway & Greenbelt	337,797,000	146,185,800 to 406,486,200	-57% to +20%
Project Scenario #1	1,153,900,000	42,486,700 to 1,823,747,000	-96% to 59%
Project Scenario #2 (1)	(144,954,200)	(903,434,800) to 320,068,000	-523% to 320%

(1) Actual funding surplus reported here

(2) Deviation based on probable deficit range as compared to the calculated funding deficit

Note: Values in table represent deficits; therefore a funding surplus is represented by a negative value. All values are US dollars at year of accrual or expenditure

Note that the reported "stand-alone" project funding deficits are all in the higher portion of the probable deficit range – indicating that assumptions used in this study associated with project financing and operation are conservative. Table 1.3-5 also indicates that even when taking uncertainty into account, all "stand-alone" projects still experience a funding deficit.

There is considerably more uncertainty associated with funding deficits for the project scenarios. This is clearly illustrated when comparing the Hampton Roads Crossing project (HRX) with Project Scenario #1. Construction costs are the same for both. But reliance on toll revenue from unimproved roadways throughout the construction schedule introduces more uncertainty into its financial feasibility.

1.3.2 Impact of Tolls on Travel Demand

Feasibility of toll implementation for the purposes of funding infrastructure improvements also constitutes an examination of the effect of tolls on travel demand. It is important to gauge the utilization of the tolled roadways – how much of the roadway capacity is being used. While roadway improvements are designed to alleviate congestion; if tolls are too high, travel demand for these roadways will be relatively low leaving a significant amount of excess capacity. The improvements the tolls are financing will therefore not sufficiently benefit the traveling public. Tolls may also cause travelers to deviate from tolled routes creating congestion problems on roadways that are part of competing routes. These effects can impact existing transportation plans and planning activities associated with other projects.

Specifically, this study intended to examine changes in roadway level-of-service and travel patterns associated with tolling of projects subject to financial analysis in the previous section. However, it is important to remember that this study analyzed project financial feasibility under conditions that maximize revenue and in many instances this assumption resulted in toll values that significantly reduced travel demand on project roadways. The travel impact analysis in this study can provide, however, useful qualitative information regarding the impact of the tolls and projects on travel demand. Travel demand impacts are discussed more extensively in Chapter 4.

2 PROJECT DEMAND AND REVENUE ESTIMATION

2.1 Demand Estimation

The Hampton Roads regional travel demand model is used to develop traffic and revenue projections for the candidate toll facilities under consideration in this study. Appendix "C" contains details of the travel demand model implementation for this study, and is particularly important since many toll road revenue forecasts have been plagued by substantial forecasting error associated with travel demand. On average, projects miss their forecasted revenues by 35-40% in the third year.[5] Projects that met projections offered at least 5 minutes of time-savings, served a higher income level, and were forecasted to grow at less than 5% annually. Conversely, projects that over forecast traffic are plagued by expansion of competing freeways, tolls too high relative to the income base (corresponding to overstatement of the value-of-time), overestimation of land use growth, and improper handling of usage patterns (peak periods, directionality, vehicle classes, etc.).

While a detailed investment-grade traffic and revenue study is beyond the scope of this project, there is need to apply the available tool, the regional transportation model, in the most appropriate manner to avoid the mistakes of failed projects noted above. The traffic and revenue forecasts will serve as one component of the initial assessment of the feasibility of these toll roads. Although this assessment will not be used to secure project financing, it is intended to develop a solid foundation for further, more detailed analysis while initiating consideration of the candidate toll facilities and their relative merits.

2.1.1 Project Demand Estimates

Financial feasibility analysis for each stand-alone project and project combination requires a toll revenue schedule for a 30-year period. Calculation of the revenue schedule requires a travel demand estimate on all tolled roadways for the years 2017 and 2026.

"No-project" and stand-alone project network models were created by modifying the Year 2026 Regional Transportation Plan network. The no-project network was defined as the Plan network minus the Hampton Roads Crossing (Segment I), Route 460, and the Southeastern Parkway and Greenbelt. Projects evaluated by this Study were then coded into the Year 2026 No-Project network model using planning data available for each project, ensuring consistency with on-going VDOT studies. This information included facility description, alignment and capacity information. Demand estimates generated reflect all land use assumptions associated with the Year 2026 Regional Transportation Plan.[6]

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5 Muller, Robert H. "Tollroad Feasibility Studies: An Historical Perspective." Presented at the 2001 Transportation Research Board Annual Meeting, 2001.

6 Air quality modeling for the 2026 Plan included a year 2017 scenario.

The travel model produced Year 2026 travel demand estimates for the projects using an array of toll rates and determined those rates (T_{mar}) that maximize revenue for each of the five (5) stand-alone projects and three (3) project scenarios. The optimal toll or T_{mar} was derived by creating demand vs. toll and revenue vs. toll curves, identifying the toll value that yields the greatest revenue. Year 2017 travel demand was then estimated using the optimal toll value.

2.2 Revenue Estimation

Once the daily revenue forecasts are produced by the travel model revenue maximizing toll values, the next step is to convert the travel demand model output into a revenue schedule for the financial model. The conversion from travel demand model outputs to a revenue schedule is dependent on a number of elements including the revenue schedule start year, non-model year revenues, the inflation rate, annualization factor, and a ramp-up factor.

2.2.1 Revenue Schedule

Start Year

For the stand-alone projects, toll revenues are not collected until after construction has been completed and the roadway is opened to traffic. Thus, the opening year is the first year following the end of the construction schedule. Construction schedules provided by HRPDC identify the opening year for each project and assume year 1 of the project schedule is 2004. Construction schedule assumptions are shown in Table 2.2-1 and are financially "unconstrained".

Table 2.2-1 "Stand-Alone" Project Schedule Assumptions

Project	Construction Start Year	Revenue Start Year
Hampton Roads Third Crossing - Segment 1*	2005	2008
Hampton Roads Third Crossing	2006	2017
Midtown Tunnel & MLK	2009	2015.5
Route 460	2010.5	2018
SP&G	2010	2017.5

* Schedule based on constrained and unconstrained schedules for staging of the full Hampton Roads crossing

Some of the projects complete construction mid-year. This is accounted for by beginning the revenue in the 2nd half of the same year. Thus, the 30-year revenue schedule includes 31 calendar years with the first and last only including half year revenues.

Creation of Full Schedule

The regional travel demand model has data available to produce Year 2000, 2017 and 2026 demand estimates and thus revenue. For the stand-alone projects, the model years 2017 and 2026 serve as reference points to calculate yearly revenue growth using linear interpolation. Combination projects us the same method, except that an additional reference point for Year 2000 provides a way to estimate toll revenues collected on the unimproved facilities during project construction. Technical Appendix "D" provides detail on calculations used to create the schedules.

Inflation Rate

All monetary elements (tolls, vehicle operating cost, and value of time) of the travel demand model use year 2000 dollars, but the financial model needs revenues in the year of accrual. Year 2000 dollars inflated at a rate of 3.89% yields year of accrual dollars. This is the same inflation rate used for the cost estimate schedule and agreed upon for the referendum by HRPDC, Solomon Smith Barney, and the State of Virginia.

Toll Increases

Since the revenue schedules are based on Year 2017 and Year 2026 (and sometimes Year 2000) forecasts, forecasting the travel demand and revenue levels associated with future toll levels would be an imprecise method to identify future revenue levels. Rather, this study assumes that tolls increase with inflation. This allows the conversion of revenues for each year from year 2000 dollars to each schedule year's current dollars by applying the estimated inflation rate.

Conversion from Daily Revenue to Annual Revenue

The travel demand model forecasts daily travel demand and revenue, but the financial analysis requires annual toll revenue. An annualization factor converts daily to annual revenue. This factor must consider the expected level of weekend traffic. Two groups of projects, according to their level of weekend traffic, use separate factors. Technical Appendix "D" contains details of annualization factor derivation.

2.2.2 Revenue Ramp-up

Toll roads experience a "ramp-up" period of traffic and revenue. Introduction of a ramp-up period into the revenue schedule accounts for this behavior. J.P. Morgan's review of start-up toll roads provides a basis for accounting for a "ramp-up" period. The publication groups toll facilities based upon shared features and compares actual traffic and revenue to forecasted values. The project that are the focus of this study best match definitions of Group 3: Developed Corridors, Parallels of Existing Roads and/or Faulty Economic Forecasts, and Group 4: Less Developed Areas.

The report provides two data sets of particular interest: 1) actual traffic and revenue as a percentage of each year's forecasted traffic and revenue, and 2) forecasted traffic and revenue growth rate for first four years. These datasets were combined to calculate a new data set of each year's actual traffic and revenue as a percentage of the opening year's forecasted traffic and revenue. Actual growth appears steady after 2 years, for both of the JP Morgan groups.

Revenue ramp-up is accounted for as follows:

- Determine the average, mean and standard deviation of observed 2-year growth of each group.
- Limit the maximum growth rate of individual facility observations at one standard deviation from the mean, and then recalculate the mean. Since the JP Morgan report has a limited number of observations in each group, this allows outlying observations to be included in such a way that their values do not dominate the mean.
- Determine the 1-year growth rate using the same procedure.
- Apply these ramp-up factors to determine the revenues for the first 2 years of project opening. Use the 2-year actual growth rate to discount project Year 3 revenue to calculate the opening year revenue, and then use the 1-year growth rate to determine Year 2 revenue.

The Hampton Roads Third Crossing projects (both full and Segment I) present a different challenge. Unlike the other projects, there will likely be a "ramp-down" period for this project as trip patterns adjust to the new toll crossing. These projects and their associated tolls will change the distribution of trips with more people electing to live and work on the same side of the harbor. However, this new steady-state condition will not occur instantaneously with the opening of the facility. Experience with transit projects is that there is a 5-year period during which development occurs around the new transit facility and people adjust their trip-ends to utilize the new service. Since these projects will not promote the same level of new development, the trip-end adjustment should be a shorter period. This study assumes a 3-year ramp-down period that closely corresponds to the 3.4 to 3.8 year range of average job tenure reported by the Bureau of Labor Statistics. Table 2.2-2, below, summarizes revenue schedule adjustments.

Table 2.2-2 Project Revenue Schedule Adjustments

Project	JP Morgan Group	Revenue Schedule Adjustments		
		Year 1	Year 2	Year 3
Hampton Roads Third Crossing - Segment 1	N/A	+ 30%	+ 20%	+10%
Hampton Roads Third Crossing	N/A	+ 30%	+ 20%	+10%
Midtown Tunnel & MLK	3	82% of Year 3 forecast	94% of Year 3 forecast	No Adjustment
Route 460	4	54% of Year 3 forecast	85% of Year 3 forecast	No Adjustment
Southeastern Parkway & Greenbelt	4	54% of Year 3 forecast	85% of Year 3 forecast	No Adjustment

3 FINANCIAL FEASIBILITY EVALUATION

3.1 Financial Feasibility Model

This study uses a proprietary toll facility financing model. The model incorporates data describing project costs, construction schedules and scheduled revenue. The toll facility financing model used in this study is the industry standard for municipal bond structuring, to structure bond issuances. Appendix "E" contains a detailed discussion of all financing assumptions and financial model structure.

3.1.1 Project Capital Costs

Capital costs were developed using an unconstrained 14-year cost expenditure schedule provided by HRPDC. The expenditure schedule was modified to reflect anticipated construction timing and duration. HRPDC also provided total project costs. This Study assumes that preliminary design and engineering (P/D&E) costs are 3% of the total uninflated project cost, and will be funded by the State. For example, if project "A" has a total capital cost of $100 million (2002 dollars), then preliminary design and engineering costs are calculated to be $3 million – yielding a total adjusted cost of $97 million. A 3.89% annual inflation factor was applied to each adjusted cost to yield inflated or year-of-expenditure (YOE) project costs. Table 3.1-2 shows information used to calculate year-of-expenditure (YOE) costs for each project.

Table 3.1-1 Capital Costs & Construction Schedule

Project	Cost Year $	P/D&E (1)	Project Costs (2)	Construction Start Date	Years to Complete	YOE Net Total Cost
HRX, Segment I	2005	53,850,000	1,795,000,000	2005	3	1,833,348,300
HRX	1999	81,000,000	2,700,000,000	2006	11	4,152,372,000
Midtown & MLK	2004	12,630,000	421,000,000	2009	6.5	548,827,600
Route 460	2000	26,820,000	894,000,000	2010.5	7.5	1,468,264,000
SP&G, I-264 to I-64	1996	14,670,000	489,000,000	2010	7.5	931,532,800
SP&G, Dominion Boulevard	1999	3,270,000	109,000,000	2010	7.5	185,180,200

(1) Preliminary design & engineering costs (funded by the State) are estimated to be 3% of non-inflated project costs and have been subtracted out of year of expenditure (YOE) net total cost

(2) Does not include operation & maintenance or financing costs – only capital costs

3.1.2 Additional Funding Sources

State and Federal

Route 460 and the Southeastern Parkway and Greenbelt projects secured additional funding that can be used to offset construction costs. The Route 460 Project secured $321 million in NHS and Primary funding. In the feasibility analysis, these funds were assigned equally to a 23-year period beginning in 2010 – when Route 460 construction begins. The Southeastern Parkway and Greenbelt Project secured $520 million in NHS and RSTP funding.[7] Similarly, the additional funding was applied equally to a 23-year period beginning in 2010 – also when construction begins for this project. Because the revenues were distributed through 2032 and the construction periods end in 2017, the final fifteen years of revenues were added to toll revenues to increase the financing capacity in those years.

Revenues produced by tolling existing facilities

As described in Section 1.3.1, a second evaluation of the Hampton Roads Crossing included tolls from existing, parallel roadways in order to generate "upfront" toll revenues. Like the additional State and Federal funding described above, revenues from existing roadways offset capital costs and increase financing capacity. In addition, "upfront" toll revenues eliminate the need to capitalize interest. These revenues were applied in the following manner: 1) in years where there were no capital requirements revenues were deposited into a construction fund, 2) in years where construction requirements existed, and the revenues to date covered capital costs, deposited and current revenues were applied, 3) in years where capital requirements were greater than available existing revenues, revenues were instead applied to bond capacity and a toll revenue bond was issued; at which point all revenues in the future were used for debt service coverage.

Available State and Federal funding sources and "upfront" toll revenues cover capital costs, including right-of-way acquisition, through the beginning of construction. The availability of additional capital sources proves extremely beneficial to the financial feasibility of funding projects.

3.2 Analysis Results

It is important to emphasize that the financial feasibility analyses described herein are predicated upon all the assumptions previously described. In particular, the issuance of investment grade rated municipal bonds will depend upon the availability of a market-acceptable traffic & revenue forecasts for project and package as well as an acceptable consulting engineer's (construction) report. Any State or Federal permits would likely need to be approved. Any State or Federal funding, including any loan or credit enhancement programs, would need to be approved and documented. If applicable,

7 $100 million in RSTP funds will be applied to the Dominion Boulevard improvements

any PPTA and/or design-build construction contract would also need to be finalized and market-acceptable. All of these things in addition to a sound financial plan are required to create an investment grade bond financing.

3.2.1 Toll Financed "Stand-Alone" Projects

This analysis produced, for each individual project, a revenue-optimized toll rate, a travel demand estimate, and an associated revenue schedule. The revenue schedule start date is based on individual project construction schedules developed in conjunction with HRPDC and are financially "unconstrained". All project toll revenues start accruing after construction of the entire facility is complete. Listed below are the optimized tolls in Year 2004 US dollars:

- HRX – Segment I **$0.12/mi.**
- Hampton Roads Crossing (HRX) **$0.11/mi.**
- Midtown Tunnel and MLK Freeway Extension (Midtown & MLK)
    - Midtown Tunnel **$0.58/mi.**
    - MLK Freeway **$0.19/mi.**
- Route 460 **$0.11/mi.**
- Southeastern Parkway and Greenbelt (SP&G)
    - Dominion Boulevard from George Washington Hwy. To Oak Grove Connector **$0.83/mi.**
    - Oak Grove Connector **$0.56/mi.**
    - Oak Grove Connector to I-264 **$0.07/mi.**

Using all the construction and financing assumptions previously described, debt-financing structures were prepared for each individual project. The results are summarized in Tables 3.2-1 and 3.2-2. Table 3.2-1 shows revenue income and expenditures. Revenue to finance the projects comes from: 1) toll revenues, and 2) NHS, RSTP and Primary sources, if available, provided by Federal and State government. Operating & maintenance costs removed from incoming revenue yields net operating revenue. The amount of net operating revenue leverages federal loans (TIFIA) and bond issues at a debt service coverage ratio of 1.25, and thus has a direct bearing on the amount of bond/loan funds available to cover project capital costs.[8] The net operating revenue, less debt service expense leaves "excess proceeds" that are designated for various reserve funds in accordance with the Plan of Finance.[9]

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8 Appendix "E" - Credit Framework, under the section "Debt Service Coverage"

9 Appendix "E" – Plan of Finance and Financal Model Overview

Table 3.2-1 "Stand-Alone" Project Cash Flow

Project	Income		Expenditures		Excess Proceeds
	Gross Toll Revenue	NHS, RSTP, and Primary (1)	Operating & Maintenance Costs (2)	Debt Service (3)	
HRX, Segment I	400,028,400	0	120,008,500	223,735,500	56,284,400
HRX	1,973,350,100	0	592,005,000	1,104,541,300	276,803,800
Midtown & MLK	427,222,400	0	128,166,700	239,181,900	59,873,800
Route 460	2,053,546,400	209,347,800	616,063,900	1,317405,000	329,425,300
SP&G	2,771,217,100	339,130,400	831,365,100	1,823,136,800	455,845,600

(1) Portion used for operating revenue.
(2) Covers open road tolling infrastructure, toll administration, and maintenance of roadway (30% of gross toll revenues)
(3) Does not include capitalized interest (refer to discussion in Appendix "E")
Note: all values are US dollars at year of accrual or expenditure

Table 3.2-2 shows capital sources for each of the "stand-alone" projects; combining Net Total Project Costs (from Table 3.1-1) with funding available from Federal and State sources as well as bond/loan proceeds. Each project on a stand-alone basis has a significant funding deficit. This outcome is completely typical for large urban toll facility projects. With no upfront or tax generated revenue support, such toll projects can rarely pay for themselves. As an example, to leverage approximately $454 million in bond and loan funds to cover capital costs on the US 460 project; the project needs over two and a third billion dollars in funding to cover debt service costs of just over a billion dollars – still resulting in nearly a billion dollar funding deficit. Bonding for these projects is particularly difficult and costly, especially given the history of under-performing toll revenue-financed projects.

Table 3.2-2 "Stand-Alone" Project Capital Sources & Cost Summary

Project	Sources		Net Total Cost (2)	Funding Deficit	Const. Start Date	Toll Revenue Start Date
	NHS, RSTP, and Primary (1)	Total Bond / Loan Funds				
HRX, Segment I	-	82,670,500	1,833,348,300	1,750,677,800	2005	2008
HRX	-	336,804,100	4,152,372,000	3,815,567,900	2006	2017
Midtown & MLK	-	83,915,300	548,827,600	464,912,300	2009	2015
Route 460	111,652,200	454,236,600	1,468,264,000	902,375,200	2010	2018
SP&G	180,869,600	598,046,400	1,116713,000	337,797,000	2010	2017

(1) Portion scheduled in the construction period
(2) For Southeastern Parkway and Greenbelt, I-264 to I-64 and Dominion Boulevard costs are combined
Note: all values are US dollars at year of accrual or expenditure

3.2.2 Toll Financed Projects Using Unimproved Roadway Toll Revenue

Based upon "stand-alone" project results, this Study also examined financial feasibility of constructing toll projects while tolling unimproved, competing roadways. As discussed in Appendix "E", the introduction of "upfront" toll revenues, especially where a verifiable traffic history is available, can dramatically improve the financial feasibility of a project. Table 3.2-3 describes each of three project "scenarios".

Roadway improvements associated with two of the project scenarios[10] are based on "stand-alone" projects. Project Scenario #1, features the Hampton Roads Crossing Project and uses the construction schedule and cost assumptions for HRX shown in Table 3.1-1. Project Scenario #2, features the improved Hampton Roads Bridge-Tunnel[11] which was not included in the "stand-alone" projects previously examined. Scenario #2 assumes the same construction expenditure rate as HRX with project costs as cited the Hampton Roads Crossing Study. Project Scenario #3, the Midtown Tunnel/MLK Freeway Extension, uses its respective construction cost schedule as shown in Table 3.1-1.

10 Same as defined in the Hampton Roads Toll Feasibility Study presentation dated October 20, 2004

11 Hampton Roads Crossing Study, Alternative #1

Table 3.2-3 Project Scenarios

Features	Project Scenario #1	Project Scenario #2	Project Scenario #3
Projects	• HRX	• Improved HRBT (1)	• Midtown & MLK
Existing/Unimproved, Tolled Roadways	• MMMBT • JRB • HRBT	• MMMBT • JRB • HRBT	• Downtown Tunnel

MMMBT – Monitor Merrimac Bridge Tunnel
JRB – James River Bridge
HRBT – Hampton Roads Bridge Tunnel

(1) Hampton Roads Crossing Study, Alternative #1

Revenue for each project scenario is based on toll values developed to satisfy three objectives: (1) maximize toll revenues; (2) ensure that competing roadway patrons are not "tolled-off"; and (3) employ "value-priced", variable tolls.[12] This study examined value-price tolling for two time periods: peak and off-peak. Table 3.2-4 shows toll values used in the project scenario feasibility analysis.

Table 3.2-4 Optimized Toll Values(2)

	Project		Unimproved Roadways(3)									
			JRB		MMMBT		HRBT		Midtown Tunnel		Downtown Tunnel	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Scenario #1 HRX	0.20/mi	0.15/mi	2.00	1.40	2.00	1.40	2.00	1.40	-	-	-	-
Scenario #2 HRBT	0.25/mi	0.15/mi	0.75	0.55	0.75	0.55	0.75	0.55	-	-	-	-
Scenario #3 Midtown & MLK	2.05/mi. 0.25/mi(1)	1.50/mi. 0.20/mi(1)	-	-	-	-	-	-	2.05	1.50	2.20	1.60

(1) Values for MLK extension portion of project
(2) All toll values in Year 2004 US dollars
(3) If roadway is improved under the subject project, project toll rates in effect once construction has completed.

12 Appendix "C" – Discussion of Potential Travel Model Modifications, under the section "Sensitivity to Value-Pricing"

Using all the construction and financing assumptions previously described, debt-financing structures were prepared for each project combination. The results are summarized in Tables 3.2-5 and 3.2-6.

Table 3.2-5 Project Scenario Cash Flow

Project	Income		Expenditures		Excess Proceeds
	Toll Revenue (1)	NHS, RSTP, and Primary (1)	Operating & Maintenance Costs (2)	Debt Service (3)	
Scenario #1 HRX	10,999,324,600	-	1,504,274,600	7,575,533,100	1,919,516,900
Scenario #2 HRBT	7,102,864,800	-	993,866,400	4,732,739,300	1,376,259,100
Scenario #3 Midtown & MLK	4,827,149,800	-	709,110,900	598,681,800	3,519,357,100

(1) Portion used for operating revenue.
(2) Covers open road tolling infrastructure and toll administration (15% of gross toll revenues)
(3) Does not include capitalized interest (refer to discussion in Appendix "E")
Note: all values are US dollars at year of accrual or expenditure

Table 3.2-5 shows revenue income and expenditures. Note that for the project scenarios the share of gross toll revenues to fund operations and maintenance expenses is 15% as opposed to 30% assumed in the analysis of "stand-alone" projects. This reduction in operating & maintenance costs assumes that roadway maintenance costs will be paid by VDOT maintenance funds; leaving "open road" tolling infrastructure and toll administration costs.

Table 3.2-6 Project Scenario Capital Sources & Cost Summary

Project	Sources		Net Total Cost	Funding Deficit	Const. Start Date	Toll Revenue Start Date
	Toll Revenue (1)	Total Bond / Loan Funds				
Scenario #1 HRX	193,496,500	2,805,000,000	4,152,372,000	1,153,875,500	2006	2006
Scenario #2 HRBT	116,279,200	1,729,219,500	1,845,498,700	-	2006	2006
Scenario #3 Midtown & MLK	251,139,900	297,687,700	548,827,600	-	2009	2009

(1) Portion scheduled in the construction period
Note: all values are US dollars at year of accrual or expenditure

Table 3.2-6 shows capital sources and costs. Scenario #1 still has a significant funding deficit, even with the addition of "upfront" toll revenues. This added revenue, however, makes Scenarios #2 and #3 financially feasible. Scenario #3, in fact, was determined to be feasible with significant excess financing capacity (note large amount of excess proceeds), which means that it could be feasible at less than the stated toll rates. Only 37% of estimated toll revenue for Scenario #3 is required to cover costs. Toll values for the Midtown and Downtown Tunnel can be reduced from the $1.50 - $2.20 range shown in Table 3.2-4 to $0.35 - $0.55.

3.2.3 Financial Risk Assessment

There are a number of risks associated with toll road development. The financing plans for these projects are based upon estimates of costs and revenues. The exact values of these costs and revenues are not truly known and may well change over the lifetime of the project: the construction schedule may slip due to delays caused by environmental or other issues; the construction costs could increase due to poor estimation or unforeseen complications; or the traffic and revenue may not reach forecasted targets due to improvements of competing facilities or changes in travel behavior. A change in these input parameters can affect the financial feasibility of a project. Understanding these risks and their financial implications can help make a better-informed decision on whether to proceed with the project.

The risk assessment used a Monte Carlo simulation model with likely input parameter distributions[13] to generate 50,000 scenarios of input combinations and evaluated the impact of these scenarios on the project funding. This analysis considered the project funding in terms of funding deficit, since all of the stand-alone projects experienced a funding deficit,. Therefore positive funding deficits represent projects that require additional funding, while negative funding deficits indicate that a funding surplus exists. Using the 50,000 project funding observations, funding deficit measures were calculated for each project. The measures include the mean funding deficit, the mean funding deficit less one standard deviation, the mean funding deficit plus one standard deviation, the minimum observation, and the maximum observation. Also included is the "baseline" or deterministic deficit - the deficit presented in Section 3.2.1.

Table 3.2-7 "Stand-Alone" Project Risk Assessment

Project	Deficit					
	Baseline	Mean	Minimum Observation	Less One Std. Deviation	Plus One Std. Deviation	Maximum Observation
HRX, Segment I	1,750,677,800	1,754,997,352	2,065,319,115	1,841,708,259	1,668,286,446	1,484,762,795
HRX	3,815,567,900	3,700,229,471	4,786,522,326	3,971,288,466	3,429,170,477	2,773,736,550
Midtown & MLK	464,912,300	434,200,555	566,918,873	469,173,347	399,227,764	276,841,404
Route 460	902,375,200	832,306,443	1,388,259,829	972,789,433	691,823,452	121,905,024
Southeastern Parkway & Greenbelt	337,797,000	276,335,988	680,997,500	406,486,190	146,185,787	(432,852,758)

(1) Actual funding surplus reported here
(2) Deviation based on probable deficit range as compared to the calculated funding deficit
Note: all values are US dollars at year of accrual or expenditure

Table 3.2-7 presents the funding deficit measures for the stand-alone projects. Once again, all positive values indicate that a funding deficit exists. While most of the projects had a mean funding deficit that was less than the baseline deficit, the most likely

13 Appendix "F" – Project Specific Parameters

outcomes (between one standard deviation less than the mean and one standard deviation greater than the mean) of all stand-alone projects still constitute a funding deficit. In fact, only the Southeastern Parkway and Greenbelt project had any observations of a funding surplus. This finding further strengthens the concept presented throughout our analysis that financing of toll roads with only project generated toll revenue is costly.

The other interesting finding from this analysis is that the Hampton Roads Third Crossing – Segment 1 was the only project whose simulation mean represents a greater deficit than its baseline value. A review of the input parameter distributions suggests that the most likely reason for this higher mean is that the input distribution range of construction start year only contains values greater than the initial value of 2005.

Analysis results are more interesting for the project scenarios. Table 3.2-8 presents the simulated funding deficit measures for the combination projects. Again, positive values represent a funding deficit, while negative values signify a funding surplus. For Project Scenario 1, the simulation mean is a lower funding deficit than the baseline deficit. The likely outcome range (between one standard deviation less than the mean and one standard deviation greater than the mean) is a deficit from $42 Million to $1,833 Million. This range is larger than that for the Hampton Roads Third Crossing indicating that the "up-front" toll revenue from competing roadways contributes greater uncertainty to the financial feasibility assessment. While there are some observations of funding surplus, including the maximum observation of a surplus of $2,709 Million, the likely outcome range implies a deficit. These results lend support to the deterministic analysis that the project would experience a funding deficit.

Table 3.2-8 Project Scenario Risk Assessment

Project	Deficit					
	Baseline	Mean	Minimum Observation	Less One Std. Deviation	Plus One Std. Deviation	Maximum Observation
Project Scenario #1	1,153,900,000	937,616,814	4,096,268,214	1,832,746,950	42,486,678	(2,709,367,344)
Project Scenario #2	(144,954,174)	(291,683,437)	1,511,380,789	320,067,970	(903,434,843)	(2,695,160,975)

(1) Actual funding surplus reported here
(2) Deviation based on probable deficit range as compared to the calculated funding deficit
Note: all values are US dollars at year of accrual or expenditure

The outcome is different for Project Scenario 2. The deterministic financial analysis found that the toll revenue could fund the project. In fact, there would be a slight surplus on the order of $140 Million if all toll revenues were used. Again, the simulated mean indicates more capital funding compared to the deterministic analysis. The likely outcome range is from a funding deficit of $320 Million to a surplus of $903 Million. The simulation produced a minimum observation of a funding deficit of $1,511 Million and a maximum observation of a funding surplus of $2,695 Million. While the observations of a funding deficit may cause concern since the deterministic analysis found the project scenario could be funded, this should be considered in light of the fact that the 2 times bond/loan coverage ratio is required to protect against some of the less favorable combinations of inputs. All measures considered, the findings support the deterministic analysis that toll revenues collected from both the project and parallel projects would provide adequate funding.

Table 3.2-9 Funding Deficit Uncertainty

Project	Funding Deficit	Probable Deficit Range	Percent Deviation (2)
HRX, Segment I	1,750,677,800	1,668,286,400 to 1,841,708,300	-5% to +5%
HRX	3,815,567,900	3,429,170,500 to 3,971,288,500	-10% to +4%
Midtown & MLK	464,912,300	399,227,800 to 469,173,347	-14% to +1%
Route 460	902,375,200	691,823,400 to 972,789,400	-23% to +8%
Southeastern Parkway & Greenbelt	337,797,000	146,185,800 to 406,486,200	-57% to +20%
Project Scenario #1	1,153,900,000	42,486,700 to 1,823,747,000	-96% to 59%
Project Scenario #2 (1)	(144,954,200)	(903,434,800) to 320,068,000	-523% to 320%

(1) Actual funding surplus reported here

(2) Deviation based on probable deficit range as compared to the calculated funding deficit

Note: all values are US dollars at year of accrual or expenditure

Table 3.2-9 shows the probable variability in funding or financial feasibility based on a risk analysis performed for this study. A more detailed discussion of analysis methods, and assumptions can be found in Appendix "F". Since the Project Scenario #3 is very well funded, an analysis of financial risk was not necessary. Note that the reported "stand-alone" project funding deficits are all in the higher portion of the probable deficit range – indicating that assumptions used in this study associated with project financing and operation are conservative.

4 TRANSPORTATION SYSTEM IMPACTS

Feasibility of toll implementation for the purposes of funding infrastructure improvements also constitutes an examination of the effect of tolls on travel demand. It is important to gauge the utilization of the tolled roadways – how much of the roadway capacity is being used. While roadway improvements are designed to alleviate congestion; if tolls are too high, travel demand for these roadways will be relatively low leaving a significant amount of excess capacity. The improvements the tolls are financing will therefore not sufficiently benefit the traveling public. Tolls may also cause travelers to deviate from tolled routes creating congestion problems on roadways that are part of competing routes. These effects can impact existing transportation plans and planning activities associated with other projects.

Specifically, this study intended to examine changes in roadway level-of-service and travel patterns associated with implementation and tolling of projects subject to financial analysis in the previous section. However, it is important to remember that this study analyzed project financial feasibility under conditions that maximize revenue and in many instances this assumption resulted in toll values that significantly reduced travel demand on project roadways. Travel demand impacts are therefore exaggerated in this study; practically, toll values on projects would be less with an implemented project. The travel impact analysis in this study can provide, however, useful qualitative information regarding the impact of the tolls and projects on travel demand.

4.1 Regional Impacts

Project impact on the system can be gauged by its impact on regional congestion. Table 4.1-1 below compares various measures of performance for the projects with the no project" condition. Project impacts to the system are not relatively great and in general; do not vary significantly between projects. Some projects provide for more efficient movement throughout the region as compared to the "no project" condition, while others improve the level of regional congestion, albeit slightly.

The connection provided between I-564 and I-664 by Segment I of the Third Crossing project (HRX, Segment I) clearly provides more efficient movement – VMT and free-flow VHT decrease. However, system delay increases with this project, indicating that while some movements are more efficient, this change in travel pattern creates congestion in locations that more than offset the benefits of the project. Southeastern Parkway and Greenbelt performs the best of the "stand-alone" projects. This project increases the efficiency of movement throughout the region, while minimizing an offsetting increase in congestion.

The only projects to offer a clear advantage over the "no project" condition are Project Scenarios #1 and #2. These projects provide a reduction in VMT, VHT and delay; indicating more efficient movement throughout the region while reducing congestion by as much as 5%. As discussed in Section 4.3, these benefits are more likely due to a spatial re-orientation of demand than route choice behavior caused by tolling roadways over the harbor that are parallel to the project improvements.

Table 4.1-1 Year 2026 Average Daily Mobility and Congestion

Project	Supply (lane-miles)	Measures of Performance				Operation Speed	
		VMT	Free-Flow VHT	Congested VHT	Delay	Free Flow	Congested
No Project	6,172	41,277,785	932,667	1,663,871	731,204	44.3	24.8
HRX, Segment I	6,204	40,841,757	918,956	1,677,599	758,643	44.4	24.3
HRX	6,269	40,376,434	912,765	1,673,962	761,197	44.2	24.1
MT-MLK	6,173	40,774,596	917,567	1,685,957	768,390	44.4	24.2
SP&G	6,299	40,790,623	917,841	1,660,695	742,854	44.4	24.6
RT 460	6,285	41,218,876	926,793	1,708,188	781,395	44.5	24.1
Proj. Scenario #1	6,269	39,414,665	895,912	1,578,657	682,745	44.0	25.0
Proj. Scenario #2	6,210	40,182,888	909,447	1,609,712	700,265	44.2	25.0
Proj. Scenario #3	6,173	41,223,208	930,423	1,684,795	754,372	44.3	24.5

VMT – vehicle-miles traveled; absent VMT from roads not included in the travel model
VHT – vehicle-hours traveled; absent VHT from roads not included in the travel model
Delay – difference between congested and free-flow VHT, in vehicle-hours
Speeds - calculated as VHT/VMT

4.2 Level-of-Service (LOS) Impacts

This study identifies 78 individual roadway segments to be evaluated as part of the study. Of those segments, 17 are related solely to build scenarios, and the remaining 61 links are for existing roadway segments. The result of the demand forecasting effort was Year 2026 No Project, “Stand-Alone”, and Project Scenario traffic volume forecasts for these segments. The volumes were provided as vehicles per day and were directional. Volumes were provided for individual projects (original 61 segments plus those for each project), as well as predetermined project scenario combinations. Analysis methods and assumptions are detailed in Technical Appendix "G".

Table 4.2-1 Year 2026 PM Level-of-Service Impacts

Roadway Segment	No Project	HRX, Seq. I	HRX	MT-MLK	SP & G	Rt. 460	PS #1	PS #2	PS #3
Primary Impact Area									
Hampton Roads Bridge Tunnel	**F**	E	**F**	**F**	**F**	E	C	C	**F**
I-664, I-264 to Route 58	C	C	B	C	C	D	B	C	C
I-664, 23rd St to Aberdeen Rd	D	D	A	D	D	D	A	D	D
Midtown Tunnel	**F**	**F**	**F**	E	**F**	**F**	**F**	**F**	E
Route 460, I-664 to Route 58 Bypass	C	D	C	D	D	E	C	C	C
Oak Grove Conn. (from I-64 to Battlefield Blvd)	**F**	**F**	**F**	**F**	D	**F**	**F**	**F**	**F**
Proposed EW Connector, near I-664	-	C	A	-	-	-	-	-	-
Southeastern Parkway, Centreville Tpk to Indian River Rd	-	-	-	-	B	-	-	-	-
Southeastern Parkway, Oceana Blvd to I-264	-	-	-	-	A	-	-	-	-
Secondary Impact Area									
I-64, I-264 to Indian River Rd	D	D	D	D	D	D	D	D	D
Brambleton Ave, Colley Ave to Boush St	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**
Downtown Tunnel (I-264 from Portsmouth to I-464)	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	C
Jordan Bridge(Poindexter from Portsmouth to I-464)	E	E	E	E	E	E	E	E	**F**
I-64, Route 199 @ Lightfoot Rd. to Camp Peary Rd.	D	D	D	D	D	C	D	D	D
I-264, Witchduck Rd to Independence Blvd	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**
Dam Neck Road, Holland Rd to London Bridge Ext	**F**	**F**	**F**	**F**	D	E	**F**	**F**	**F**
Birdneck Rd., I-264 to VA Beach Blvd	E	E	E	E	E	E	E	E	E
Battlefield Blvd., Great Bridge Bypass to Volvo Pkwy	E	D	D	D	**F**	D	D	D	D
Kempsville Rd., Centreville Tpk to Indian River Rd	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**
Indian River Rd., I-64 to Centreville Tpk	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**
Oceana Blvd., Gen Booth Blvd. to Tomcat Blvd.	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**

Analyses were conducted for the PM peak hour for all freeway segments analyzed and both AM and PM peak hours for all other segment types. The freeway analysis were conducted utilizing the highest directional ADT volume forecasted and assuming a 100 percent directional split. Therefore, only one peak period was analyzed and was reported as the PM peak. Analysis results for all roadway segments can be found Technical Appendix "G". Table 4.2-1 shows PM peak LOS at several key roadways associated with the proposed projects and their impacts areas. As indicated in the Table, most LOS improvement is confined to the roadway segments that are being improved.

For some of the projects a very good level of service may be an indicator of capacity that is under utilized. The secondary impact areas are relatively unchanged. These patterns of LOS changes may be the consequence of using larger toll values that maximize revenues – travelers are unwilling to divert from congested roadways to use the tolled roadways.

4.3 Travel Pattern Impacts

This study includes an examination of travel pattern impacts for the components of both project packages using "reduced" tolls. A tabular summary of travel pattern changes can be found in Technical Appendix "H".

4.3.1 Methodology

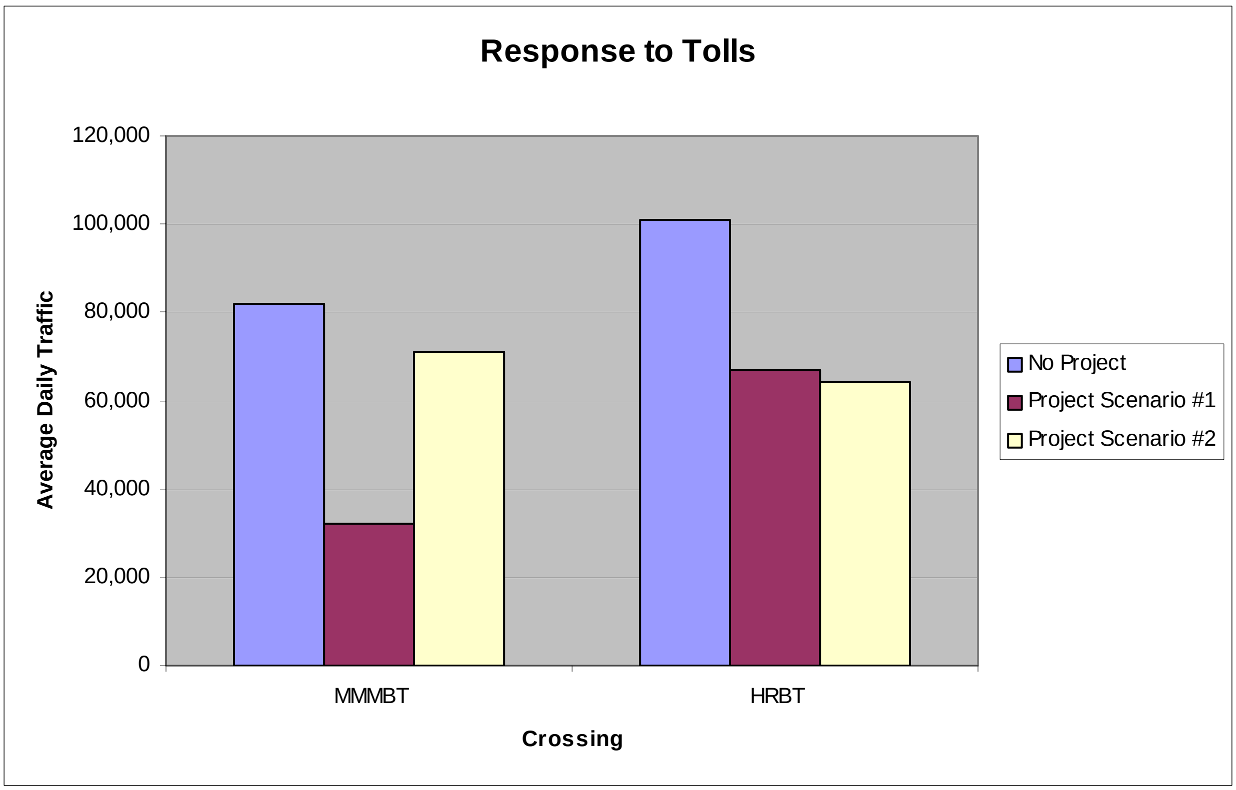
Trip origin-destination difference tables were produced for each stand-alone project and project combination, based on the "no-project" condition in Year 2026 between each of the 14 localities or jurisdictions in the Hampton Roads area. The trip distributions were provided as trips per day. A tabular comparison was made between the No Build scenario and an individual project scenario to show the percent change in trips between the localities and the change in the actual number of trip ends. Those changes over 10% and over 1000 trip changes per day were flagged as a major change in a user's decision to travel between the localities due the presence of a project. Graphics displaying travel pattern differences are located in Technical Appendix "H".

4.3.2 Analysis Results

The inclusion of tolled roadways will provide incentive for travelers to change destination locations in an attempt to minimize their generalized cost of travel (time and tolls). Although small travel pattern changes can be found throughout the region for all projects, a distinct pattern change associated with Project Scenarios #1 and #2 is evident – a re-orientation of travel demand away from travel between the York Peninsula and the Southern Hampton Roads region.

Figure 4.3-1 clearly shows a reduction in demand across the harbor. Under Project Scenario #1 the Monitor Merrimac Bridge Tunnel demand decreases by more than 50% while capacity on the roadway increases due to improvements. The Hampton Roads Bridge Tunnel behaves in a similar fashion for both of the project scenarios. Note that in project scenarios #1 and #2, the James River Bridge was tolled as well. This reduction in demand is not due to route diversion, but a re-orientation of demand – with tolls, travelers are finding it too expensive to cross the harbor and satisfy the purpose on their trip by going to destinations on either side of the harbor. Technical Appendix "G" provides more detailed information regarding re-orientation of demand.

Figure 4.3-1 Harbor Crossing Reductions



Technical Appendix

Appendix A

Letter from Phil Shucet; July 16, 2003

HRPDC
ORIG COPY

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, VIRGINIA 23219-2000

PHILIP A. SHUCET
COMMISSIONER

July 16, 2003

Mr. Louis R. Jones, Chairman
Metropolitan Planning Organization
c/o Mr. Arthur L. Collins, Executive Director/Secretary
Hampton Roads Planning District Commission
723 Woodlake Drive
Chesapeake, VA 23320

RE: Draft 2026 Hampton Roads Regional Transportation Plan

Dear Mr. Jones:

In a letter dated June 24, 2003 from Mr. Arthur Collins, the Department was asked to determine if the "Draft" 2026 Hampton Roads Regional Transportation Plan adopted by the MPO during its meeting on June 18, 2003 meets the fiscal constraint requirements of the Federal Transportation Planning regulations. Our review of the draft plan, along with the assumptions used to produce it, indicates that the plan, as currently configured, does not meet the requirements for fiscal constraint. Specifically, we find that the reliance on a regional gas tax is not a reasonably foreseeable source of revenue for the current plan update.

The Department previously furnished the MPO staff with estimates of funding revenues that, in our judgment, are reasonably expected to be available to carry out the 2026 Regional Transportation Plan. Also, in their letter dated April 8, 2003, the Federal Highway Administration (FHWA) offered guidance regarding funding sources for the current plan update.

We are committed to work with you to adopt a plan that meets fiscal constraint requirements. To that end, we are willing to consider tolls as a source of revenue for certain recommended improvements in the regional transportation plan. I suggest that the staffs of the MPO and VDOT work cooperatively to determine which recommended improvements might be appropriately considered for toll revenue funding.

Regarding the projects that might be funded with revenue sources other than tolls, we encourage you to display these in any fashion you wish, but outside the context of a fiscally constrained plan. While such projects are frequently described in an "illustrative" plan or "vision" plan, we invite you to select a name of your choice for these additional projects, as long as it is clear that they fall outside the confines of a fiscally constrained plan.

HRPDC
JUL 17 2003
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Mr. Louis R. Jones
July 16, 2003
Page Two

To meet the timeline required for the final adoption of a fiscally constrained long-range plan that meets the requirements for air conformity, we urge you to revise your draft plan as soon as possible.

I want to assure you that VDOT stands ready to assist you in any way possible as you complete the planning process.

Sincerely,

Philip A. Shucet
Commissioner

cc: Honorable Whittington Clement
Mr. Roberto Fonseca-Martinez
Mr. Arthur Collins
Mr. George Wallace
Mr. James Spore
Ms. Susan E. Schruth, FTA
Ms. Karen J. Rae, VDRPT
Commonwealth Transportation Board Members

Appendix B

Letter from FHWA; April 8, 2003

U. S. Department of Transportation

Federal Highway Administration

Virginia Division
(804) 775-3320

400 N. 8th Street, Rm. 750
P. O. Box 10249
Richmond, VA 23240

April 8, 2003

Mr. Louis R. Jones, Chairman
c/o Mr. Arthur L. Collins, Executive Director
Hampton Roads Planning District Commission
723 Woodlake Drive
Chesapeake, Virginia 23320

Dear Mr. Jones:

In response to a request from Mr. Dwight Farmer of your staff, the following information clarifies our position on the financial constraint of the Hampton Roads 2026 Long Range Plan. We have significant concerns about the various funding scenarios being presented to the MPO for consideration as part of the financially constrained plan. As you are aware, 23 CFR 450.322(b)(11) requires that all long-range transportation plans include a financial plan that "demonstrates consistency of proposed transportation investments with already available and projected sources of revenue." This requirement is particularly critical in air quality non-attainment and maintenance areas, such as Hampton Roads, in order to ensure implementation of projects and programs to help attain air quality compliance goals. The information which has been discussed thus far at the MPO includes combinations of tolls and taxes to provide additional revenues. I would like to address each of these strategies in detail.

Tolls - In the presentation to the MPO on March 19, 2003, your staff proposed tolling a number of facilities in the region. Of those proposed, I am concerned that you have specifically included I-64 on the Peninsula. As discussed in detail in our letter of December 6, 2002, Section 129(a) of Title 23, United States Code prescribes where tolls can be implemented on the Interstate system. Tolls are not permitted on the Interstate system, except where there is substantial reconstruction or rehabilitation of a bridge or tunnel facility. I-64 on the Peninsula would not qualify for this exemption. The letter also discussed Section 1216(b) of the Transportation Equity Act for the 21st Century which established the Interstate Toll Pilot Program. Under this program, a State may collect tolls on an Interstate highway for the purpose of reconstructing or rehabilitating an Interstate highway that could not otherwise be adequately maintained or functionally improved without the collection of tolls. The pilot program provided for a maximum of three projects nationwide and they must be in different states. The Commonwealth of Virginia has submitted an application under this pilot program for the I-81 corridor. This application has received conditional approval by FHWA. Therefore, it is not reasonable to assume that tolls can be implemented on I-64 on the Peninsula. Additionally, in our letter of December 6, 2002, we also stated that "any inclusion of toll revenues in the financial plan for the 2026 Hampton Roads Long Range Transportation Plan would need to have written concurrence from the Virginia Department of Transportation." I would expect to see this written concurrence well in advance of submittal of the plan document for a conformity determination.

Taxes - The MPO is also considering funding scenarios that include the imposition of regionally specific taxes on sales and/or gasoline. It is our understanding that under current State law, changes to sales or gasoline taxes (including regionally specific taxes) must be approved by the Virginia General Assembly. A regional sales tax proposal was approved by the Virginia General Assembly in the 2002 session and subsequently failed in a referendum was held in November 2002. Given that neither the local jurisdiction nor the MPO have the legal authority to impose such taxes, and that previous attempts to impose such taxes have failed, we do not believe it is reasonable to assume this revenue as an assumption of the financial plan for the 2026 plan. However, if there is documentation of pending action by the Virginia General Assembly to provide for these revenues or to provide such authority to the MPO we will reconsider the acceptability of new taxes as part of the financially constrained plan.

If the MPO chooses to present alternative revenue scenarios as part of an effort to fund the unmet transportation needs in the region, it is appropriate to include these scenarios in a vision plan or list unfunded projects or portions of projects in the plan as illustrative projects. The MPO would only be able to move forward into the TIP those projects which are included in the constrained portion of the plan and only those projects would be considered in the conformity analysis. However, should additional funding become available, the MPO could move projects or phases of projects into the constrained plan by vote of the MPO and a subsequent conformity finding (if the projects are not neutral).

I hope this clarifies our concerns regarding the proposed alternative revenue sources. Our office must make a determination on whether or not the plan is financially constrained when the plan is submitted for a conformity finding. In addition, we must make a finding that the plan meets all Federal laws and regulations when approving the TIP. Unless our concerns are satisfactorily addressed, we will be unable to make either finding on the Hampton Roads 2026 Long Range Transportation Plan and Federal funds would not be available for projects within the Hampton Roads MPO area. As always, my staff is available to assist you with this or any other planning related issue. If you have further questions on this issue or others related to the planning process, please contact Jennifer DeBruhl of my staff at (804) 775-3335.

Sincerely,

Roberto Fonseca-Martinez
Division Administrator

Attachments

cc: Philip A. Shucet
Jane Wimbush

Appendix C

Travel Demand Forecasting – State of Practice Review

Hampton Roads Regional Travel Demand Model

Discussions of Potential Travel Model Modifications

Travel Model Modifications Implemented For This Study

State-of-Practice Review

The Transportation Planning community has a long history of developing and sharing travel demand forecasting model practices and improvements. This Study uses information and experience, confirmed and supplemented by a literature review, to assess the suitability of the regional model system and possible model enhancements for this project.

Automobile Demand Elasticities

The most important model function for this project is the capability to accurately predict the level of route diversion caused by tolls. This topic has been the subject of numerous studies, including three studies that each reviewed and compiled the findings of a number of independent projects. These studies imply a full range of elasticities from -0.03 to -0.5. Study elasticities are shown in Table C-1.

Table C-1 Demand Elasticity Studies

Author	Elasticity Values	Basis
Goodwin[14]	-0.16 to -0.5	Fuel Price
Oum[15]	-0.13 to -0.45	Automobile Usage
Burris[16]	-0.03 to -0.35	Tolls

While it is useful to consider these elasticity values to evaluate the travel model's performance, there should be caution in doing so. Since traveler's behavior to tolls are not expected to exhibit constant demand elasticity[17], the elasticity value just represents the elasticity at the point of measurement. Further, each of the three compilations include independent projects with their own observations of elasticity values, which could be based upon differing methodologies,[18] and each compilation could use different approaches for determining each range.[19] There is also the complication as to

14 Goodwin, P. B., "A Review of New Demand Elasticities with Special Reference to Short and Long Run Effects of Price Changes", *Journal of Transport Economics and Policy*, Vol. XXVI, No. 2, May 1992.

15 Oum, Tae Hoon, W. G. Waters II, and Jong-Say Yong, "Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates", *Journal of Transport Economics and Policy*, Vol. XXVI, No. 2, May 1992.

16 Burris, M. W., "The Toll-Price Component of Travel Demand Elasticity", *International Journal of Transport Economics*, Vol. XXX, No. 1, February 2003.

17 In reality, individuals' values of time are not constant – people are more willing to pay when saving a large amount of time.

18 For instance, point elasticity is computed differently than arc elasticity.

19 For example, Goodwin considered elasticity of automobile travel with respect to fuel, while Burris

which demand is being measured – the true (OD) demand or the demand exhibited for the facility. Elasticities measuring this latter type of demand are also dependent on other factors that influence the route demand, particularly the network topology, in addition to the monetary fee. These factors cause some degree of incompatibility when comparing demand elasticities with each other and with the demand model results. This Study examines elasticity values calculated from the model results for a series of toll sensitivity experiments, and consider them in light of reference elasticity values found in literature. These reference values are not presented to be the criteria for preparing the demand forecasting model for the project, but rather as a backdrop against which to consider the values predicted by the model.

Value of Time and Vehicle Operating Cost

For highway assignment, the Hampton Roads travel demand model uses a generalized travel cost function to convert all elements of travel disutility into a common unit (cents). To do so, the function relies upon two factors – the value of time (VOT) and vehicle operating cost (VOC). The VOT is used to convert travel time into a cost unit. The version of the demand model run by the HRPDC currently uses a VOT of $16.64 / hour in year 2000 dollars. A general guideline is that the VOT is somewhere in the range of one-quarter to one-half of the average wage rate. According to the U.S. Census Bureau, the median annual household income was $42,472 in 2000 for the Norfolk-Virginia Beach-Newport News MSA.[20] Following the procedure specified by the U.S. Department of Transportation, this converts to an hourly wage rate of $21.24.[21] The general guideline would then suggest a VOT between $5.31 and $10.62 / hour.

Thus, the state of practice suggests that VOT used by the Hampton Roads model is too high relative to the wage rate. Recall that use of high values of time was one of the common features of projects whose actual traffic and revenue failed to meet projections. It is important to note that this relatively high VOT has not caused problems in previous model uses because those studies were not focused on toll usage. Rather, the VOT was used to convert travel time to cost in order to balance it against the travel distance as converted to cents by the VOC. However, moving forward with this project, it is essential that the model's VOT be revised to values that are more applicable in a toll

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considers demand elasticity with respect to tolls.

20 Virginia's Electronic Labor Market Access, http://www.velma.vec.state.va.us/vecweb/poptot/390515720.pdf, last viewed July 2, 2004.

21 U.S. Department of Transportation, Office of the Secretary of Transportation, "Departmental Guidance for the Valuation of Travel Time in Economic Analysis", found at http://ostpxweb.dot.gov/policy/Data/VOT97guid.pdf, July 2, 2004. This document describes calculation of the hourly wage rate as "median annual household income, as reported by the Bureau of the Census, divided by 2,000 hours." The document also discusses how to determine the VOT from this hourly wage rate by applying factors. However, it is not recommend using the values implied by these factors as a basis for critiquing the model's value because of the fundamental difference in the purpose of VOT calculation – the "Guidelines" are for benefit evaluation, while our project will use VOT as a behavioral predictor.

road context.

Another important VOT consideration is the value associated with commercial vehicle traffic. Based on compiled findings of a number of truck value-of-time studies it is found that an average truck VOT is $25.55; in addition a stated-preference survey identified a truck VOT of $49.42.[22] These values are both higher than the $18.10 / hour provided by the U.S. DOT in its recent update to the Value of Time guidelines,[23] and all of these values are higher than the rate effectively applied to trucks in the current model.[24] The next section discusses the impact of this difference in VOT.

As mentioned earlier, the operating cost factor is the other parameter needed by the generalized travel cost function, and it is used to convert travel distance into a monetary cost. The model system currently uses a value of $0.10 / mile.[25] This factor has also been a topic of discussion in the literature. The Victorian Transport Policy Institute references a VOC value of $0.12 / mile and a range from $0.115 / mile to $0.148/ mile, the former from an internal study and the latter from the American Automobile Association.[26] In light of this, the value used in the model, $0.10 / mile, appears very reasonable.

Traffic Impact of Toll Collection

Historically, introduction of new toll roads have been opposed not only due to the tolls charged, but also for the delays that may be caused by collection of these tolls. With the advancement of ITS, the latter is becoming less of an objection, and would most certainly not be a credible objection by the planned opening of any of the proposed toll facilities examined in this study. Open Road Tolling (ORT) is a technology that uses transponders mounted in vehicles to collect tolls as vehicles pass the collection point at full speed. This technology has already been installed in such places as Florida[27], as well as Georgia and Oklahoma.[28] At these facilities, ORT has been shown to cause little to no impact on the speeds and capacities of the facilities. It is envisioned that all of

22 Smalkoski, Brian and David Levinson, "Value of Time for Commercial Vehicle Operators in Minnesota" Transportation Research Board International Symposium on Road Pricing, Key Biscayne, Florida. November 20-22 2003.

23 U.S. Department of Transportation, Office of the Secretary of Transportation, "Revised Departmental Guidance for the Valuation of Travel Time in Economic Analysis" distributed by Memorandum February 2003, Tables 1 and 3. Found at http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf, last checked July 2, 2004.

24 Since trucks are not separated from other trips, they use the same $16.64 / hour VOT.

25 To support model validation, this value has been cut in half for certain link classes when applied in the generalized travel cost equation.

26 Victorian Transport Policy Institute, "Vehicle Costs", *Online Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications,* (http://www.vtpi.org/tca/tca0501.pdf), 2003.

27 Pustelnyk, Steve. "Express to success: Electronic toll collection plaza design allows for high-speed, open-road tolling", *Roads & Bridges*, September 2000.

28 Majdi, Saïd, "Open Road Tolling", *ITS American Newsletter*, Vol. 12, No. 5, May 2002.

the candidate projects would be equipped with this advanced tolling technology, and thus there is no reason to include a toll collection delay in the network representation of these facilities.

Hampton Roads Regional Travel Demand Model

This section discusses the model system and its application for this study. The Hampton Roads model is a traditional four-step travel demand model, and was translated to the TP+ development platform in its most recent model update. The model includes approximately 1,000 traffic analysis zones, three trip purposes (Home Based Work, Home Based Other, and Non-Home Based), HOV / SOV distinction, and a full daily traffic assignment. The model system has undergone extensive validation and has served as the basis for numerous regional studies.

Ideally, in the study of travel demand and revenue potential of new toll road facilities, one would develop more detailed tools that utilize additional data to address the assumptions inherent in the regional model that are critical for accurately predicting traffic and revenue. However, in the context of this study as the first step of analyzing toll road feasibility, a modified version of the current regional transportation model is the primary basis for analysis of tolled roadways.

A number of challenges present themselves when using this regional model in a toll road study:

- *Limited Toll Road Observations* - The model system was developed and calibrated with data from only one toll facility in the study area – the Chesapeake Expressway. This limited the calibration and validation of the model with respect to tolls. It should be noted that the Chesapeake Expressway is often used by vacationers traveling to the Outer Banks of North Carolina, as opposed to commuters who will comprise the primary target market for the proposed toll facilities associated with this study. These two travel market segments typically exhibit different behavior, particularly with respect to value-of-time.
- *Uniform Value of Time (VOT)* - Another limitation of the model system is that the generalized travel cost function used for converting all elements of travel disutility into common units is the same regardless of trip purpose. This implies that all travelers value their time the same, regardless of the trip purpose.
- *Daily Highway Assignment* – Typically, it is during the morning and evening peak periods that toll facilities offer the largest travel timesavings and are most attractive, but daily assignment blends the peak and off-peak periods together.
- *No explicit Truck Traffic* - Truck traffic is not explicitly separated in the model, but rather is blended with passenger vehicles. Trucks are presumably one of the intended target segments of the proposed toll facilities, and not explicitly differentiating them may limit the model system’s ability to forecast traffic and

revenue.

This study needs to adapt the travel model in a way that best addresses these challenges while maintaining the overall integrity of the model. Like other regional models, the Hampton Roads travel demand model has been used for several other studies, and thus wholesale changes that substantially deviate from the fundamental travel model characteristics as used for those other studies should only be pursued under extreme circumstances. Instead, this Study recommends a series of adaptations that maintain the overall integrity of the model. This Study considered several such adaptations, ultimately implementing those most effective with respect to modeling tolled roadways within this study's constraints. This implementation benefited from a state-of-practice review and a series of experiments performed to assess the performance of the model system and our adaptations in various tolling situations, ultimately using these findings to offer a set of recommended model adaptations.

Discussion of Potential Travel Model Modifications

Building on the discussion of the challenges of using the regional model for this project and the state of practice review of conventional toll modeling parameters, this section identifies potential model modifications needed for this study, and discusses the complexity of such adaptations and their likely impact on model performance.

Development of Route Diversion Model

Often, toll behavior has been modeled using route diversion models, which determine the probabilities of travelers choosing to use each alternative route. These types of models consider the attributes of each route, such as travel time, travel distance, and toll levels, to estimate the utility a traveler would experience from using that route, and then compute the probabilities of route usage based upon those utilities. The probabilities of route usage are then used to establish the shares of trips using each facility, and this whole process is performed outside or as a component of the highway assignment process in order to more directly address the use of the toll facility. These types of models offer advantages over the current model approach, which relies on highway assignment to account for each facility's attributes, and ultimately usage. However, developing such a model for this study would require substantial effort and new data collection, and is outside the scope of this study.

Highway Demand Assignment by Trip Purpose

Individuals' travel behavior varies depending on the purpose of their trip. The Hampton Roads travel model differentiates travel demand into the following purposes: Home-Based Work, Home-Based Other, and Non-Home Based. Travelers making Home-Based Work trips are likely to exhibit different behavior than for Home-Based Other trips, particularly with respect to their value of time. Despite the categorization of demand by trip purpose, in the travel model, trips are aggregated together for highway assignment. A better representation of travel behavior would be to modify highway assignment to disaggregate demand by trip purpose.[29] Implementation of this change also requires an adjustment to the end of mode choice processing so that a trip table for each purpose is produced for highway assignment. The highway assignment module in turn needs to be adjusted to accommodate the additional trip purpose trip tables and to include a separate generalized travel cost specification for each trip purpose. This modification is practical to implement for this study. Based on experiments conducted for this study, this modification did not adversely affect estimated roadway patronage compared to observations in the base year.

Trip Purpose-specific Value of Time (VOT)

In coordination with the development of trip purpose-specific highway assignment, a separate generalized travel cost specification for each purpose can reflect trip purpose-specific VOT. The enhancement to perform trip purpose-specific assignment mechanically enables the treatment of each trip purpose differently and makes practical the consideration of different VOTs to each trip purpose in this study. There are many possible VOTs that can be used, and in this study different values were tested, while assessing their impacts on the performance of the travel model.

Update Vehicle Operating Cost Parameter

In addition to VOT, the vehicle operating cost (VOC) is another term in the computation of generalized travel cost. As the discussion in the literature review section noted, the model system currently uses a VOC of $0.10 / mile, while the literature recommends values of roughly $0.12 / mile. The current value seems appropriate when considering that the current model specification applies to all trips, and the average vehicle occupancy associated with those trips.[30] The use of separate generalized travel cost specifications by trip purpose also accommodates different VOCs, by trip type.[31.] This study evaluates the impact of this change and its impact on the performance of the travel model.

Sensitivity to Value-Pricing

Through the Value Pricing Pilot Program, FHWA is promoting the use of market-based approaches for alleviating congestion problems. Particularly relevant to this study, is the program element that allows for tolling on existing interstate highways, provided that variable tolls are used. Variable tolls are tolls that change depending on the level of congestion, such that higher tolls are charged during more congested periods.

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29 Note that by considering each trip purpose separately, variations of the generalized travel cost function can be applied by trip purpose. This does not mean that each trip purpose will be assigned independently, since the effects of the combined trip purpose link volumes will be used to determine the effective travel speeds within the equilibrium assignment.

30 The $0.12 / mile roughly equals the $0.10 / mile for vehicle occupancy of ~ 1.2.

31 Notably SOV, HOV, and external trips.

The most sophisticated variable tolling initiatives adjust the toll in real time according to the current traffic conditions, while a more simplistic approach varies tolls by time of day based upon the average level of congestion during that time period. It is ideal to vary tolls values depending on the level of congestion, but given the available forecasting tool, the daily travel demand model, there is need to develop a more basic approach.

The value pricing methodology could be based on two premises:

1. A higher toll during the peak period, and
2. Travel conditions are more congested during the peak period.

A simplifying assumption is to treat all HBW and HOV trips as peak period trips. This assumption allows us to apply a different toll to these trips. Thus, the first premise of the methodology entails applying a *peak premium rate* to the tolls charged to HBW and HOV trips through the generalized travel cost equation in the daily travel model. This peak premium rate can be set as part of the process that determines the toll rate that maximizes revenue.

The second premise can be addressed in two stages. First, use a *peak volume factor* in the calculation of link travel times to determine a *travel time adjustment factor*. Next, apply this travel time adjustment factor in the generalized travel cost expression to represent the more congested travel times experienced in the peak period. As this process would suggest, implementation would require the determination of the peak volume factor in advance.

Generalized Travel Cost in Trip Distribution

In addition to accounting for travelers' route choice behavior associated with tolled roadways, it is also important to consider the impact of tolls on trip distribution.[32] The trip distribution step in the regional travel model determines travel demand orientation, geographically, between different locations in the Hampton Roads region. In the Hampton Roads model and most travel models, this determination is dependent on a measure of "spatial separation" between locations in the region. If the separation between two locations in the region is large, demand between the locations will be relatively low and vice versa. In the current regional travel model, travel time between the various locations in the region defines this separation – thus trip distribution is not sensitive to the impact of tolls on demand orientation. It is conceivable that with the introduction of tolls to one or more of the harbor crossings, that some commuters will find the trip too expensive to accommodate on a daily basis and will "re-orient" their travel such that they do not need to cross the harbor – preferring to live and work on the Peninsula or Southside areas of the region.

It is important to account for this demand re-orientation behavior in the regional travel model if the study is to credibly account for the affects of tolls associated with estimated demand/revenue and transportation system impacts. Accounting for this travel behavior

32 Especially when tolled roadways are major facilities such as interstates and principal aterials

requires generalizing the definition of spatial separation used by the trip distribution model to include travel costs other than time – explicitly tolls. The need for this modification has to be balanced with its practicality. Changes in this definition of separation or generalized cost used by the trip distribution model could theoretically change average regional trip lengths and change estimated demand orientation to the extent that a comprehensive model recalibration is necessary. A comprehensive model re-calibration is outside the scope of this study.

Speed Feedback

Another consideration associated with implementation of generalized costs in trip distribution is the consistency of speeds or travel times used by trip distribution and trip assignment in the regional model. The current regional model uses speeds in trip distribution and assignment that were manually adjusted to be consistent in the base year. In this type of model there is no guarantee that speeds will be consistent in scenarios other than those associated with the base year land use and infrastructure description. This limitation of the regional model was deemed as not adequate in the context of this study for estimating tolled roadway demand. Without an automated way to adjust speeds used in trip distribution, the travel model cannot account for a possible re-orientation of demand arising from changes in the travel time component of generalized cost.[33] Although a significant undertaking, this Study implements an auto-convergent feedback loop between trip distribution and trip assignment. This feedback loop updates travel speeds using the "method of successive averages" and uses a convergence criteria sanctioned by Federal guidelines.[34]

Several experiments were conducted for this study with variations in the definition for generalized cost. These experiments examined the response of the trip distribution model to tolls and evaluated impacts on average trip lengths and demand orientation compared to those observed in the base year. All but one formulation of generalized cost was shown to require a comprehensive model re-calibration. This formulation calculates generalized cost in units of time, including time and toll value as its components and is sensitive to changes in VOT by trip purpose.[35] This formulation was used in the study.

Heavy Vehicles

As noted earlier, the Hampton Roads model does not explicitly consider truck trips. This poses another challenge for accurately predicting tolled roadway demand and

33 Demand re-orientation due to the presence of tolls (as previously discussed) can reduce congestion on some roadways, thus increasing travel speed; reducing the travel time component of generalized cost and in effect countering, in some cases, the demand re-orientation effect that tolls have.

34 Ninety-five percent of network links vary less than five percent in assigned volume from the previous feedback iteration

35 Albeit outside the study area, this formulation of generalized cost was shown to improve the model's estimation of travel behavior associated with Coleman Bridge crossings

revenue in light of significant heavy vehicle activity. This region includes a substantial amount of heavy vehicle trips due to the presence of local ports. The ports of Norfolk and Newport News are among the Top 50 U.S. ports in terms of total tonnage[36] and Top 25 in terms of containerized cargo.[37]

Heavy vehicles are implicitly included in the travel demand model by their inclusion in the data used for developing non home-based travel, the external trip table, and the traffic counts used for calibration and validation.[38] Ideally, heavy vehicles would be explicitly represented, but the most common methods for doing so – various surveys of truck drivers and truck movements – are beyond the scope and timeframe of this project. Alternately, a procedure similar to the one detailed in the Federal Highway Administration's *Quick Response Freight Manual* could be used, but this procedure would still require significant effort to estimate freight trip tables and extensive model recalibration, and likely fail to accurately represent freight traffic associated with the ports.[39]

When considering the current model specification in terms of its impact on toll modeling; the model treats heavy trucks like any other vehicle - heavy vehicles will be charged the same toll rate and will use the same value of time as other non home-based vehicles. This effective lower toll rate will have the mixed effect on predicted revenues: it will understate the revenue of each effective heavy vehicle, but overstate the number of those vehicles that would use the toll facility.[40] As previously noted, heavy vehicle VOTs found in the literature are substantially higher than the VOT for work trips.[41] Since in reality, this higher VOT will be used to consider the travel time savings from the toll facility against the larger truck toll rate, it is not clear what the net impact would be on the number of truck trips that use the facility, let alone the resulting toll revenue calculated with the higher toll rate. In light of these circumstances, the associated risk of increasing model uncertainty and the scope of this study, there is no compelling reason to dedicate substantial effort to altering the model to account for heavy vehicles.

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36 U.S. Army Corp of Engineers, http://www.iwr.usasce.army.mil/ndc/fatcard/fc02/fcvesage.htm, last checked June 21, 2004.

37 Port Import Export Reporting Series (PIERS), posted at http://www.marad.dot.gov/Marad_Statistics/C-Port-Tot.html, last checked on July 2, 2004. Note that containerized cargo generally includes substantial intermodal connections with trucks.

38 But note that they were considered without any passenger car equivalency factors.

39 Cambridge Systematics, Comsis Corporation, and University of Wisconsin-Milwaukee, *Quick Response Freight Manual,* prepared for Federal Highway Administration, September 1996. In case of the Hampton Roads model where employment data is only maintained at the retail and non-retail levels, this manual recommends applying standard rates to estimate employment by needed categories. This approach would under-represent transportation employment and ultimately trips associated with the ports.

40 The number of vehicles would be overstated since the decision in the model is based on a lower toll than what would be charged for trucks.

41 As noted in the State of Practice Review section, a range of truck VOTs were found from $18.10 to $49.42 per hour, compared to the current model's VOT of $16.64, which was also noted to be high.

Travel Model Modifications Implemented For This Study

State of the practice guidance suggests there are model modifications appropriate for this study. The model's performance with the following enhancements has been examined and deemed acceptable:

1. Modification of Trip Distribution – requires generalizing the definition of spatial separation used by the trip distribution model to include tolls so that model is sensitive to the impact of tolls on demand orientation. This new definition calculates cost in units of time, including time and toll value as its components and is sensitive to changes in VOT by trip purpose.
2. Modification of Highway Assignment – change highway trip assignment so that each of the following trip purposes and types is treated separately and sensitive to changes in VOT by trip purpose: Home-Based Work, Home-Based Other, Non Home-Based, HOV, and external trips.
3. Modify the values-of-time and vehicle-operating costs used in estimating generalized cost associated with trip distribution and highway trip assignment in accordance with values shown in Table 2.1-1. Values-of-time are used in distribution and assignment; vehicle-operating costs are used only in assignment.
4. Add a *peak period volume factor*, in the calculation of link travel times and apply this factor in the generalized travel cost expression to represent the more congested travel times experienced in the peak period.
5. Implement an auto-convergent feedback loop between trip distribution and trip assignment.

Table C-2 Trip Distribution/Assignment Parameters

Trip Purpose	Value-of-Time(1)	Vehicle-Operating Cost(2)
Home-Based Work	$7.43	$0.12
Home-Based Other	$3.72	$0.10
Non-Home Based	$7.43	$0.10
HOV	$14.87	$0.06
External	$7.43	$0.10

(1) Year 2000 US dollars per hour
(2) Year2000 US dollars per mile

Appendix D

Derivation of Peak Period Volume Factor

Calculation of Full Revenue Schedules

Derivation of Revenue Annualization Factors

Derivation of Peak Period Volume Factor

Diurnal travel data collected for the development of the regional model was used to derive the peak period volume factor. The percentage of HBW trips that occur during the peak periods, which were identified as the consecutive three AM and three PM hours with the highest total trips (AM peak from 7am – 10am and PM peak from 3pm – 6pm[42]), constituted 57.9% of total HBW trips. The peak period factor, the ratio of the percentage of average hourly daily trips occurring in a peak period hour against the percentage of daily trips in an average hour, was calculated as follows:

- Peak hour share = (4,912 peak period trips) / (11,000 daily trips) / 6 hours = 7.44% of trips
- Average hour share= 100% / 24 hours = 4.17% of trips
- Peak period factor = 7.44% / 4.17% = 1.79

Finally, the peak period factor was adjusted to account for the HBW trips that occur outside the peak periods. This adjusted peak volume factor was calculated as follows:

Adjusted Peak Volume Factor = 1+ (1.79 – 1) * 57.9% = 1.46

Thus, this Study uses a peak volume factor of 1.46 in our value pricing methodology. Adjusting the travel times for the non-HBW trips was also considered, however the distribution of these trips is nearly uniform throughout the day, implying an "off-peak" factor of 1.0.

Calculation of Full Revenue Schedules

The regional travel demand model has data available to produce Year 2000, 2017 and 2026 demand estimates and thus revenue. For the stand-alone projects, the model years 2017 and 2026 serve as reference points to calculate yearly revenue growth using linear interpolation, where:

$$\text{Growth}_{2017\text{-}2026} = (\text{Revenue}_{2026} - \text{Revenue}_{2017}) / 9 \text{ years}$$

Yearly revenue growth is in units of Year 2000 US dollars. Creation of a schedule of revenues requires subtracting or adding the growth increment to Year 2017 revenue – subtracting for years prior to 2017 and adding for years after.

Combination projects us the same method, except that an additional reference point for Year 2000 provides a way to estimate toll revenues collected on the unimproved facilities during project construction. Year 2000 demand estimates do not include any project improvements, but Year 2017 and 2026 demand estimates include project improvements. The additional reference point provides two growth increments:

42 Based on diurnal travel data from "Hampton Roads Crossing Study-Compendium of Technical Traffic Information", July 1996

$$Growth_{2000\text{-}2017} = (Revenue_{2017} – Revenue_{2000}) / 17 \text{ years}$$

$$Growth_{2017\text{-}2026} = (Revenue_{2026} – Revenue_{2017}) / 9 \text{ years}$$

Creation of a schedule of revenues for combination projects proceeds in a way similar to the stand-alone projects. First, subtract $Growth_{2000\text{-}2017}$ from Year 2017 revenue for years prior to the opening year. Then subtract $Growth_{2017\text{-}2026}$ from Year 2017 revenue for year prior to 2017, but after opening. Next, add $Growth_{2017\text{-}2026}$ to Year 2017 revenue for years 2018 through 2025 and to model year 2026 revenue for years 2027 and greater.

Derivation of Revenue Annualization Factors

The travel demand model forecasts daily travel demand and revenue, but financial analysis requires annual toll revenue. An annualization factor converts average weekday revenue (based on the travel model) to annual revenue; accounting for the expected level of weekend traffic. Since the level of weekend traffic varies by project, projects are divided into two groups according to their weekend traffic level to develop and apply a separate factor for each group.

Group 1 assumes that each weekend day earns half as much revenue as the model output for an average weekday, and thus:

For each week, 5 weekdays + (2 weekend days * 1/2 weekday/weekend day) =

6 weekdays

Annualization rate = 312.86 weekdays/year =

(6 weekdays/7days) * 365 days/year

This group includes the Midtown Tunnel / MLK Freeway Extension project, and Southeastern Parkway and Dominion Boulevard segments of Southeastern Parkway and Greenbelt Project.

Group 2 assumes that each weekend day earns two-thirds as much revenue as model output for an average weekday, and thus:

For each week, 5 weekdays + (2 weekend days * 2/3 weekday/weekend day) =

6 1/3 weekdays

Annualization rate = 330.24 weekdays/year =

[(6 1/3 weekdays) / 7 days] * 365 days/year

This group includes the Hampton Roads Third Crossing Projects (both full and Segment 1), and the Oak Grove segment of Southeastern Parkway and Greenbelt Project.

The Southeastern Parkway and Greenbelt Project includes project segments from each group, and therefore developed a composite annualization rate for the portion of model year 2026 revenue attributable to each group. The Southeastern Parkway (from I-264 to Rte 168) and Dominion Boulevard (from GW Highway to Oak Grove Connector) segments account for 63.2% of project revenue, while the Oak Grove Connector segment constitutes 36.8% of project revenue. Thus, for the project:

Annualization rate = 319.25 weekdays/year =

[(312.86 weekdays/year * 63.2%) + (330.24 weekdays/year* 36.8%)].

Appendix E

Legal, Credit, and Debt Structure Framework

Plan of Finance and Financial Model Overview

Legal, Credit and Debt Structure Framework

Rating agency guidance and industry best practices incorporate financial provisions that provide minimum legal operating parameters to limit the possibility of default and bankruptcy. Typical fiscal requirements for a toll road enterprise with outstanding bonds include:

- A toll revenue covenant with minimum required debt service coverage levels
- Minimum required funding levels of various debt service and operating reserve funds
- Minimum financial tests for the issuance of additional bonds
- An order of priority for the payment of operations, debt service and other reserves and/or returns provided by the flow of funds
- Responsibility to maintain the toll road facility at certain minimum standards
- Authority to replace an operator under certain circumstances
- Requirements to provide certain capital improvements at various stages of the project's life cycle
- Requirements to produce periodic financial statements and a budget
- Requirements to re-engage the traffic consultant if financial performance does not meet covenant levels.

Legal Framework

Toll road securitization should allow for a stable and predictable legal framework. The main points are summarized below. An important aspect of the legal framework includes the independent authority of toll road enterprises to raise tolls when revenues fall below certain levels. This authority provides toll roads with the ability to recover losses caused by inflationary pressures, under-usage or project cost overruns. Rating agencies will examine the ability to enforce contracts between the public and private sector, as well as the clear distinction of the roles and responsibilities each recognize. In the case of the public sector this may include the responsibilities between various governmental levels. Public–Private partnerships should be structured to provide protections to bondholders using the following:

- Documentation detailing the ownership structure of the project, as well as financial information of private sponsors.
- Concession agreements
- Bankruptcy and enforceability options
- Authorizing legislation governing the project
- Ability to fund improvements, increase toll charges and any required regulatory approval

- Construction liquidated damages for late completion

Toll Covenants

Typical toll roads provide a pledge to levy tolls at a ratio of net revenues (revenues less operating and maintenance expenses) to debt service of 1.25 times. Covenants above 1.50 times are generally not looked upon favorably – depending on the sensitivity of motorists to toll increases. The ability of a toll road to implement toll increases in a timely manner also plays a large role in credit ratings and market acceptance. Legal provisions concerning the ability to raise toll charges should render the toll road autonomous and describe the timely ability to increase tolls. As will be noted later in this report, there is a material difference in legal toll covenants and actual operating forecasts for debt service coverage that rating agencies demand for an investment grade credit rating for a start-up toll facility.

Additional Bonds Test

Additional Bonds Tests (ABT) that include only historical revenues tend to receive higher credit ratings than tests allowing for projected toll revenues. However, it is common for toll road projects to allow for such projected toll revenue tests. For start-up toll facility financings and smaller but expanding systems where there are no other non-toll revenues available, it is typically a necessity that a projected ABT is needed for any completion financing or major system expansion. In cases where projected revenues are used rating agencies shift their focus to management and the conservativeness used in calculating projections. The additional bonds test should closely approximate the ratio used in the toll covenant.

Debt Service Reserve Fund

A dedicated debt service reserve fund (DSRF) in order to fund any deficiency in debt service requirements is necessary for toll road financing. It is often legally allowable to substitute an insurance surety policy for a cash funded DSRF, but this option is likely not available for a start-up toll financing for reasons of credit concerns.

Credit Framework

The initial analysis of the economics used to forecast a toll roads' sustainability and ability to meet bond holders' requirements will be at the forefront of rating agency evaluations. Credit market participants will closely scrutinize all numerical projections used to develop operating pro forma analyses. Ultimately, the credit rating received is composed of several underlying projections, including: project construction, operating and maintenance expenses, and traffic and revenue forecasts. There inevitably is uncertainty in such estimates and therefore significant perceived risk by rating agencies. For an entity undertaking a new toll facility without existing toll system or outside revenue support, the emphasis on these projections is strong.

Construction Estimates

Construction risk can be a major obstacle to a new start-up in obtaining an investment-grade rating. Project construction costs should be estimated conservatively for start-up toll roads. Primary concerns include the timely completion of construction as well as completion within budget. Start-up toll roads should detail the protection to bondholders in the event of project overruns or delays through the availability of developer contributions, contractor equity, public grants, or other revenue sources that limit the amount of debt necessary for construction costs. The following concerns related to project construction should be addressed at the outset of a start-up toll road:

- Right-of-Way (ROW) and Environmental Permitting. Start-up toll roads that are planned for construction in developed areas have a greater risk of possible ROW acquisition overruns. ROW acquisition can be one of the largest cost components for new roads, and the majority of required ROW is preferably acquired prior to construction. However, in projects where this is not possible, the risk can be mitigated through phased construction offering links to connector roads at each segment. Required compensation for environmental impacts should also be included in project costs.

- Design complexity and technology. Complicated interchanges, road designs, or tunnels, if applicable, put bondholders at risk throughout the construction phase of the project. Electronic toll collection (ETC) systems that have not been tested will put bondholders at risk after construction has been completed. Though not required, the review of construction design by an independent engineer may bolster credit ratings by verifying that projected costs have been properly estimated.

- Contractor experience and contract terms. Rating agencies tend to offer higher credit ratings to start-up toll roads being constructed by established contractors. The demonstrated ability of a contractor to complete similar projects within budget and on time is a valued aspect of the evaluation of construction risk. Contractors should possess the financial strength to perform the construction requirements and financial obligations specified in the contract. Different contract terms may offer more protection against cost overruns. Depending on the complexity of the construction a fixed price or turnkey contract may be desired. Other protections, such as early completion incentives, liquidated damage provisions and construction insurance are looked upon favorably by rating agencies.

- Cash reserves. The availability of cash reserves and lines of credit can ultimately be the safeguard against cost overruns or delays in construction. These reserves should be sufficient to cover interest payments for the period of delay or fund cost overruns to ensure timely project completion.

Operations and Maintenance Estimates

Operating risks associated with the proper operation and maintenance of toll roads can also impact bondholder security. The uninterrupted operation and revenue generation of a toll road is of vital importance to long-term project viability. Normal operations and maintenance (O&M) expenses typically range from 10% to 25% of toll revenues. Aggressive marketing and use of ETC can significantly reduce O&M expenses. The proper maintenance of the asset is a primary concern to rating agencies. In the cases of inexperienced toll road operators or toll roads owned by financial investors, O&M can be contracted to experienced operators. The ability to outsource O&M expenses to a capable and experienced third-party operator can be viewed as a positive financial factor.

The importance of initial O&M estimates become greater as traffic grows and roads mature. Operating expenses tend to grow throughout the life of the road. Despite the small share of revenues attributed to O&M costs, its importance should not be underestimated as it relates to the projects total financial margin. Capital renewal and replacement costs should be carefully noted, as regular capital expenditures are necessary to maintain the peak revenue generating capability of the toll road. In addition, while maintenance expenditures are relatively predictable, the replacement cycle of ETC systems may be more difficult; therefore adequate provisions should be made for them. Scheduled capital and maintenance needs tend to be peak and valley, and should be smoothed out through appropriate capital reserve funds so that debt financing is not required.

Traffic Forecasts

The project financing of toll roads makes traffic studies a centerpiece of credit analysis. The strength and timing of a project's debt service capabilities are largely determined by the future cash flows received from anticipated traffic patterns. The need for reliable traffic studies is heightened in start-up toll roads due to the typical use of ascending debt service structures. Reliance is often placed on medium to long-term traffic growth; highlighting the need for conservatively accurate traffic forecasting. Standard and Poor's rating agency has experienced "that optimism is a consistent trend in toll road forecasting." Many times traffic forecasting errors were caused by inaccurate assumptions made when entering key inputs. Typical causes to unreliable toll road traffic studies include:

- Overestimating users' willingness to pay toll charges and toll increases
- Future economic downturns
- Development of land use along the toll road corridor, including future development being slower or less than anticipated.
- Improper estimation of time-savings derived by commuters through the use of toll roads, as well as overlooking future improvements to competing toll-free routes.
- Overestimating commercial (truck) routes

- Lower than anticipated off-peak/weekend traffic

The economic viability of start-up toll roads can be measured with the existing traffic base (or predicted market share), predictable traffic growth and affordable toll rates ensuring adequate cash flow to meet debt service and other requirements. Dependency on future development cause traffic studies to become speculative because of the uncertainty associated with the pace of development. Market share of a start-up toll road can be derived from the existing traffic base and the existence of toll-free roads and congestion. Frequency and purpose of travel also factor into traffic forecasting and can be derived from existing roads. The willingness of patrons to pay toll charges and continue use despite toll increases will ultimately depend on the time-savings associated with the toll road as well as the economic means of potential patrons.

Perhaps the most critical element to a reliable traffic forecast is the “ramp-up” period, “the process of attracting customers onto the newly built road and the development of user acceptance”[43]. An optimistic ramp-up period may prove to be too large an obstacle for a toll road to recover from. A large margin of error in the ramp-up period calculates into a deficiency in later year revenues. It is for that reason that the ramp-up period should be conservatively forecasted. Ramp-up periods tend to be shorter in projects that relieve existing traffic congestion and longer in projects that depend on future development. The overall feasibility of a toll road and the debt service coverage maintained throughout the ramp-up period can be protected through the back-loading of bond principal and slow ascending debt service. This debt structure helps to ensure that debt service obligations can be met in cases where actual revenues do not meet projections. However, this debt structure also increases the overall debt service costs significantly, and therefore diminishes the ability of a toll enterprise to accumulate capital reserves or afford additional debt. The structuring of debt service will be covered later in this report.

Ramp-up forecasting risks are mitigated in situations where the expected primary users of the project are already using other toll roads, traffic congestion or few competitive non-toll roads exist. Other factors that lessen the pressure of the ramp-up period are the strategic and well-designed placement of connections to other roads as the project is developed as well as public awareness campaigns. Ultimately, the inability to accurately predict ramp-up should be balanced through conservative assumptions.

Traffic studies should account for the economic perspective of a particular corridor. Factors used in this estimation should include: population growth, residential, commercial, and industrial development, economic competitiveness and interrelationships with adjacent economic regions. An in-depth analysis of potential future land-use patterns through information gathered from planning organizations, state and local officials, and private-land developers can be conservatively incorporated into traffic models to supplement traffic forecasts. Additional diligence in modeling traffic

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patterns – such as the creation of peak and off-peak modeling – reduces the risk stemming from the oversimplification of assumptions, as well as providing for greater precision in complex projects. Once base case forecasts have been established sensitivity analyses that calculate the tolerable levels of differences in assumptions will result in higher credit ratings. Major rating agencies will test base case forecasts independently, but view sensitivity tests created ahead of time as positive rating factors. Typically, rating agencies test for delayed revenues and decreases in revenues ranging from 25%-50%.

Debt Structure Framework

Debt structuring for project operating revenue bonds, in particular toll revenue bonds is often far different from typical tax-backed governmental debt structures. The schedule of principal and interest payments will reflect the degree of senior and subordinate debt, some level of capitalized interest during and after the expected construction period, and an expected ramp-up period for projected toll revenues.

Ascending Debt Service

The "back-loading" of principal is often necessary to enhance the operating success of a start-up toll road project. As start-up toll road revenues increase over time larger payments of principal and interest can be made. The back loading of principal has two effects on toll road projects: While back loading of debt results in higher interest rates and lower ratings, it preserves financial flexibility during the initial years of operations. "A typical back-loaded debt service schedule has developed in the U.S. for start-up toll road projects that require substantial new development to support sizable annual debt service payments."[44]

Capital Appreciation and Current Interest Bonds

Typical start-up toll road revenue financings are structured with a mix of capital appreciation bonds and current interest bonds. Capital Appreciation Bonds (CAB), will be issued during the construction and ramp-up periods of the project. CABs will enable the debt structure to be largely back-loaded, ensuring that no payments on the bonds will be made until operating revenues have stabilized. Current Interest Bonds (CIB) will be used to level the debt service structure and help to enhance credit quality. CIBs have a lower interest cost than CABs, so their use will lower total borrowing costs. CIBs will also be structured to be heavily back-loaded, but will provide for semi-annual interest payments beginning upon their issuance. The mix of CABs and CIBs are subject to the various operating parameters of the toll facility being financing as well as credit market conditions.

Capitalized Interest

Capitalized interest is also somewhat unique to project operating revenue bonds.

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Basically, bond proceeds are used to pay interest on the bonds in the early years. The amount of capitalized interest is sized to cover construction and typically twelve months beyond the construction completion date to guard against a delay in project opening to revenue generating traffic. This study assumes a bond funded capitalized interest fund will be incorporated in any start-up toll road financing. Debt amortization is deferred until after the capitalized interest period, at a minimum.

Debt Service Reserve Fund (DSRF)

A debt service reserve fund will be included at the onset of any toll road bond financing. Typically DSRFs cover one-year of debt service requirements. Typical funding of the DSRF occurs in three ways: (1) Bond proceeds, (2) Incrementally from bond proceeds and system revenues over a pre-determined period (traditionally five years), (3) Surety bond or letter of credit. The amount of a DSRF that can be funded from bond proceeds is limited by Treasury regulations. In order to meet credit market requirements, especially for toll road financings with ascending annual debt service, the trust indenture might incorporate a requirement to fund up the DSRF from available excess toll revenues over time.

Debt Service Coverage

Typically, projected debt service coverage (as opposed to the toll rate covenant and additional bonds test legal requirements) on start-up toll roads should reach a minimum level of 2.0 times for senior lien debt and 1.5 times for junior lien debt. This study assumes debt service coverage on HRPDC's toll road bonds of 2.0 times projected net operating revenues (total toll revenues less operating and maintenance expenses) and that some form of subordinate debt – preferably governmental loans or developer/contractor debt – making the effective coverage "1.25". While this may imply that revenues are left un-leveraged for construction, typically the coverage cash flow is needed to fund debt and operating reserves, extra-ordinary maintenance and replacement capital needs.

Governmental Assistance

The inclusion of equity from government funds reduces the need to issue senior project debt. Obviously, Federal or state grants are the most effective form of government participation. Federal funding amounts are typically used for the initial design and engineering costs and initial construction costs. State and/or local dedicated non-toll revenues can also be extremely helpful in supporting any toll revenue debt financing plans. Many toll road financings also have pledged gas taxes, sales tax, registration fees, or some similar transportation related revenue that is not dependent upon toll facility traffic and operation.

Other governmental assistance can come in the form of subordinate debt or loans, environmental mitigation banks, and non-competition clauses. This Study will concentrate on governmental loan programs. Below are three examples of loan programs that would be applicable to this study.

Transportation Infrastructure and Finance Innovation Act (TIFIA)

The TIFIA program provides secured loans, loan guarantees, and lines of credit from the Federal government for surface transportation infrastructure projects of national or regional significance. Eligibility extends to any highway, transit or railroad project in excess of $50 million, and can include intermodal facilities, border crossing infrastructure, expansion of multi-State highway trade corridors, and other investments with regional and national benefits. The program leverages Federal funds by requiring private sector participation in project financing.

A total of $780 million of contract authority is provided to pay the estimated cost to the Federal government of providing credit assistance under TIFIA. The contract authority can support annual credit assistance of up to $2.6 billion. Repayment of the Federal credit instruments is required (on a subordinated basis) to come from tolls, user fees, or other dedicated revenue sources.

In order to be eligible for the program projects must meet certain requirements for funding, specifically:

- Any highway or transit project eligible for funding under 23 U.S.C. or 49 U.S.C. 53 is eligible for TIFIA. Other eligible projects may include international bridges; intercity rail or bus projects; and freight rail projects. SAFETEA expands the eligibility of freight rail projects to be consistent with the proposed Freight Transportation Gateways program (section 1205).
- Projects must meet the applicable Federal grant funding rules, including planning, right-of-way acquisition, competitive procurement and Buy America requirements. Total eligible project costs must be at least $50 million. SAFETEA reduces this threshold from the current level of $100 million. Projects that principally involve the installation of an intelligent transportation system (ITS) must meet a $30 million threshold.

The Secretary selects projects to receive TIFIA credit assistance through a competitive application process administered by the TIFIA Joint Program Office. TIFIA projects are selected on the basis of eight statutory criteria, including national or regional significance; creditworthiness; private participation; accelerating project schedules; the use of new technologies; the use of budget authority; environmental stewardship; and the reduction of Federal grant assistance.

The TIFIA credit instrument may be subordinate to other senior debt obligations on the project. Senior obligations must meet several requirements:

- The senior debt must receive an investment grade rating.
- The senior debt must be secured by the same revenue stream as the TIFIA credit instrument.
- The total amount of the senior project obligations must equal or exceed the total amount of the TIFIA instrument. This requirement is added under SAFETEA.

The amount of the Federal loan or line of credit may not exceed 33 percent of the anticipated eligible project costs.

VDOT Toll Facilities Revolving Account

The Toll Facilities Revolving Account ("TFRA") is a separate subaccount within the Transportation Trust Fund. TFRA was created under §33.1-23.03:4 of the Code of Virginia to pay or finance all or a part of toll facilities constructed under the provisions of Title 33.1. The 1986 Special Session II of the General Assembly, the Commission on Transportation in the 21st Century, recommended the establishment of TFRA for a method to finance or refinance existing and potential toll facilities. On July 1, 1987, TFRA was created and in 1995 the statute was amended to clarify the intent that the funds allocated from TFRA for a planned or operating toll facility shall be considered as an advance of funding for which TFRA shall be reimbursed. TFRA is funded through interest earnings on the Construction Funds and Highway Maintenance and Operating Funds of various projects throughout the state.

Toll projects seeking to qualify for funding through TFRA must first be included as part of the Commonwealth Transportation Board's (CTB) Six-Year Improvement Program. The Six-Year Improvement Program allocates funds for transportation projects proposed for construction, development or study in the next six fiscal years and is updated annually. After a project is included in the Six-Year Improvement Program the CTB prioritizes projects based on several criteria, including: the ability of a project to reimburse the toll facilities revolving account in the future – "Funds allocated from the TFRA shall be considered as an advance of funding for which the Account shall be reimbursed," a reasonable term on the loan, the ability to repay the Board it's portion of any costs incurred in accordance with a comprehensive agreement with respect to a transportation facility, and that the operator's return on its investment is limited to a reasonable rate.

State Infrastructure Bank

Virginia's State Infrastructure Bank (SIB) was authorized in September 1996 with the signing of a Cooperative Agreement between the Federal Highway Administration (FHWA) and the Virginia Department of Transportation (VDOT) under provisions of Virginia's Public-Private Transportation Act (PPTA) of 1995, Section 350 of the National Highway System (NHS) Designation Act of 1995 and Section 33.1-23.03:4 of the Code of Virginia.

The purpose of the SIB was to make alternative loan-based financing available to eligible public and private entities for transportation projects. Virginia's SIB was capitalized with $18 million of federal funds and $4.5 million of state matching funds provided from the Toll Facilities Revolving Account in March 1998. The funds are designated as revolving funds with repayments to be used to make loans for additional projects.

Flow of Funds

A well-defined flow of funds, or priority of toll revenues, within the enterprise structure is important for toll road bond issuance and financial stability. A dedicated bond proceeds account(s) held by the bond trustee and an appropriate cash flow priority are viewed as necessary tools to ensure that the toll road cash flow is directed in accordance with rating requirements and prudent financial management. Debt service payments are typically subordinated to operational and routine maintenance expenses. Cash flow is then usually applied in the order of interest and principal on bonds, and next filling any DSRF reserve requirements. Excess cash flow is then applied to any subordinate debt and various reserve requirements.

It is common for tax-backed revenue bond flow of funds to allow revenues after debt service and DSRF to “escape” the trust indenture and be used for any lawful purpose. For toll road enterprise financings, however, it is important to have a “closed” flow if funds where all toll revenues stay in the toll enterprise.

Plan of Finance and Financial Model Overview

This study uses a proprietary toll facility financing model. This model is integrated, combining Microsoft excel software and DBC Finance (“DBC”) software. The toll revenue model incorporates data input, including construction schedules and revenue sources from Microsoft EXCEL and operates simultaneously with DBC, the industry standard for municipal bond structuring, to structure bond issuances.

Using toll revenues for each stand-alone project, and defined project combination scenarios and packages; operations expenses were subtracted from toll revenues resulting in a net revenue pledge used as security for toll revenue bonds. As additional (non-tax) funding sources were identified for specific projects, they were applied to either increase bonding capacity, offset construction requirements or both.

This study assumes the following priority of funds for the toll-financing model:

- Pledged Revenues is equal to Gross Revenues less O&M expenses, i.e. net operating revenues. Gross Revenues include the interest earnings from the O&M Reserve Fund, Renewal & Replacement Fund, and General Reserve Fund.
- Pledged Revenues cover Net Debt Service, which is gross annual debt service less capitalized interest and less interest earnings on the debt service accounts.
- DSRF is next in line from Pledged Revenues. The DSRF deposit that can be legally funded from bond proceeds will be limited the maximum annual debt service (“MADS”) for a five-year period. Given the ascending debt service structure, the DSRF requirement will not be fully funded from bond proceeds and will require future deposit from toll revenues. The DSRF is restricted in use to the payment of bond debt service.
- The next priority is an operations and maintenance reserve fund (“O&M Reserve Fund”) to be funded from excess toll revenues at two months worth of O&M expenditures with the initial fund up from the first available revenues. The O&M Reserve Fund should come behind the DSRF fund in the flow of funds. O&M

Reserve Fund balances would be restricted in use to O&M expenditures in the event annual cash flow was insufficient for such purposes.

- A renewal & replacement fund ("R&R Fund") should be maintained at an adequate balance from toll revenues. The R&R Fund should come behind the DSRF and the O&M Reserve in the flow of funds priority. R&R Fund balances would be restricted in use to non-recurring maintenance expenditures as well as O&M expenditures and debt service on the bonds in the event annual cash flow was insufficient for such purposes.
- A loan repayment account should be established next within the flow of funds for the repayment of government loans and developer/contractor notes. Interest on unpaid balances would accrue at 3% per annum compounded semi-annually beginning when surplus toll revenues exist. The loan repayments come after the R&R Fund.
- Finally, excess revenues flow to a general reserve fund.

The net revenue pledge, additional funding sources and construction requirements were entered into DBC to structure bond financing according to an array of inputs detailed below.

Composition

Toll revenue bonds were structured using a combination of CIBs and CABs. Because CABs do not pay interest periodically, they are a common feature of start-up toll facility financings. For the same reason, CABs also have a higher cost of borrowing associated with them and as such are only issued as necessary to complete a financing.

Interest Rates

Current Municipal Market interest rates were assumed for bond transactions. A credit spread was applied to interest rates in order to simulate actual market pricing. It is expected that stand-alone toll revenue bonds to be credit rated "BBB" at best and therefore such bonds would carry a higher interest rate.

Debt Service Structure

Toll revenue bonds were structured for ascending debt service, i.e. debt service increases annually as toll revenues increase, maintaining a 2.0x coverage ratio. Toll revenue bonds can be structured for ascending debt service because of the ability to raise toll rates in the future if revenues are lower than projected.

Coverage

Toll revenue bonds were structured to maintain 2.0 times projected coverage (net toll revenues divided by debt service) over ascending annual debt service, as recommended by rating agencies in order to achieve investment grade. Subordinate toll revenue bonds and loans were structured to maintain 1.25 times projected coverage. This coverage is reasonable for any project or combination scenario when combined with innovative financing techniques and PPTA.

Capitalized Interest

Due to the delay in revenues and upfront construction costs associated with start-up toll facilities, many are required to capitalize interest payments until the toll facility is opened. It is further recommended that interest be capitalized through the first six to twelve months of construction to provide for potential construction delays or a longer than anticipated ramp-up period.

Other Costs

Cost of Issuance, Underwriters Discount and Bond Insurance were applied to each bond issue. Cost of Issuance was assumed to be $250,000 per transaction and bond insurance was assumed to be equal to 40 basis points of total debt service. Underwriter's Discount is calculated on a per bond basis (discount/$1,000) and differs by both the type of bond and the security backing. $6.50 and $7.25 were applied to toll revenue CIBs and toll revenue CABs, respectively. These costs are normal costs associated with the issuance of municipal bonds, and closely parallel the costs of similar transactions.

Based on experience with start-up toll facility financings the overall plan of finance was structured in accordance with market standards. Given a market acceptable traffic & revenue report and consulting engineer's report, all of the financing assumptions utilized to structure the plan of finance are acceptable to rating agencies and credit enhancers and are sufficient to achieve investment grade credit ratings of "BBB" or better. DBC was incorporated to structure bond financings according to construction requirements and available revenue sources. The financial model calculates long-term debt service schedules, applicable debt service coverage requirements, and excess revenues remaining after debt service payment.

Two separate financing structures were provided to the Metropolitan Planning Organization in September and October 2004, each with an alternate plan of finance including the attributes explained previously. The initial analysis anticipated utilizing toll revenue bonds to finance stand-alone projects. The second analysis incorporated tolling existing roadways in order to generate upfront financing sources, thus limiting the additional cost of capitalizing interest. Table 3.1-1 below compares the different structures.

Plans of finance were structured differently due to the introduction of additional and alternative revenue sources, above new toll revenues, as the study progressed. For instance, the first analysis attempted to finance stand-alone projects solely using toll revenues produced by those facilities. As such, interest was capitalized through the construction phase. A greater amount of CABs were also issued in order to maximize financing proceeds. In comparison, the second analysis, which included revenues produced by tolling existing facilities, did not require capitalized interest or the issuance of as many CABs. Each plan of finance was structured to achieve investment grade credit ratings.

Table E-1 Debt Financing Structures – Toll Revenue Bonds

	Stand Alone Toll Facilities	**Combination Toll Facilities**
CIBS	yes	Yes
CABS	yes	Yes
Coverage	2.00	1.75
Structure	Ascending	Ascending
Capitaled Interest	Thru Construction Period	N/A
Bond Insurance	40 bps	40 bps
Underwriter's Discount	$7.50/$6.25 ($/1,000)	$7.50/$6.25 ($/1,000)
Costs of Issuance	$250,000	$250,000
Multiple Issuance	No	Yes

Capitaled interest - interest that is included "upfront" in the financing, or capitalized, therefore not paid from annual revenues (prepaid through bond proceeds)
Underwriter's Discount – this is the bankers per bond fee associated with selling the bonds
Costs of Issuance – normal costs associated with selling bonds (fees for attorney, financial advisor, rating agencies)

Appendix F

Risk Analysis – Methods and Parameters

Simple sensitivity analysis and Monte Carlo simulation was used to gauge financial risk associated with deterministic estimates of financial feasibility. This appendix describes the methodology employed, the input parameters subject to risk, and distributions of values used for those parameters.

Sensitivity testing is the most common method employed. In sensitivity testing, an input or combination of inputs to the project financial model are varied and the resulting impact on the finances is measured. In this way, that impact can be isolated as a way to consider the project under different conditions, based on input parameters that would most likely vary..

Monte Carlo simulation is another method for assessing the project risk. Monte Carlo simulation is a powerful tool used for measuring and preparing for uncertainty by allowing us to consider many possible outcomes rather than a single solution, and it provides for the presentation of results as a range of outcomes rather than as a single result. Applying Monte Carlo simulation to our financial analysis requires input of a distribution of likely values rather than use a single input value for various financial elements. Monte Carlos simulation then generates a number of scenarios that are a combination of randomly selected values for each input (based upon the input distribution).

Monte Carlo Simulation Model

We also executed Monte Carlo simulation to perform a comprehensive risk analysis. Other sections of the report describe the creation of the revenue schedule and the development of the financial model. To perform Monte Carlo simulation, we needed to integrate these elements together so that the impact of changes to common inputs can be measured together.

As discussed in Appendix “E”, DBC Finance is used to calculate the bonding capacity used in the financial model. This analysis used the “Crystal Ball” add-in to Microsoft EXCEL to execute Monte Carlo simulation, and needed the entire financial model, including the bonding capacity, native to EXCEL. This required emulating, in EXCEL the logic embedded in DBC Finance. Since some of this logic could not be exactly replicated in EXCEL, some simplifications to the EXCEL financial model were necessary, with the objective of closely replicating the values determined by the DBC-based financial model. A pivot methodology that applied the risk assessment from the EXCEL-based model onto the DBC-based financial model results was used to account for discrepancies in the two models. The result was an EXCEL model that combined the basic revenue and cost information so that each change in input values would be reflected in the revenue schedule, cost schedule, and ultimately financial feasibility determination.

The assessment measures derived from the risk analysis are the mean, mean plus one standard deviation, mean less one standard deviation, maximum, and minimum funding deficit.

Project Specific Parameters

The first step of the analysis was to select those input parameters to the financial model subject to risk and specify their distribution of likely values. The following input parameters were identified that could have a significant impact on project financial feasibility:

- Toll Revenue – daily revenue forecast generated by the travel demand model
- Annualization Factor – the factor used to convert from daily to yearly revenue
- Ramp-up Factor – the factor used to discount (amplify) the toll revenue immediately after project opening
- Inflation Rate – the rate used to inflate construction costs and toll revenue
- Operations and Maintenance Percentage – percentage of toll revenue used to cover operations and maintenance
- Construction Start Year – year of construction beginning
- Interest Rate – the interest rate applied to bonds and loans
- Preliminary Design and Engineering Costs – percentage of total project cost to be accrued during Preliminary Design and Engineering
- Construction Cost – total project construction cost
- Construction Period Length – duration of project construction

Some of these input parameters are fundamental to the financial model and the assumptions made regarding the value of each could significantly impact the financial analysis. A risk analysis was completed for each project or scenario by specifying a frequency distribution of input parameter values for the Monte Carlo simulation; customized for each project or scenario. Input parameter distributions were assumed to be triangular with the initial value (that used during the deterministic analysis) as the most frequent. Described below describe the upper and lower parameter limits used for each of the individual risk analyses.

Hampton Roads Third Crossing - Segment 1

Table F-1 shows the input distribution limits of the parameters specified for the Hampton Roads Third Crossing Segment 1 (HRX S1). Toll revenue varies from 70% to 160% of the travel demand model's forecast. The distance between the upper limit and initial value is greater than that of the lower limit and initial value. These limits reflect an opinion that despite efforts to adapt the Hampton Roads regional travel demand model

As the discussion of the revenue schedule development describes (Chapter 2), the ramp-up factor of -30% for the HRX S1 actually represents a ramp-down period (hence the negative ramp-up value) as travelers change their driving patterns in response to the new tolls. This parameter has distribution limits from double the initial value to no impact.

The inflation rate is another parameter specified to have a greater share of the distribution on the lower side of the initial value. The lower limit is based on the *Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004*, which contains the forecasts from many leading economists for a variety of measures including the Consumer Price Index. This value is substantially lower than the initial value, representing the current low interest rate situation. The upper range is not extended much higher than the initial value because the inflation rate to is not expected to increase that much.

Based on the beliefs of the HRPDC, the upper limit of the Operations & Maintenance factor was restrained from increasing much over the initial value, as they believed that costs much greater than the initial 30% would be covered as a VDOT expense.

At the time of the analysis (Fall 2004) it was highly unlikely that construction would begin sooner than the scheduled start year of 2005 – thus, only the upper limit was adjusted by 1 year to 2006.

The remaining adjustments follow a symmetric approach. The interest rate distribution limits were set at +/- 25% of the initial value. Similarly, the Preliminary Design & Engineering cost limits were set at +/-1% of the initial value. Construction cost input distribution limits are +/-10% of the initial value, and the construction period length distribution limits are +/- 1 year from the initial value.

Hampton Roads Third Crossing

Table F-2 contains the parameter distribution limits for the full Hampton Roads Third Crossing. These limits are very similar to the ones used for Segment 1 alone. The most significant difference is in the construction start year, where the distribution limits are specified as up and down a year from the initial value. Other differences are in the construction cost and construction length, but we apply the same logic to calculate the parameter distribution limits as with Segment 1.

Midtown Tunnel and MLK Freeway Extension

Table F-3 contains the parameter distribution limits for the Midtown Tunnel and MLK Freeway Extension project. Most logic used to assign the parameter distribution limits are the same as for the Hampton Roads Third Crossing projects. The differences in the initial values of the annualization factor and ramp-up factors are discussed in Section 2.2. Due to the differences in the initial values, the limits also vary.

One aspect of this project that is different from the previous projects is that the revenue is scheduled to begin mid-year. The financial risk model is developed to use full year data, and this analysis implemented rounding logic in order to maintain a full year start.

Thus, this feature caused the revenue to begin a half-year later for this project.

US Route 460

Table F-4 contains the parameter distribution limits for the US Route 460. Most logic used to assign the distribution limits are the same as for the previous projects. The limits relating to the annualization and ramp-up factors are different for the reasons described in Section 2.2. As previously described, the financial risk model uses full years and had the effect of shifting the used construction start year forward half a year.

Southeastern Parkway and Greenbelt

Table F-5 shows the input distribution limits used in the Monte Carlos simulation analysis of the Southeastern Parkway and Greenbelt project. Again, many of the distributions are the same as those described for previous projects, with the differences stemming from the initial construction values (cost and length) and the values used to create the revenue schedule. Beyond these differences, we apply the same logic to create the distributions.

Project Scenario 1

Project Scenario 1 is an version of the Hampton Roads Third Crossing project, and thus the Monte Carlo simulation input distributions, which are displayed in Table F-6, are virtually the same. The one difference is the initial value for the Operation and Maintenance Percentage. Project Scenario analysis assumed that only 15% of revenues would be used towards covering toll operations and administration, and that toll revenue would no longer be used towards covering facility maintenance. Thus, distribution limits of 10% to 20% were used for this parameter.

Project Scenario 2

Table F-6 presents the parameter distribution limits for Project Scenario 2. Many of these values are identical to those used to analyze Project Scenario 1. The only difference is the initial value, and thus limits for the construction cost parameter.

Project Scenario 3

The deterministic feasibility analysis of Project Scenario 3 determined that only 37% of the toll revenue was necessary to finance the project. Since the project is funded with such abundance, an analysis of financial risk was not necessary.

Table F-1 Input Parameter Distributions – HRX, Segment 1

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	330	275	350	Little upper movement possibilities
Ramp-up Factor	-30%	-60%	0%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004
Operations & Maintenance Percentage	30%	15%	35%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2005	2005	2006	Up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim. Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	1,795,000,000	1,615,500,000	1,974,500,000	Down / up 10%
Construction Length	3	2	4	Down / up 1 year

Table F- 2 Input Parameter Distributions - Hampton Roads Third Crossing

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue Factor	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	330	275	350	Little upper movement possibilities
Ramp-up Factor	-30%	-60%	0%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004;
Operations & Maintenance Percentage	30%	15%	35%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2006	2005	2007	Down / up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	2,700,000,000	2,430,000,000	2,970,000,000	Down / up 10%
Construction Length	11	8	14	Down / up 25%

Table F-3 Input Parameter Distributions - Midtown Tunnel and MLK Freeway

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue Factor	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	313	270	335	Little upper movement possibilities
Year 1 Ramp-up Factor	21.3%	0%	42.6%	Double to no impact
Year 2 Ramp-up Factor	14.2%	0%	28.5%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004;
Operations & Maintenance Factor	30%	15%	35%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2009	2008	2010	Down / up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	421,000,000	378,900,000	463,100,000	Down / up 10%
Construction Length	7	5	8	Down / up 25%

Table F-4 Input Parameter Distributions - US Route 460

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue Factor	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	313	270	335	Little upper movement possibilities
Year 1 Ramp-up Factor	85.7%	0%	171.4%	Double to no impact
Year 2 Ramp-up Factor	57.2%	0%	114.4%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004;
Operations & Maintenance Percentage	30%	15%	35%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2010	2009	2011	Down / up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	894,000,000	804,600,000	983,400,000	Down / up 10%
Construction Length	8	6	10	Down / up 25%

Table F-5 Input Parameter Distributions - Southeastern Parkway and Greenbelt

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue Factor	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	319	270	340	Little upper movement possibilities
Year 1 Ramp-up Factor	85.7%	0%	171.4%	Double to no impact
Year 2 Ramp-up Factor	57.2%	0%	114.4%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004;
Operations & Maintenance Percentage	30%	15%	35%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2010	2009	2011	Down / up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	657,314,964	591,583,467	723,046,460	Down / up 10%
Construction Length	8	6	9	Down / up 25%

Table F-6 Input Parameter Distributions - Project Scenario 1

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue Factor	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	330	275	350	Little upper movement possibilities
Ramp-up Factor	-30%	-60%	0%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004;
Operations & Maintenance Percentage	15%	10%	20%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2006	2005	2007	Down / up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	2,700,000,000	2,430,000,000	2,970,000,000	Down / up 10%
Construction Length	11	8	14	Down / up 25%

Table F-7 Input Parameter Distributions - Project Scenario 2

Parameter	Initial Value	Lower Limit	Upper Limit	Logic
Toll Revenue Factor	1.0	0.7	1.6	Despite model adaptations, most likely estimating low.
Annualization Factor	330	275	350	Little upper movement possibilities
Ramp-up Factor	-30%	-60%	0%	Double to no impact
Inflation Rate	3.89%	2.5	4.5	Lower limit from Blue Chip Economic Indicators Long-Range CPI forecast Mar 10, 2004;
Operations & Maintenance Factor	15%	10%	20%	Restrain upper limit since assume VDOT would pick up higher costs
Construction Start Year	2006	2005	2007	Down / up 1 year
Interest Rate	5.85%	4.39%	7.31%	Down / up 25%
Prelim Design & Engineering	3%	2%	4%	Down / up 1%-pt
Construction Cost	1,200,000,000	1,080,000,000	1,320,000,000	Down / up 10%
Construction Length	11	8	14	Down / up 25%

Appendix G

Traffic Impacts – Level-of-Service

Note: This appendix is oversized (11”x17”) and bound under separate cover.

Appendix H

Traffic Impacts – Travel Patterns

Note: This appendix is oversized (11”x17”) and bound under separate cover.

Appendix I

Index of Acronyms and Abbreviations

ABT – Additional Bonds Test

ADT – Average Daily Traffic

BBB – “BBB”; minimum investment grade bond rating

CAB – Capital Appreciation Bonds

CIB – Current Interest Bonds

CTB – Commonwealth Transportation Board

DBC Finance – general bond structuring software tool (www.dbc.biz/)

DSRF – Debt Services Reserve Fund

ETC – Electronic Toll Collection

FHWA – Federal Highway Administration

HBO – Home Based Other

HBW – Home Based Work

HCS – Highway Capacity Software

HOV – High Occupancy Vehicle

HRBT – Hampton Roads Bridge Tunnel

HRPDC – Hampton Roads Planning District Commission

HRX – Hampton Roads Crossing

JRB – James River Bridge

LOS – Level of Service

MADS – Maximum Annual Debt Service

MLK – Martin Luther King

MMMBT – Monitor Merrimac Bridge Tunnel

NHB – Non-Home Based

NHS – National Highway System

O&M – Operations and Maintenance

OD- Origin/Destination

ORT – Open Road Tolling

P/D&E – Preliminary Design and Engineering

PHF – Peak Hour Factor

PPTA – Public-Private Transportation Act

ROW – Right-of-Way

RSTP – Regional Surface Transportation Program

SAFETEA – Safe, Accountable, Flexible and Efficient Transportation Equity Act

SIB – Virginia State Infrastructure Bank

SOV – Single Occupant Vehicle

SP&G – Southeastern Parkway & Greenbelt

TFRA – Toll Facilities Revolving Account

TIFIA – Transportation Infrastructure and Finance Innovation Act

VDOT – Virginia Department of Transportation

VHT – Vehicle Hours Traveled

VMT – Vehicle Miles Traveled

VOC – Vehicle Operating Costs

VOT – Value of Time

YOE – Year of Expenditure Cost