COLUMBIA RIVER CROSSING CEVP®

Final Report

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August 2011

Columbia River CROSSING

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Cover Sheet

Columbia River Crossing CEVP®

Revised Draft Report: Columbia River Crossing CEVP®

Submitted By:

Golder Associates Inc.

Cooperating Agencies:

Washington State Department of Transportation, Oregon Department of Transportation

Abstract:

Results of CEVP modeling based on a workshop held May 2 – 6, 2011

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ACRONYMS

ADA	Americans with Disabilities Act
CDF	cumulative distribution function
CEVP	Cost Estimate Validation Process
CO	Change Order
CRA	Cost Risk Assessment
CRB	Columbia River Bridge
CRC	Columbia River Crossing
CEVP	Cost Estimate Validation Process
DB	Design-Build
DBB	Design-Bid-Build
FEIS	Final Environmental Impact Statement
FFGA	Full Funding Grant Agreement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GCCM	General Contractor Construction Manager
ITS	intelligent transportation systems
LRT	light rail transit
NET	Not Earlier Than
ODOT	Oregon Department of Transportation
RBS	risk breakdown structure
RFP	request for proposal
RFQ	request for qualifications
ROD	Record of Decision
ROW	right-of-way
SAEO	Strategic Analysis and Estimating Office
SME	subject matter experts
SR	State Route
WSDOT	Washington State Department of Transportation

YOE	year of expenditure

A complete glossary of terms is posted on the SAEO website:
http://www.wsdot.wa.gov/publications/fulltext/CEVP/Glossary.pdf

Foreword

For nearly all projects more things ***might*** happen than ***will*** happen; outcomes vary and cannot be guaranteed to 100 percent certainty. This is particularly true when a project is early in the design process and not fully defined.

Through a collaborative process between the project team, external risk experts, cost experts, and subject matter experts, we identify uncertainty ranges and possible risk events that can affect project objectives. The evaluation is conducted for the project commensurate with the level of project development. For this project, the risk-based estimating processes followed by the Washington State Department of Transportation (WSDOT) were used. The WSDOT process, termed Cost Estimate Validation Process (CEVP®), represents a "snapshot" for that project under the conditions known at the point in time.

The process normally deals with significant project risk events that are identifiable and quantifiable. A focused list of significant risks, drawn from extensive combined experience, results in actionable information directed at critical project issues. This allows WSDOT to identify the highest priorities for complex projects.

Project risk management relies on sound estimating practices and sound risk assessment practices; ***both*** are needed to fully convey the project characteristics. A sound base schedule estimate ***and*** base cost estimate must be prepared. Every project estimate should have a "Basis of Estimate" (see Cost Estimating Manual for WSDOT Projects; also basis of estimate template is posted at: http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/Information.htm).

Risk assessment is not a measure of estimate accuracy:

The project team must examine each critical item and predict its possible extreme values considering all risks, including compounding effects. It is important to understand that the range, as considered in this method, is not the expected accuracy of each item. ***This is a key issue.*** *Risk analysis is not an analysis of estimate accuracy. Accuracy is dependent upon estimate deliverables and estimate maturity. Contingency, as determined via the use of risk analysis, is not a measure of estimate accuracy. Rather it is a reflection of risk at any specified or desired probability of not completing the project within the estimate.*

AACE International Recommended Practice No.41R-08
RISK ANALYSIS AND CONTINGENCY DETERMINATION USING RANGE ESTIMATING
TCM Framework: 7.6 – Risk Management
June 25, 2008

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LPA Phase I Summary

Columbia River Crossing Project

Portland, OR and Vancouver, WA

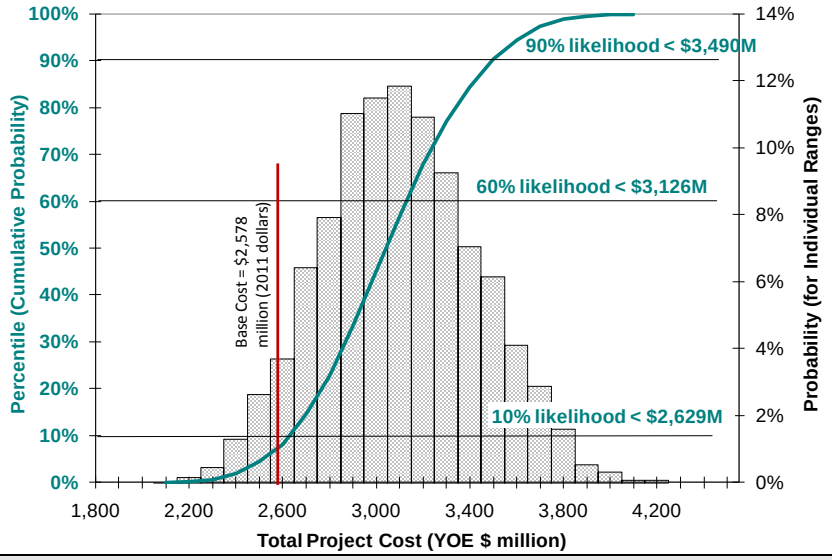
August 2011

Project Description

CRC is a long-term, comprehensive project to reduce congestion, enhance mobility and improve safety on I-5 between SR 500 in Vancouver, Wash., and Victory Boulevard in Portland. Project elements include:

- Replacing the Interstate Bridge
- Extending light rail to Vancouver
- Improving the highway corridor and five closely-spaced interchanges
- Enhancing pedestrian and bicycle paths and access to local networks
- Using transportation demand management features
- Applying electronic tolling

CEVP Cost Range *(as of May 2011 analysis, without risk mitigation)*



Project Benefits

Benefits to local residents, the natural environment and the regional economy include:

- Reduced congestion on I-5 and adjacent neighborhoods
- A more reliable trip for freight, autos, and transit
- 20,000 new and sustained jobs with improved access to ports and highways
- 70 percent fewer collisions per year
- No bridge lifts
- Reduced emissions and improved water quality
- Earthquake protection

CEVP Schedule Range (by percentile)

Task	***10th***	***60th***	***90th***	
Issue Columbia River Bridge Design-Build RFP	*Oct 2012*	*Oct 2012*	*March 2013*	*Completed analysis in May 2011.*
Construction Complete	*Aug 2021*	*March 2022*	*Aug 2022*	

Key Project Cost Risks (Mean impact value in 2011 dollars; M = million)

Threats (increases)

- Increase size of lid at Evergreen (+$18.4 M)
- Columbia River bridges base uncertainty with low level of design (+$17.1 M)
- Uncertain market conditions for design-bid-build contracts (+$16.8 M)
- Type change for mainline connector to Hayden Island (+$14.2 M)

Opportunities (savings)

- Test shaft/pile program (-$39.0 M)
- Uncertain market conditions for design- build contracts (-$37.9 M)
- Accelerate construction of Hayden Is. / SR-14 / Marine Dr. design-build contracts (-$19.6 M)

Key Assumptions

- In-water work is allowed year-round with construction activity restrictions during critical periods.
- Main river crossing will be a deck truss structure.
- Full funding is available; potential for delay treated via separate model scenario.
- Cost escalation rates based on WSDOT CCI/CPMS indices.
- Project to be delivered through a mix of design-build and design-bid-build contracts.

Key Project Schedule Risks

Threat (Mean impact to critical path)

- Issues relating to floating homes (1.8 months)
- Railroad agreement term sheets take longer (1.5 months)
- Issues managing design-build procurements (1.5 months)
- Agreement between FHWA and FTA on shared parcels (1.5 month)
- Delay getting possession and use for river crossing (1.1 months)
- Hayden Island elevated transit station changes to at-grade (1.1 month)

Opportunities (Mean acceleration potential)

- Accelerate construction of Hayden Is/SR14/Marine Drive (-3.6 months)
- Accelerate construction of Columbia River Bridge (-0.8 months)
- Longer work hours available than assumed (-0.5 month)

Level of Project Design 0% 100%

August 2011

Columbia River CROSSING

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Executive Summary

A Cost Estimate Validation Process (CEVP®) workshop was held May 2-6, 2011 for the Columbia River Crossing project. The objectives of the CEVP were to validate and quantify uncertainty and risk in the project cost and schedule and to develop risk management strategies to control the key project risks.

Base Cost Review

The project team reviewed the current base cost estimate during the May 2-6, 2011 workshop. The updated base costs reflect the most recent information available concerning project costs, and are considered a reasonable estimate for project costs at this time. Based on the CEVP review, the base cost for the Phase 1 Final Environmental Impact Statement (FEIS) Build alternative is approximately $2,578 million (all costs, in 2011 dollars), and for the Full Build alternative is approximately $2,742 million (all costs, in 2011 dollars). The CEVP base cost excludes inflation, uncertainty, and risk and opportunity, which are addressed during the risk assessment.

Project Alternatives

Two project alternatives were considered during the workshop:

- Phase 1 FEIS Build: All activities shown on flow chart; however, some interchanges would not be fully built out to their final proposed scope.
- Full Build FEIS: All activities shown on flow chart, plus additional cost and time for some activities to complete additional project scope. In the Full Build alternative, the entire project will be built out as currently proposed.

Funding Scenarios

Two funding scenarios were modeled:

- Baseline: all funding milestones are met as proposed in the base schedule.
- Delayed: major funding milestones are delayed by one funding cycle (nominally one year).

Key Results

For the project as defined in this CEVP, results indicate that at a 60 percent confidence level, the Phase 1 FEIS alternative could be built at a cost of approximately $3,126M (YOE) and could be completed by March 2022.

Key cost risks include the following (values are mean cost increases in 2011 dollars):

- Increasing the size of the lid at Evergreen ($18.4M).
- Base uncertainty in the cost of the river crossing bridge ($17.1M).
- Uncertain market conditions for design-bid-build contracts ($16.8M).
- The potential to change the mainland connector to Hayden Island ($14.2M).

Key cost opportunities include the following (values are mean cost savings in 2011 dollars):

- Use of a test shaft program to reduce the cost of foundations ($39.0M).
- Uncertain market conditions for design-build contracts ($37.9M).
- Not needing to case drilled shafts down to the Troutdale formation ($21.6M).
- Accelerating construction of the Hayden Island / SR-14 / Marine Drive design-build contract ($19.6M).

The most-likely critical path for the overall schedule, considering schedule risks, runs through either the FEIS and Record of Decision or Agreements, then right-of-way acquisition for the Columbia River Bridge (CRB), and finally through award and construction of the CRB. As evaluated in this CEVP, this sequence of activities has an approximate 54 percent chance to drive the schedule.

The next most-likely critical path again starts with either the FEIS and Record of Decision (ROD) or Agreements, and then feeds into right-of-way acquisition for Marine Drive, Hayden Island, and SR 14, then on to award and construction of these interchanges. As evaluated in this CEVP, this sequence of activities has an approximate 46 percent chance to drive the overall project schedule.

The FEIS and ROD have an approximate 38 percent chance to drive the schedule, due to various possible combinations of risks. It is generally not possible to identify any one combination of risks as being most critical. The most significant of these schedule risks are:

- Delay in agreement between Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) on shared parcels, with a mean schedule impact of approximately 1 month.
- Other delays to FEIS, with a mean schedule impact of approximately 1 month.

Right-of-way acquisition for both the Columbia River Bridge and the adjacent interchanges (Hayden Island, SR 14, and Marine Drive) could also experience delays and have an approximate 1/3 chance (each) to drive the overall project schedule.

Funding risks were excluded from the risk model; however, the effect of delayed funding was assessed through sensitivity analyses. Based on the sensitivity analyses, at the 60 percent confidence level the effect of a one-year delay in funding is about $53M for the Phase 1 Build option and about $57M for the Full Build Option. The primary impacts of a funding delay are to add one year of inflation and one year of extended overhead costs to the project. Per WSDOT

policy, inflation has been calculated using WSDOT's cost inflation tables over the project period. Inflation would have a larger impact on estimated costs if the funding delay were longer and/or if uncertainty in inflation rates were to be considered.

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1 Introduction

1.1 Project Summary

The Columbia River Crossing (CRC) Project is a joint effort co-sponsored by Washington State Department of Transportation (WSDOT) and Oregon Department of Transportation (ODOT) to replace the existing I-5 Columbia River Bridge, add light-rail transit, add bike and pedestrian paths, and improve six interchanges along I-5 in Portland, Oregon and Vancouver, Washington. Major project elements include:

- Columbia River Bridge: Currently planned as two deck-truss bridges with transit and pedestrian / bike pathways within the bridges. The current plan is to build the river crossing bridge as a design-build project.
- Marine Drive, Hayden Island, and SR-14 Interchanges: The current plan is to package these three interchanges as a design-build project.
- Fourth Plain and SR-500 Interchanges: The current plan is to package these two elements of the project as a design-bid-build project.
- Mill Plain Interchange and McLoughlin Bridges: The current plan is to package these two elements of the project as a design-bid-build project.
- Light Rail Transit: The TriMet light rail system will be extended to Hayden Island and across the new Columbia River Bridge and into Washington to a terminus near Clark College. In addition, park-and-ride lots and structures will be built. The current plan is to package Oregon and Washington light rail construction as separate design-bid-build projects while the park-and-ride lots will be packaged as one design-build project.

1.2 Methodology

This Cost Risk Assessment was conducted following the approach described in *WSDOT Guidelines for CRA-CEVP Workshops*. Parsons provided leadership for the cost assessment and Golder Associates Inc. provided leadership for the risk assessment. An independent perspective on various aspects of the project was provided by subject matter experts (SMEs), including project team members, external experts, and WSDOT staff specialists. A listing of the project workshop participants is given in Appendix A. More information on the CEVP process and WSDOT's approach to risk management can be found at http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/

The inputs for the analysis were gathered during a workshop held in Vancouver, WA from May 2nd through May 6th, 2011.

1.3 Workshop Objectives

1. Develop a common understanding among the participants of the Cost Estimate Validation Process (CEVP).

2. Describe project characteristics, schedule, cost, and risk issues. Identifiable and quantified risk events replace vaguely defined contingency.

3. Collaboratively review and validate project schedule and cost estimate; the collaborative project team is comprised of the Columbia River Crossing project team, specialty groups, and independent project, cost, and risk experts.

4. Review project key assumptions and constraints and identify and quantify risks.

2 Project Assumptions

2.1 Project Assumptions

The scope of work analyzed in this assessment included:

- Bridges (design-build)
  - Columbia River
  - North Portland Harbor (between Hayden Island and Delta Park)
- Interchanges
  - Marine Drive (design-build)
  - Hayden Island (design-build)
  - SR 14 (design-build)
  - Mill Plain (design-bid-build)
  - Fourth Plain (design-bid-build)
  - SR 500 (design-bid-build)
- Light Rail (design-bid-build)
  - Extension of existing light rail transit (LRT) from the terminus at Expo Center across Hayden Island, the Columbia River, and through downtown Vancouver with a terminus near Clark College, including stations and other related improvements.
  - Expansion of TriMet's maintenance facility at Ruby Junction and construction of a new operations center (this work will be performed by TriMet independently of the CRC project)
- Pedestrian and bicycle connections to bridge crossings
- Park and ride structures (design-build)

The incorporation of design-build in the delivery strategy for some elements of the project is a change from the last CEVP performed on the project, which assumed design-bid-build for all project elements.

Per WSDOT CEVP® guidelines, inflation was assumed to occur at WSDOT cost inflation table rates as shown below in Table 2-1. No allowance was made for uncertainty or risk in inflation rates.

Table 2-1 WSDOT Cost Inflation Rates

Year	Base PE Inflation Rates	Base ROW Inflation Rates	Base Construction Inflation Rates
2011	1.58%	0.08%	3.11%
2012	1.64%	3.42%	3.69%
2013	1.99%	7.74%	2.69%
2014	2.99%	6.21%	3.18%
2015	3.30%	6.40%	2.81%
2016	2.94%	5.48%	1.70%
2017	2.65%	2.68%	1.61%
2018	2.50%	1.99%	1.90%
2019	2.48%	2.05%	1.49%
2020	2.50%	2.48%	1.72%
2021	2.47%	3.02%	1.66%
2022	2.38%	3.12%	1.63%
2023	2.32%	3.10%	1.63%

2.2 Common Assumptions

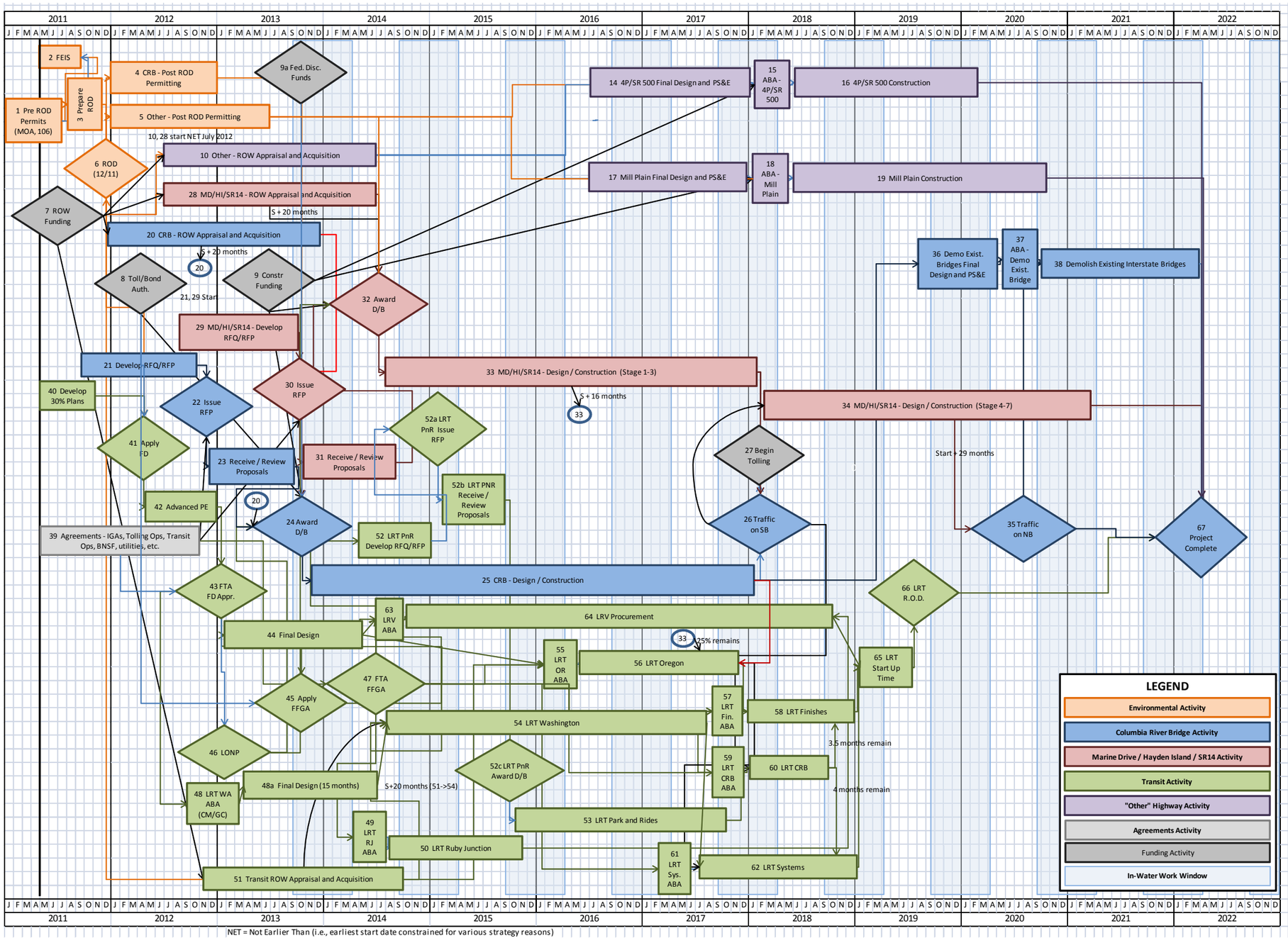
The WSDOT Strategic Analysis and Estimating Office (SAEO) maintains a list of common assumptions for its risk assessments. The current list of assumptions is located at http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/default.htm.

2.3 Project Flow Chart

Flow charts are used to provide a graphical depiction of the project delivery strategy and schedule at a level of detail appropriate for the CEVP®. Flow charts define a set of key activities, milestones, and precedence relationships and are used to model the project schedule (including delays or accelerations due to risk events) and to calculate cost inflation for each activity. The risk assessment flow chart for this project is shown in Figure 2-1.

For clarity, complete flow chart logic, including activity dependencies and lag between activities, is presented in Appendix D.

Figure 2-1. CRC Project Flow Chart



NET = Not Earlier Than (i.e., earliest start date constrained for various strategy reasons)

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2.4 Scenarios and Sensitivity Analyses

Two build alternatives (separate model runs) were evaluated both with and without delayed funding scenarios. The build alternatives and funding scenarios were defined as follows:

- Phase 1 Final Environmental Impact Statement (FEIS) Build – All activities shown on flow chart (Figure 2-1). However, some interchanges would not be fully built out to their final proposed configuration.
- Full Build FEIS – All activities shown on flow chart, plus additional cost and time for some activities to complete additional project scope. In the Full Build alternative, the entire project will be built out as currently proposed.
- Funding scenarios:
    - Two funding scenarios were defined in the workshop: a *Baseline* funding scenario in which all major funding milestones occur as scheduled; and a *Delayed* funding scenario in which there is essentially a "one-cycle" delay in each of three major funding approvals. These differences in funding scenarios are summarized in Table 2-2.

Starts for some construction activities are constrained by cash flow implied by funding milestones above. Some activities are constrained to Not Earlier Than (NET) start dates due to other considerations (e.g., don't want to build something and then leave it sitting unused for too long). Otherwise, assume "early starts" based on completion of predecessor project-development activities.

Table 2-2 Funding Scenarios and Milestones

Milestone No.	Description	Baseline Funding Date	Delayed Funding Date
8	Tolling / bonding authority	4/1/2012	7/1/2013
9	State construction funding	7/1/2013	4/1/2014
9A	Federal Discretionary Funds	10/1/2013	10/1/2014

2.5 Exclusions

Assumptions are necessary for any analysis, and the results of the analysis must clearly state the assumptions on which they are based. Probabilistic assessments attempt to include all relevant uncertainties so that the results are as inclusive and robust as possible (i.e., the results will "stand the test of time"). The more uncertainties that are excluded, the more "constrained" or "conditional" the results are. However, in many cases an owner has good reason to exclude particular uncertainties from the analysis. The bulleted items below represent issues that were discussed during the workshop, but were not quantified or modeled for this analysis. All results presented in this report assume the following (unless noted specifically):

- There is no uncertainty in the timing of funding. However, the effect of potential funding delay is examined by modeling separate "Funding" scenarios (i.e., Baseline vs. Delayed) so that results can be compared across scenarios.

- There is no uncertainty in project phasing (i.e., what is built when). The effect of different build options is examined via modeling separate "Build" scenarios (i.e., Full Build versus Phase 1) so that results can be compared across scenarios.

- There is no uncertainty or risk in construction, preliminary engineering, and right-of-way cost inflation rates. However, some year-to-year variability in annual inflation rates is captured through WSDOT's cost inflation table rates.

- There is no significant change in project definition or scope (i.e., the project becomes something substantially different). Minor scope uncertainties are included.

- There is no reduction or loss of funding.

- There is no removal or loss of transit component.

- There is no significant change in structure type for the river crossing (e.g., from composite deck truss to cable-stayed bridge), per direction of Washington and Oregon Governors.

- There are no other "fatal flaw" issues (e.g., significant force majeure, like failure of existing river bridges before or during construction, which results in emergency project acceleration).

In addition, per standard CEVP policy, life-cycle cost impacts (e.g., related to maintenance) resulting from the materials and systems to be installed by this project were not explicitly considered in the analysis. However, input from the WSDOT Maintenance Office was considered in the formulation of particular risks that were explicitly analyzed (e.g., related to possible design changes). Also, costs provided by TriMet for project elements currently assumed to be constructed by TriMet were not reviewed during the CEVP.

In addition to the assumptions listed above, results in this report are "unmitigated" in that they reflect the current project plan, but not potential future risk management. Risk management attempts to identify and implement cost-effective risk-mitigation actions (or avoidance or allocation) that could reduce cost and schedule risks or exploit cost and schedule opportunities. Additional risk management opportunities may be available for this project. Except for specific issues already addressed and documented in the risk register (Appendix C), no "credit" has been given in these results for future mitigation, and formal risk mitigation was outside the current scope of the CEVP.

3 Base Cost Review

3.1 Activities

- April 25, 2011 - Prep Session
- April 25, 2011 - Soft Cost Discussion with Alaska Way Viaduct Replacement Program Director
- April 26, 2011 - Soft Cost Discussion with Alaska Way Viaduct Replacement Program Cost Estimating Lead
- May 2-6, 2011 – CEVP Workshop

3.2 Process during the Workshop

Cost and schedule validation occurs throughout the workshop. The schedule validation begins as part of the flowcharting activities and continues to be modified and refined through discussions with the subject matter experts as part of the cost and risk evaluation. A major portion of the cost validation occurs early in the workshop following finalization of the flowchart. In some cases cost validation occurs as part of the risk discussion later in the workshop to facilitate efficiencies of subject matter expert's time. This was the case for right-of-way (as an example) where the base costs were discussed just in advance of the risk. Final base cost estimates are updated for use in the modeling after the workshop, with the adjustments and modifications agreed upon during the workshop incorporated into the final base estimate.

Another important element of the cost review and validation is assessing variability and uncertainty in the base costs, exclusive of risk and opportunity. Recognizing and quantifying this "base uncertainty" explicitly captures uncertainty in the participants' abilities to know with certainty (in advance) the unit cost or quantity for a particular line item in the estimate. Uncertainty in a particular base-cost item (either a line item or group of line items) was generally assessed in terms of a reasonable low (e.g., 10^{th} percentile) and reasonable high (e.g., 90^{th} percentile) for the cost, or for the unit prices and quantities separately. Significant correlations among base uncertainties were also captured in the risk model.

3.3 Schedule Validation

Schedule assumptions that drive portions of the overall schedule, and which are indicated on the flowchart as gray diamonds, are milestone activities which in some instances may constrain the schedule. These activities include:

- Right-of-Way Funding
- Toll/Bond Authority

- Federal Discretionary Funding
- Construction Funding
- Commencement of Tolling

A shift in the delivery strategy for the various elements of the project has occurred since the last CEVP was performed on the project. Design-build is now anticipated to be included as part of the delivery strategy for the main-span bridge and the approaches at each end of the bridge. Additionally, the Park and Ride Structures will be delivered using design-build. The change in strategy has required revised logic to the early (environmental, right-of-way, and preliminary engineering) components of the schedule and the flowchart.

For the CRC project, major components of the schedule are the construction of the main span bridge and the construction of the interchange and highway work on each end of the bridge that allows for traffic to be shifted from the existing bridge to the new bridge. This traffic shift allows for toll collections to begin on the new bridge structure. In addition, several activities drive and constrain the transit portion of the schedule. With this in mind, dedicated time, in addition to the flowcharting activity, was spent discussing the main span construction duration, the interchange construction on each end of the bridge, and activities leading up to the design, right-of-way and construction of transit elements.

3.3.1 Main Span Construction Schedule

This discussion spanned several days and a few iterations of evaluation. The original schedule included a total of 56 months to deliver the design-build project. The schedule was based on 10 months of design followed by 46 months of construction. A construction schedule was presented that outlined the use of two crews constructing piers in sequence followed by erection of the super structure. Many ideas were discussed about how to reduce the overall schedule of the construction activities. However, in the end it was agreed that without further, detailed evaluation and correlation to the base cost of the main span structure the duration of 46 months should remain. However, the base schedule was reduced to 50 months by overlapping the design and construction schedule by six months; essentially beginning construction four months after notice-to-proceed on the design-build contact.

3.3.2 Hayden Island/SR14 Construction Schedule

Construction schedules for the two interchanges were thoroughly discussed. The base assumption is similar to the main span schedule, with 8 months of design followed by 33 months of construction for stages 1-3, and 36 months of construction for stages 4-7. Discussion centered on the overall construction duration and overlapping design and construction activities. However, due to the complex design in these interchanges, it was felt that the full 8 months of design should be retained prior to the commencement of any construction activities. With respect to the construction durations, it was felt that efficiencies could be achieved. After some discussion, it was agreed that there was potential to save about six months in the construction schedule (about one month in each of the six stages of construction). This potential savings was captured as an opportunity in the risk register and the base durations remain unchanged.

3.3.3 Pre-Advertisement Schedule Modifications

A significant amount of discussion surrounded pre-Advertisement activities, especially as it relates to the environmental process and funding approvals related to transit work. Ultimately, the base durations were accepted as originally presented with the following exceptions:

- Pre-ROD Permits was increased from 3 months to 6 months
- Preparation of the FEIS was increased from 4 months to 5 months
- Preparation of the Record of Decision (ROD) was increased from 3 months to 4 months

Finally, after completion of the workshop, CRC Management revised the delivery method assumption for the Marine Drive Interchange from design-bid-build to design-build. The schedule and flowchart activities of the Marine Drive Interchange were deleted for "Final Design and PS&E," "Ad/Bid/Award," and "Construction." These activities were incorporated into the flowchart activities to "Develop request for qualifications (RFQ)/request for proposal (RFP)," "Receive/Review Proposals," and "Design/Construct" for the Hayden Island and SR14 Interchange Design-Build portions of the project.

3.4 Cost Validation

A "Basis of Estimate" document (Appendix B) has been prepared by the project team which defines the methodology used in developing the estimate, assumptions, scope of the project and delivery method of construction projects. Excerpts from the document are included below.

The project is at the conceptual level of design development with some elements being more advanced than others. The bridges across the Columbia River and North Portland Harbor, as well as land-side bridges in Oregon, are at about the 5 percent level of design while the transit infrastructure and bridges in Washington are at about the 20 percent level of design. All major features are fairly well defined; for example, areas of bridges, the length of highway lanes, the length of transit guideway, and number of stations are known with a reasonable degree of certainty.

The project base cost estimate (see summary in Table 3-1) is divided into the following major categories:

- Marine Drive interchange
- Hayden Island interchange, including the approach spans for bridges over the Columbia River
- SR 14 interchange including the approach spans for bridges over the Columbia River, Evergreen Boulevard bridge over I-5 and adjacent Community Connector
- Mill Plain interchange, including the I-5 bridge over McLoughlin Boulevard
- Fourth Plain interchange, including the 29th Street bridge over I-5

- SR 500 interchange including the 33rd Street bridge over I-5
- Removal of existing bridges across the Columbia River
- New bridges over the Columbia River
- Transit guideway in Oregon
- Transit guideway in Washington
- Park and ride structures
- Project elements to be designed and constructed by TriMet

The current base cost estimate assumes the following construction delivery methods:

- Design-build for bridges across the Columbia River
- Design-build for the Hayden Island, Marine Drive, and SR 14 interchanges
- Design-bid-build for the Mill Plain, Fourth Plain and SR 500 interchanges
- Design-bid-build for the transit guideway and associated improvements (note that a GCCM delivery method is also being considered for transit construction in Washington)
- Design-bid-build for the removal of the existing Columbia River Crossing Bridges
- Design-build for the park and ride structures

It should also be noted that the estimate is divided into two full estimates based on scope reductions identified that can be phased over time. The first estimate is the “Full Build” which encompasses the entire scope of the project envisioned. The second estimate is “Phase 1” which defers scope elements in the Marine Drive Interchange and the SR500 Interchange. No changes other than reduced quantities are captured in the Phase 1 estimate. The minimal nature of the scope reductions does not warrant an adjustment to unit pricing or changes to any of the soft costs (mobilization, construction management, etc.).

Consistent with prior estimates, approximately 60 percent of the capital cost can be attributed to bridges, about 55 percent of which comprises the bridges across the Columbia River and North Portland Harbor. With the understanding that a major portion of project cost is bridges and structures, the most effort in cost validation is placed on these items. Also, in changing the delivery method for a major amount of the construction valued to design-build, quite a bit of time was utilized during (and in advance) of the workshop to identify these costs. As in the past, transit costs have been provided by TriMet. With TriMet’s recent and relevant experience constructing projects, their estimates are generally accepted as being the best information available and only a cursory review was performed during the workshop. Similarly, with highway elements such as pavement, earthwork, traffic/intelligent transportation systems (ITS), stormwater facilities, traffic control, environmental mitigation, and other smaller cost items, WSDOT has a great depth of data in costing these items. Time is spent to review these items;

however, in general there are only minor revisions to quantities and unit prices in order to match the current bidding environment. These changes have a minor impact on the overall cost of the project and therefore less time is attributed to the validation of these costs.

Table 3-1 Summary of Base Cost Estimates (2011 dollars)

	Highway	Transit	Total
Full Build	$2,099,708,971	$642,650,214	$2,742,359,185
Phase 1	$1,934,880,766	$642,650,214	$2,577,530,980

Note: Costs expended to date, planning and preliminary engineering costs, and program-management costs over the life of the project (combined base estimate of $205.5 million) are included in Table 3-1.

3.5 Changes to the Base Estimate

Following is a summary of the individual items within the estimate that have been revised, or in some cases, agreed upon based on discussions during or after the workshop:

- Marine Drive Interchange was changed from Design-Bid-Build to Design-Build.
- North Portland Harbor Bridges have been divided and incorporated into the Marine Drive Interchange costs or the Hayden Island Interchange costs.
- Transit (Expo to State Line) was changed from Design-Build to Design-Bid-Build.
- Transit (State Line to Clark College) was changed from Design-Build to Design-Bid-Build.
- Final Design costs as part of the CRC Main Span design-build contract will change from 15 percent to a most likely number of 7 percent, with a range from 5 percent-9 percent.
- Final Design costs as part of the Marine Drive/Hayden Island/SR14 and the Park and Ride Structures design-build contracts will change from 15 percent to a most likely number of 8 percent, with a range from 6 percent-10 percent.
- Design and Construction Management costs as part of the CRC Main Span design-build contract will change from 7.5 percent to 2 percent.
- Design and Construction Management costs as part of Marine Drive/Hayden Island/SR14 and the Park and Ride Structures design-build contract will change from 7.5 percent to 4 percent.
- Owner costs associated with the development of design-build procurement documents is established as 1.5 percent of construction estimate for the CRC Main Span (no change) and 1.0 percent of construction estimate for the subsequent design-build procurements (Marine Drive/Hayden Island/SR14 and the Park & Ride Structures), which is a reduction from 1.5 percent.

- Program Management costs are not included as part of the construction estimate and are not estimated as a percentage of the construction value. The project team has developed a cost estimate based on past expenditures and a future staffing plan based on required deliverables and staffing levels. Program Management costs will be incorporated into the overall financial plan and CEVP model, but will not be generated as part of the construction estimate.

- Stipends for design-build procurements will be changed from a percentage of construction value to a lump sum plug number based on the size and complexity of the contract. Included values for the CRC Main Span design-build procurement assume four shortlisted firms with a $2 million stipend per unsuccessful bidder. Included values for the Marine Drive/Hayden Island/SR14 design-build procurement assume four shortlisted firms with a $2 million stipend per unsuccessful bidder. Included values for the park-and-ride structures design-build procurement assumes, four shortlisted firms with a $1 million stipend per unsuccessful bidder.

- Insurance and bond costs were deleted from the soft cost portion of the CRC Main Span (1.5 percent of constructed value), as it was determined that the insurance and bond costs were included in the overall development of the CRC Main Span estimate.

- Insurance and bond costs were reduced from 1.5 percent of constructed value to 0.5 percent of constructed value for the Marine Drive/Hayden Island/SR14 and the Park & Ride Structures design-build contracts. The reasoning behind the change was that bid tab unit prices were used to develop these estimates and would therefore include some level of insurance and bonding. Adding a small premium (0.5 percent of constructed value) was agreed upon to provide a realistic base cost for these contracts.

- When insurance and bonding cost premiums are included in the design-build projects it will be included as a cost for the design-builder, not the owner.

- All legal, review and permit fees were removed from the base costs. These elements are covered in the estimated costs for the individual items on the flowchart related to legal, review, and permitting.

- Based on the level of estimating completed to date for the CRC Main Span Bridge, a minor items allowance (known but unestimated items) of 2 percent of construction value was included and agreed upon by the group.

- A base uncertainty range for the CRC Main Span Bridge was agreed upon as -10 percent to +20 percent.

- The North and South Approach Structures estimates were developed in a similar material, labor, and equipment build up process as the CRC Main Span Bridge. With this in mind, a minor items allowance (known but unestimated items) of 2 percent of construction value was included and agreed upon by the group.

- A base uncertainty range for the North and South Approach Structures was agreed upon as +/-10 percent.

- Base uncertainty was evaluated on a bridge-by-bridge basis and updated for current information. The base uncertainty range is included on the base cost estimate spreadsheet.

- A general point of discussion with respect to steel costs in the land side bridges was undertaken. Based on recent bid information, it was felt that the costs used in the estimates were a bit too high and should be reduced to match the following:

  - Post Tensioning = $5.00/lb

  - Epoxy Coated Rebar = $1.00/lb

  - Rebar = $0.75/lb

- The structural steel price for the North Portland Harbor bridges was reduced to $2.20/lb.

- Right-of-way parcels required for the Ruby Junction maintenance facility have been split between the costs for a TriMet project and the CRC program of projects. During discussions in the workshop about these parcels, it was felt that some additional parcels may need to be covered in the CRC program. After evaluation, no additional parcel costs were added back to the CRC program.

- The right-of-way base costs for the Oregon side of the project did not include the 30 percent condemnation allowance that has been used in the past and was included in the right-of-way costs developed for the Washington side of the project. The 30 percent condemnation allowance will be included and incorporated into the overall base cost estimate.

- A temporary bridge is required to be constructed as part of the overall construction of the Marine Drive Interchange. The cost will be added to the base cost.

- A change order allowance (for owner budgetary purposes) should be included. Since the estimate in most cases is based on unit prices from previous projects and the low bid price was not used as the basis for the unit pricing, some level of change order allowance is assumed to be in the current estimate. With that in mind, a 1 percent CO allowance on the design-build contracts and a 2 percent CO allowance for the design-bid-build projects will be added to the base in the owner cost portion of the estimate.

- Fluctuations (e.g., due to market conditions) for structural steel were discussed. For structural steel not in the truss, as an overall cost it was agreed to use:

  - $2.00/pound as a low

  - $2.20/pound as most likely

  - $2.90/pound as a high

- Similarly, for the truss steel, material costs could fluctuate, resulting in:

- $0.36/pound as a low
- $0.58/pound as most likely
- $1.28/pound as a high

Overall, the changes to the base cost made during the workshop resulted in a reduction in the estimated base cost for both the Full Build and Phase 1 alternatives. The base costs (in 2011 dollars) and overall base cost differences are summarized in Table 3-2. Note that the costs in Table 3-2 include right-of-way, off-site mitigation, and construction-related costs only. Costs expended to date, planning and preliminary engineering costs, and program-management costs over the life of the project (combined base estimate of $205.5 million) are not included in Table 3-2. Including these costs, the base cost for the Phase 1 Build alternative is $2,578 million (2011 dollars), and the base cost for the Full Build alternative is $2,742 million (in 2011 dollars).

Table 3-2 Changes to Base Cost Estimate

	Pre-workshop	Post-workshop	Difference
Full Build	$2,742,457,636	$2,536,809,185	$205,648,451
Phase 1	$2,599,943,398	$2,371,980,980	$227,962,418

4 Risk Assessment Results

4.1 Introduction

During the project workshop, the group identified and characterized 1) uncertainty in the base project cost and schedule, and 2) cost and schedule risks and opportunities. Appendix C (the Risk Register) is organized around the specific risk issues previously adopted by the Columbia River Crossing project team. The risk register does not follow the WSDOT Risk Breakdown Structure).

These risks span all aspects of the project, including construction, design, environmental, right-of-way, management, and political issues. Under each major heading, such as Construction, Appendix C lists the identified cost and schedule risks and opportunities for the project. The description risk and opportunity in Appendix C is complementary to the base cost and schedule described in Section 3, and with assessed base-cost uncertainties. Therefore, Appendix C should be used in conjunction with the base cost and schedule (Section 3) and the key project assumptions and exclusions summarized in Section 2.

Appendix C includes some risks that are identified as "minor" because the mean (average) value of those risks falls below screening criteria. For the project assessment, the combined effect of the minor risk issues (i.e., those falling below the consensus threshold value) was accounted for using an "aggregated minor risk" item. Similarly, a category of "unidentified risks" attempts to account for uncertainties that were not explicitly identified by the workshop participants. The same approach was used (separately) for minor and unidentified cost and schedule risks and opportunities.

A total of 208 risks (threats and opportunities) were identified, of which 74 were determined to be significant (the remainder are either minor, were excluded, or have been resolved). Significant risks are defined as having a mean cost impact of at least $0.5M or a mean schedule impact of at least half a month. The risks are broken down by category as shown in Table 4-1.

The most significant results from the workshop and risk assessment are summarized in the following sections. Note that results in this report reflect a "snapshot" of the alternatives at the time of the workshop, and include no "credit" for future potential risk mitigation efforts (i.e., results are "unmitigated") unless otherwise noted in the Risk Register (Appendix C). Ultimately, the base uncertainties will reduce over time as the project evolves, and the risks and opportunities will either occur or not (i.e., the probability for each will converge to either 1 or 0).

Table 4-1 Risk Breakdown Structure

RBS Category	Total Number of Risks Identified	Number of Significant Active Risks
Agreements	11	6
Construction	12	3
Contracting and Procurement	11	7
Design / PS&E	14	1
Environmental	13	12
Geotechnical	3	2
Highway	40	12
Right-of-Way	20	11
Structures	19	12
Stormwater	13	0
Tolling	1	1
Traffic	2	1
Transit	38	12
Utilities	11	3
Total	208	83

4.2 Model Scenarios

Two build alternatives (separate model runs) were evaluated for both no funding delay and with a funding delay. The build alternatives were defined as follows:

- **Phase 1 FEIS** – all activities shown on flow chart (Figure 2-1). However, some interchanges would not be fully built out to their final proposed configuration.
- **Full Build FEIS** – all activities shown on flow chart, plus additional cost and time to some activities to complete additional project scope Full Build: assumes that the entire project is built out as currently proposed.

The **Baseline Funding scenario** is defined as follows:

- Tolling / bonding authority (Milestone 8): 4/1/2012
- State construction funding (Milestone 9): 7/1/2013
- Federal Discretionary Funds (Milestone 9a): 10/1/2013
- Starts for some construction activities are constrained by cash flow implied by funding milestones above
- Some activities are constrained to Not Earlier Than (NET) start dates due to other considerations (e.g., don't want to build something and then leave it sitting unused for too long)
- Otherwise, assume "early starts" based on completion of predecessor project-development activities

As defined in the CEVP workshop, the **Delayed Funding scenario** is essentially a "one-cycle" delay in each of three major funding approvals:

- Tolling / bonding authority (Milestone 8): 7/1/2013 (versus Baseline = 4/1/2012)
- State construction funding (Milestone 9): 4/1/2014 (versus Baseline = 7/1/2013)
- Federal Discretionary Funds (Milestone 9a): 10/1/2014 (versus Baseline = 10/1/2013)
- All other assumptions are the same as for the Baseline Funding Scenario.

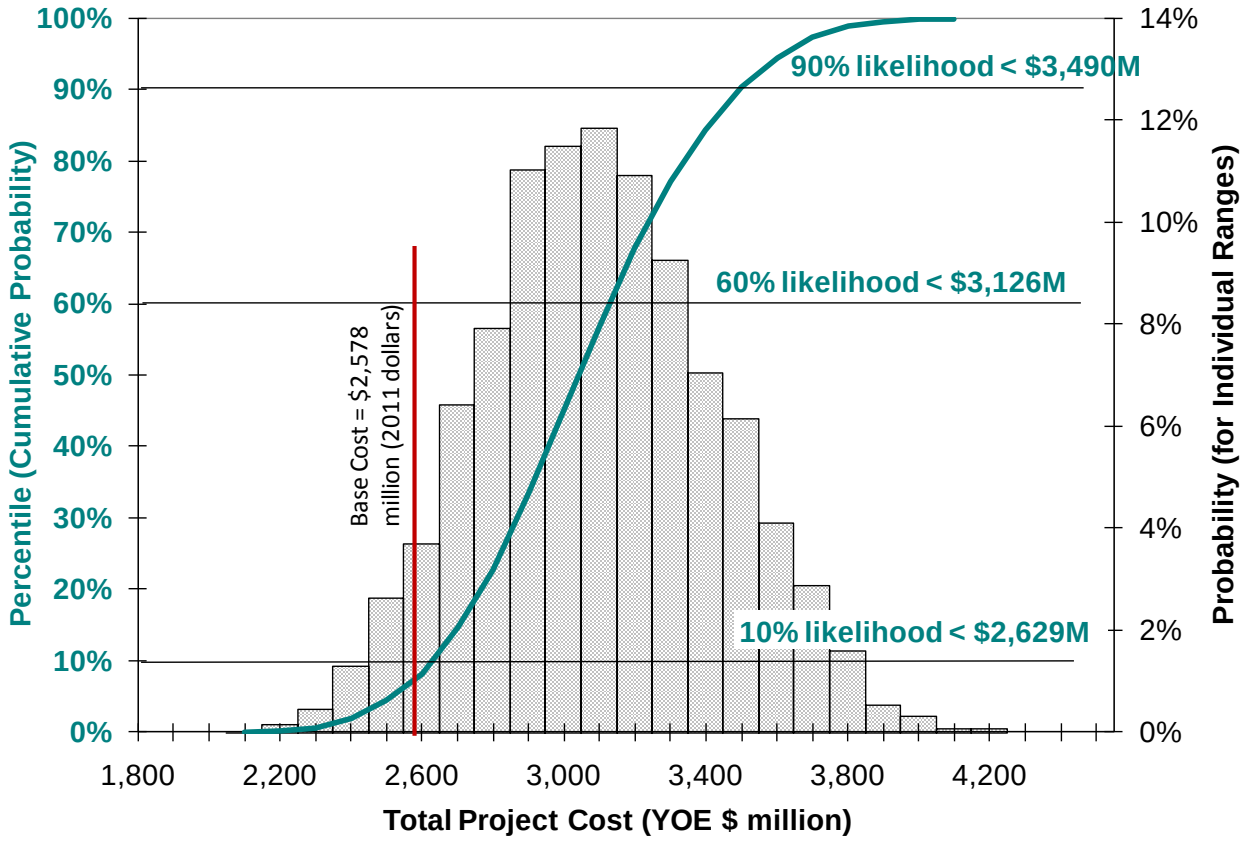
4.3 Baseline Funding

4.3.1 Phase 1 FEIS Build

As shown in Figure 4-1, results from this CEVP indicate that at the 60 percent confidence level, the Phase 1 FEIS Build alternative can be completed at a cost of $3,126 million (in year-of-expenditure or YOE dollars), compared to the base cost estimate (before inflation, risk and opportunity) of $2,578 million. Results indicate that there is a 90 percent chance that this alternative will cost less than approximately $3,490 million YOE.

These results include $120.35 million in costs expended to date, as well as the impacts from inflation, base uncertainty, and cost and schedule risk and opportunity. However, as stated previously (Section 2.5), these results exclude particular uncertainties and risks (e.g., per WSDOT policy). These assumptions and exclusions are essential to consider when using results from this CEVP.

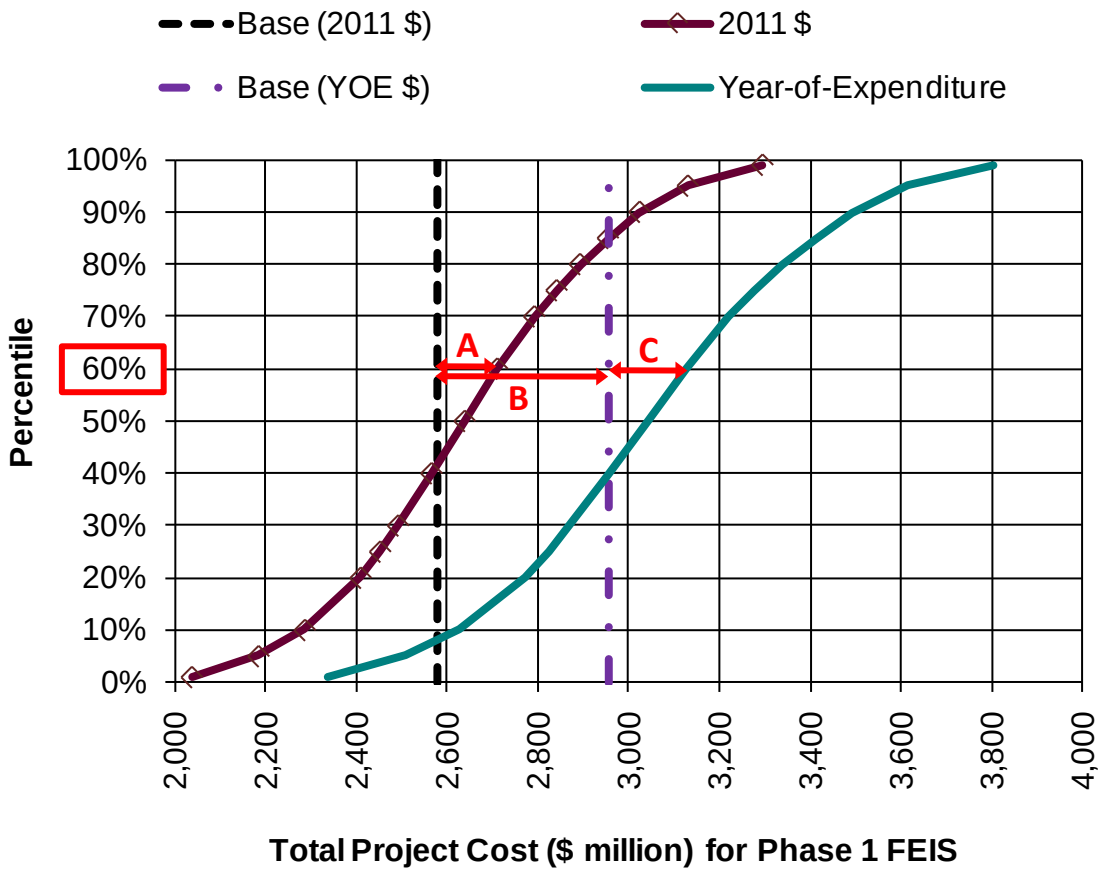
Figure 4-1. Uncertainty in Overall Project Cost for Baseline Funding, Phase 1 FEIS. Includes previous costs of $120.35 million



Increases in the total project cost relative to the base cost stem from a combination of inflation, uncertainty in the base estimate, and risks and opportunities described in the risk register (Appendix C). These components are illustrated in Figure 4-2.

In Figure 4-2, the vertical dashed line at $2,578 million represents the base cost estimate in 2011 dollars, and the vertical line at $2,958 million represents the base cost in YOE dollars. The difference between these two ($380 million YOE) represents the effect of inflation on the base cost. The two cumulative distribution functions (CDFs) shown in Figure 4-2 represent the combined effects of base uncertainty, risks, and opportunities on the base cost, before inflation (for the left-most CDF) and including inflation (for the right CDF). At the 60 percent confidence level, uncertainty, risk, and opportunity combine to add $133 million in cost to the uninflated base cost ("A" on Figure 4-2), or $169 million to the inflated base cost ("C" on Figure 4-2).

Figure 4-2. Components of Uncertainty in Overall Project Cost for Baseline Funding, Phase 1 FEIS



A = combined (net) impact at 60th percentile of base-cost uncertainty, cost risk, cost opportunity, and cost of schedule delay (before inflation) = $132.7 million (2011 $)

B = inflation on base cost (before base uncertainty, risk, or opportunity) = $380.4 million (YOE $), assuming WSDOT cost inflation table rates.

C = net impact at 60th percentile of inflation on base cost plus base-cost uncertainty, cost risk, cost opportunity, and cost of schedule delay = $168.6 million (YOE $)

Figure 4-3 illustrates the significance of the identified cost risks in terms of a mean cost *increase* in 2011 dollars. Key cost risks include increasing the size of the "community connector" lid at Evergreen ($18.4 million - risk Struc 27), base uncertainty in the cost of the river crossing bridge ($17.1 million), uncertain market conditions for design-bid-build contracts ($16.8 million - risk Procurement 3), and the potential to change the mainland connector to Hayden Island ($14.2 million - risk Struc 21).

Similarly, Figure 4-4 illustrates the significance of identified cost opportunities in terms of the mean cost *savings* in 2011 dollars. Key cost opportunities include use of a test shaft program to reduce the cost of foundations ($39.0 million - risk Struc 31), uncertain market conditions for design-build contracts ($37.9 million - risk Procurement 11), not needing to case drilled shafts

down to the Troutdale formation ($21.6 million – risk Struc 36), and accelerating construction of the Hayden Island / SR-14 / Marine Drive design-build contract ($19.6 million - risk Construction 8). Note that each of these risks could result in a range of potential cost changes; only the mean values are shown in the figures. A number of other risks can also impact the overall project cost, as shown in Figure 4-3 and Figure 4-4. The risks are described in more detail in the risk register.

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Figure 4-3. Contribution to Total Mean Cost Risk (in 2011 dollars) for the Phase 1 FEIS Alternative

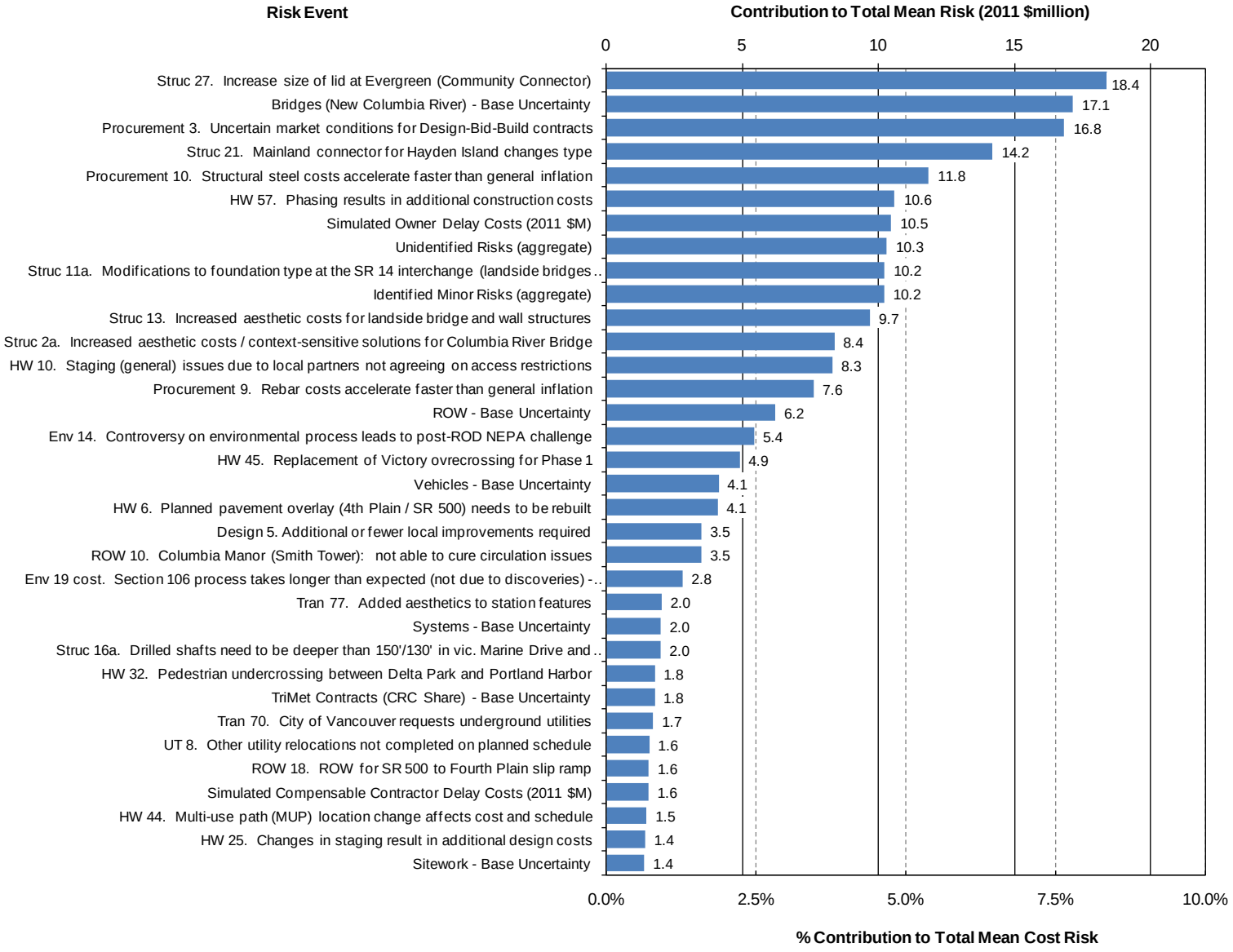

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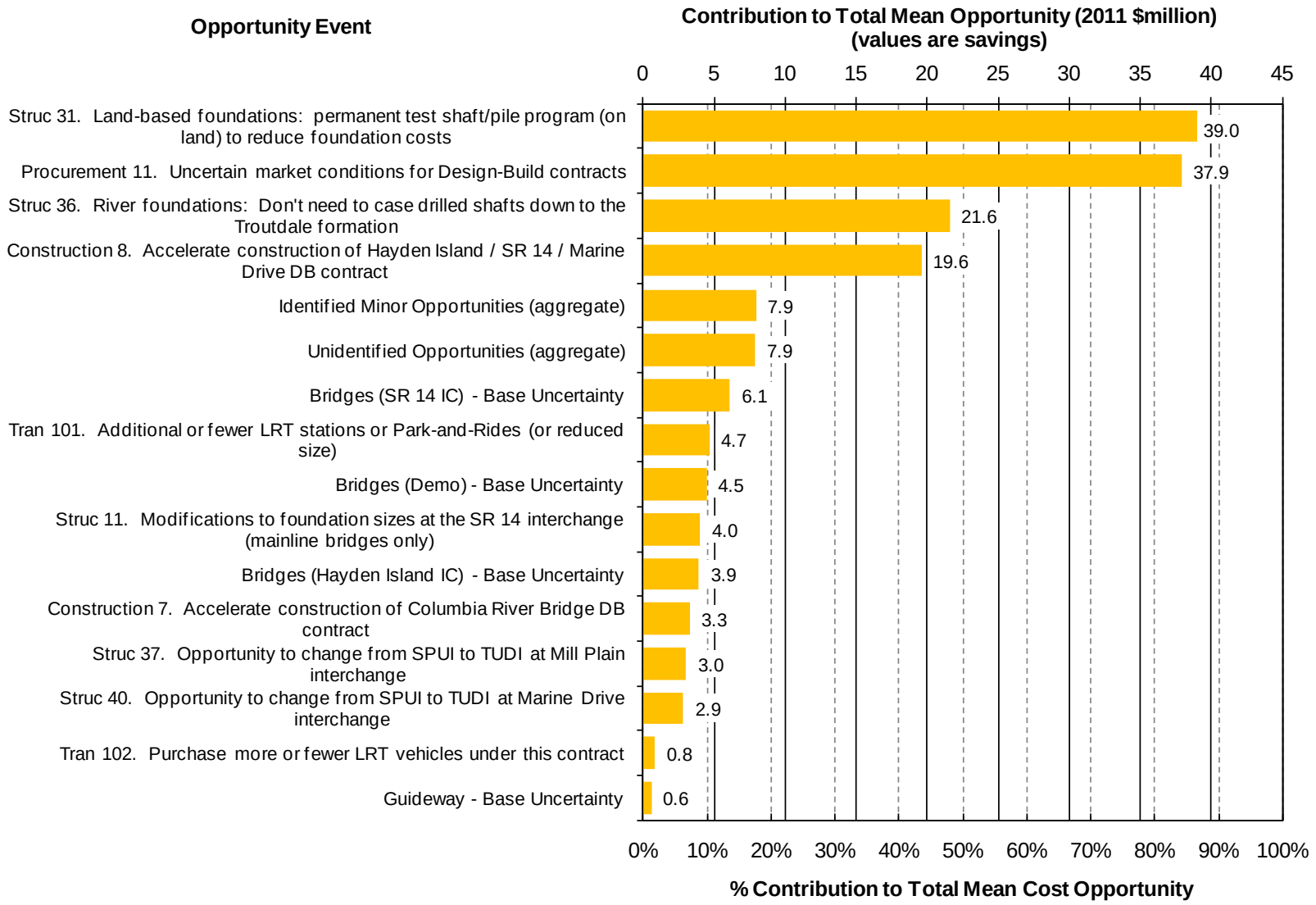
Figure 4-4. Contribution to Total Mean Cost Opportunity (in 2011 dollars) for the Phase 1 FEIS Alternative



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For the assumptions made (Section 2.5), the CEVP results indicate that at a 60 percent confidence level, the Phase 1 FEIS Build can be completed by March 2022, as compared to the base schedule completion date of November 2021 (Figure 4-5 and Table 4-2). As evaluated in this CEVP, there is a 30 percent likelihood of meeting the base completion date. The results also indicate there is a 90 percent chance the project will be completed by late summer 2022. Start and end dates for all Phase 1 FEIS Build activities at the 10 percent, 60 percent, and 90 percent levels of confidence are presented in Appendix E.

Note that these schedule results exclude the uncertain potential for funding delays, which WSDOT recognizes are likely. WSDOT has captured the potential impacts of funding delays separately via a Delayed Funding model scenario (see Section 4.4).

Figure 4-5. Uncertainty in Overall Project Schedule for Baseline Funding, Phase 1 FEIS

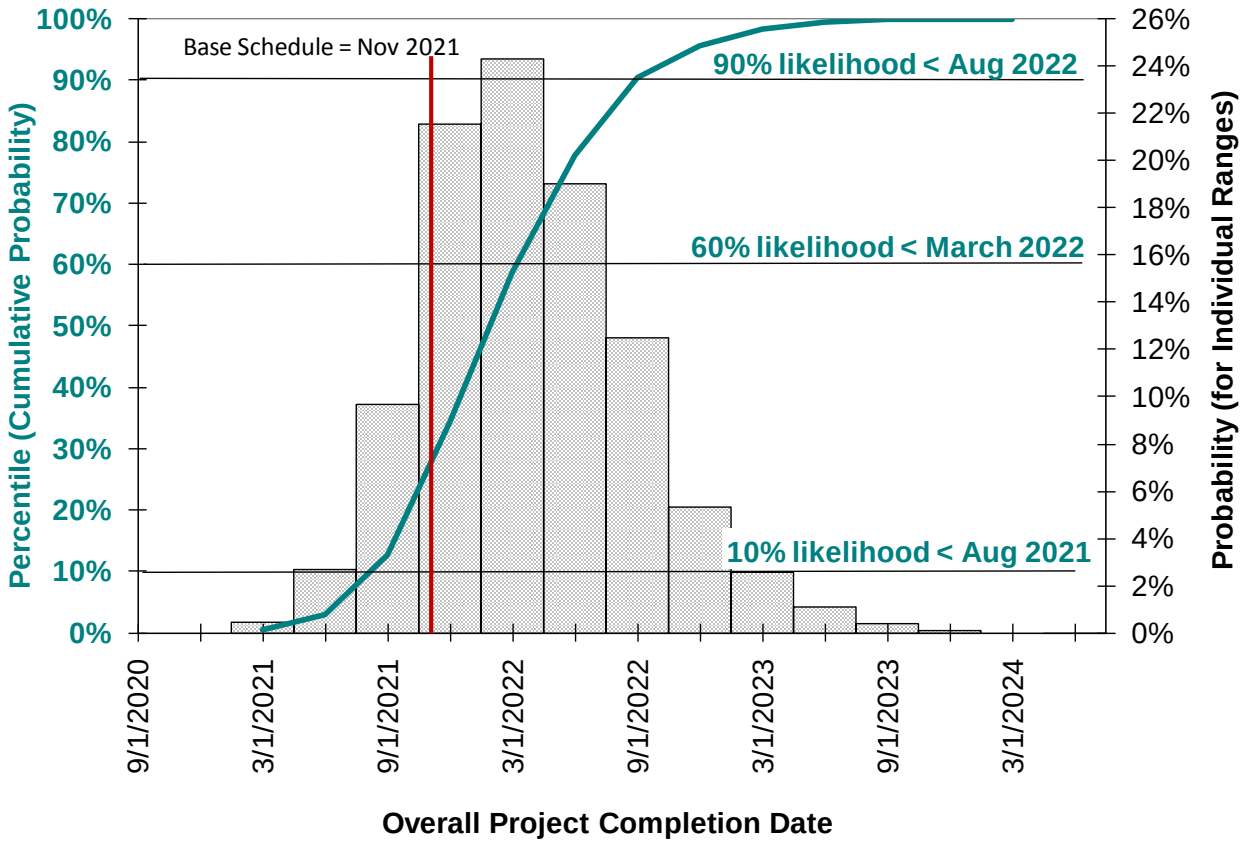


Table 4-2 Uncertainty in Major Schedule Milestones for Baseline Funding, Phase 1 FEIS Build

Activity Number / Milestone	Base	10th Percentile	60th Percentile	90th Percentile
6. ROD	11/30/2011	11/30/2011	2/19/2012	6/23/2012
22. Issue RFP CRB	10/31/2012	10/31/2012	10/31/2012	3/21/2013
24. Award DB CRB	10/1/2013	10/1/2013	1/18/2014	5/4/2014
26. Traffic on Southbound CRB	12/4/2017	11/18/2017	5/23/2018	11/9/2018
27. Begin Tolling	12/4/2017	11/18/2017	5/23/2018	11/9/2018
30. Issue RFP MD/HI/SR14	12/1/2012	12/1/2012	5/20/2013	10/3/2013
32. Award DB MD/HI/SR14	3/3/2014	3/3/2014	7/20/2014	1/20/2015
35. Traffic on Northbound CRB	5/6/2020	2/11/2020	9/3/2020	2/26/2021
41. Apply for Entry to FD	4/1/2012	4/1/2012	4/1/2012	6/23/2012
43. Approval to enter FD	1/31/2013	1/31/2013	6/8/2013	10/18/2013
45. Apply for FFGA	10/1/2013	10/1/2013	10/1/2013	10/18/2013
46. Letter of No Prejudice	1/31/2013	1/31/2013	6/8/2013	10/18/2013
47. FFGA Approved	7/2/2014	7/2/2014	7/2/2014	10/20/2014
52a. Issue RFP for LRT Park-and-Ride	3/3/2015	3/3/2015	3/3/2015	6/21/2015
52c. Award LRT Park-and-Ride DB	10/3/2015	10/3/2015	10/3/2015	1/20/2016
66. LRT Revenue Operations Date	12/6/2019	2/9/2020	8/30/2020	3/25/2021
67. Overall Project Complete	11/6/2021	8/14/2021	3/6/2022	8/29/2022

Notes:
1. FD = Final Design
2. FFGA = Full-Funding Grant Agreement
3. LRT = Light Rail Transit

The flow chart shown in Figure 2-1 depicts a number of possible activity sequences in the overall project schedule. The schematic in Figure 4-6 illustrates the likelihood that various activities could become critical (i.e., drive the project schedule) considering schedule risks. For each activity, the probability that the given activity is on the critical path is shown in black (e.g., **4 percent**) while the schedule risks or opportunities that could drive that activity to become critical are shown in red (e.g., **Env 14**).

From Figure 4-6, the most-likely critical path for the overall schedule, considering schedule risks, runs through either the FEIS and Record of Decision or Agreements, then right-of-way acquisition for the CRB, and finally through award and construction of the CRB. As evaluated in this CEVP, this sequence of activities has an approximate 54 percent chance to drive the schedule.

The next most-likely critical path again starts with either the FEIS and ROD or Agreements, then feeds into right-of-way acquisition for Marine Drive, Hayden Island, and SR 14, then on to award and construction of these interchanges. As evaluated in this CEVP, this sequence of activities has an approximate 46 percent chance to drive the overall project schedule.

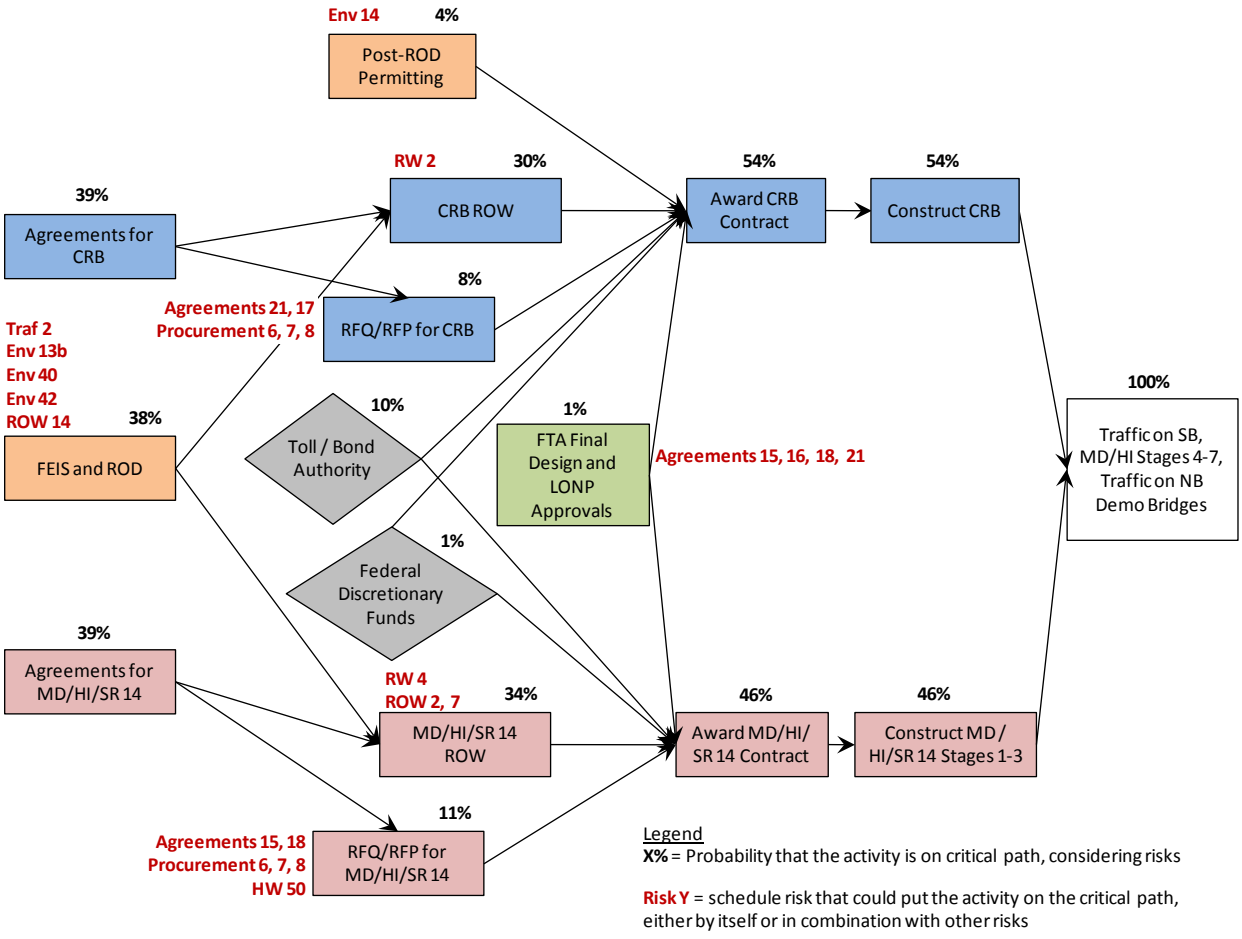
The FEIS and ROD have an approximate 38 percent chance to drive the schedule, due to various possible combinations of the risks shown on Figure 4-6. Note that it is generally not possible to identify any one combination as being most critical. The most significant of these schedule risks are:

- ROW 14 (Delay in agreement between Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) on shared parcels), with a mean schedule impact of approximately 1 month;
- Env 40 (Other delay to FEIS), with a mean schedule impact of approximately 1 month; and

Right-of-way acquisition for both the Columbia River Bridge and the adjacent interchanges (Hayden Island, SR 14, and Marine Drive) could also experience delays and have an approximate one-third chance (each) to drive the overall project schedule.

Delays to procurement activities (RFQ/RFP) for design-build contracts for both the Columbia River Bridge and the surrounding interchanges are also possible, but these activities are less likely than the corresponding right-of-way acquisition activities to drive the overall project schedule.

Figure 4-6. Schematic of Uncertainty in Critical Path and Significant Schedule Risks (Baseline Funding, Phase 1)



4.3.2 Full FEIS Build

The second build alternative evaluated during this CEVP is the Full Build FEIS. As shown in Figure 4-7, the CEVP results indicate that at a 60 percent confidence level, the Full FEIS Build can be completed at a cost of $3,365 million (YOE) compared to the base cost estimate of $2,742 million (2011 dollars). Similarly, results in Figure 4-8 and Table 4-3 indicate that the Full Build could be completed by March 2022 with 60 percent confidence. The base completion date is November 2021. Note that there are only minor differences in the schedule results between the Phase 1 and Full-Build alternatives, because the base schedules were assessed to be the same and only four risks on the register were assessed to differ between the two build alternatives.
The significant cost and schedule risks are very similar for the two build alternatives. Figure 4-9 highlights the difference in cost risks between the Full Build and Phase 1 FEIS alternatives. Brown bars on Figure 4-9 for risks HW 66, HW 67, and HW 61 indicate that these risks apply for Full Build but not Phase 1. Similarly, risk HW 45 is not shown in Figure 4-9 because it does not apply to the Full Build alternative. Cost opportunities (see Figure 4-4) and critical path uncertainties (see Figure 4-6) are virtually identical for the two alternatives.

Figure 4-7. Uncertainty in Overall Project Cost for Baseline Funding, Full Build FEIS. Includes previous costs of $120.35 million

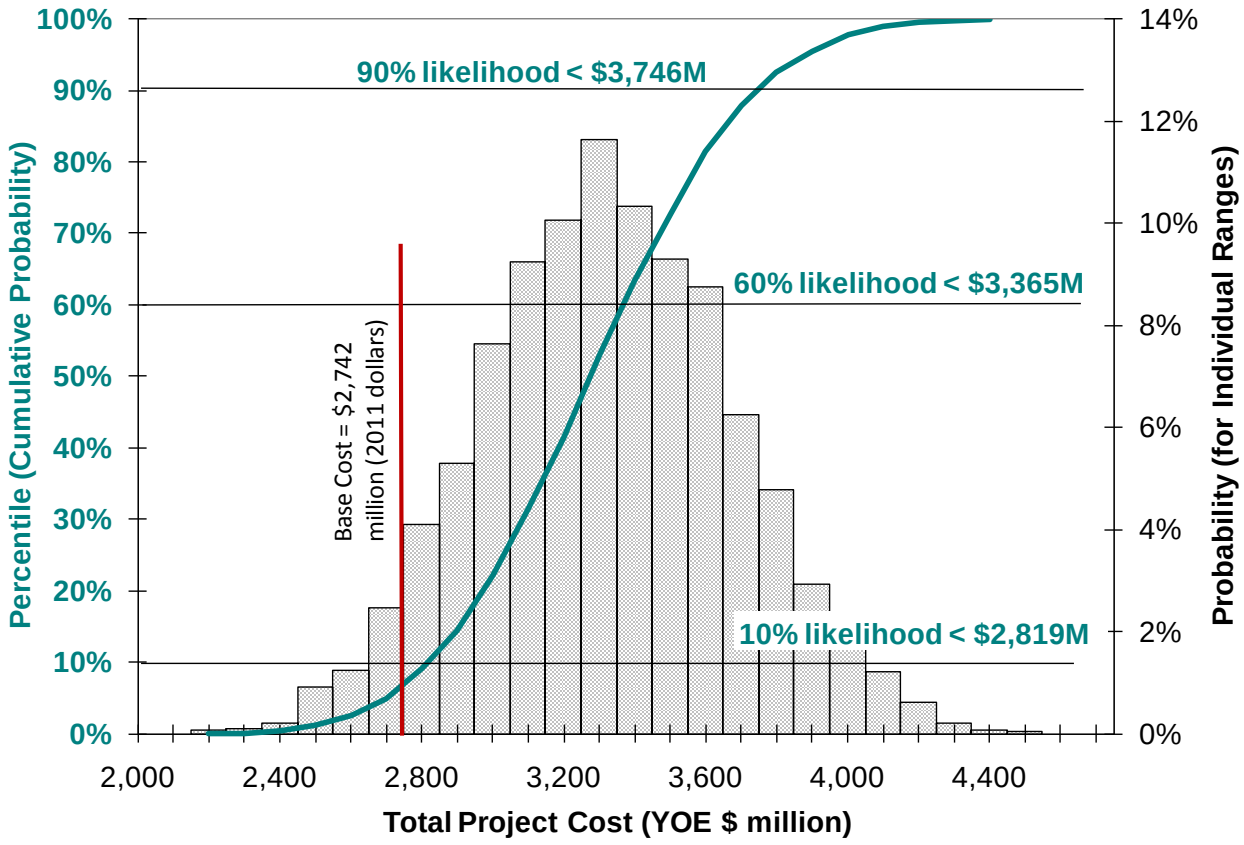


Figure 4-8. Uncertainty in Overall Project Schedule for Baseline Funding, Full Build FEIS

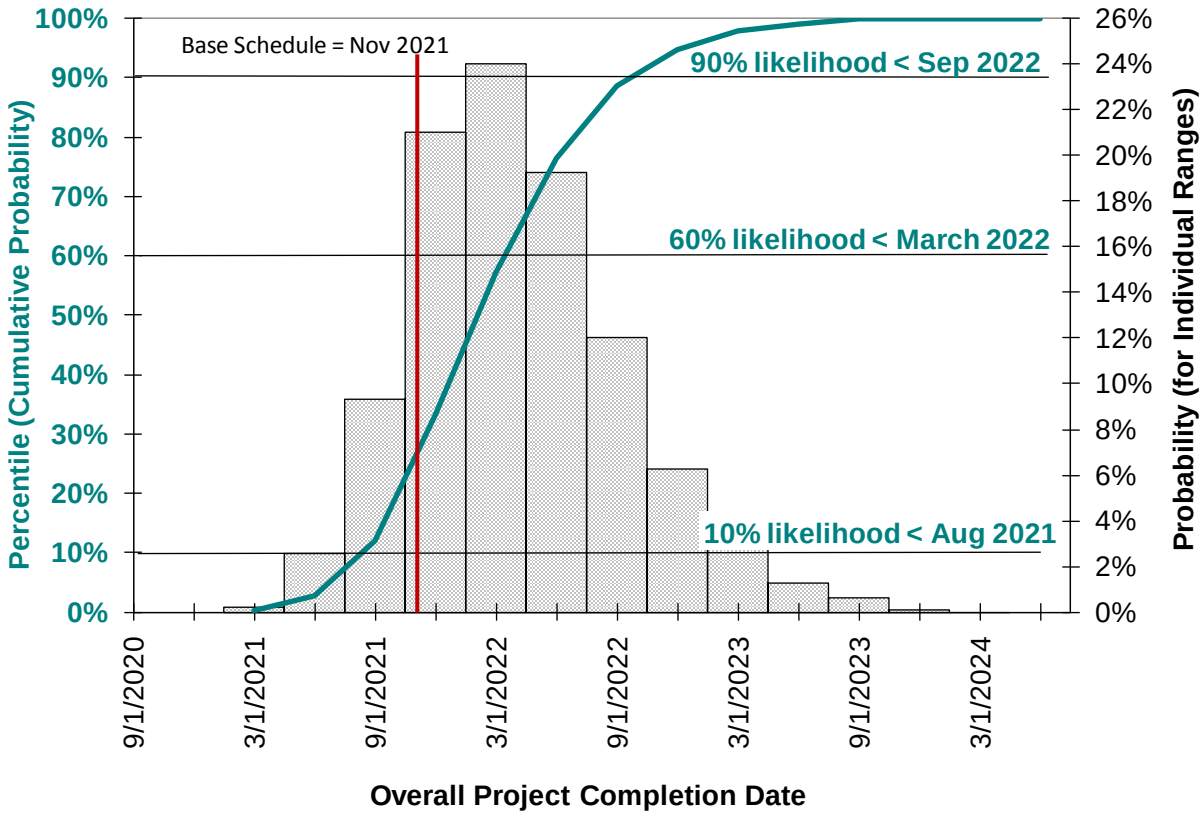


Table 4-3 Uncertainty in Major Schedule Milestones for Baseline Funding, Full Build FEIS

Activity Number / Milestone	Base	10th Percentile	60th Percentile	90th Percentile
6. ROD	11/30/2011	11/30/2011	2/20/2012	6/23/2012
22. Issue RFP CRB	10/31/2012	10/31/2012	10/31/2012	3/23/2013
24. Award DB CRB	10/1/2013	10/1/2013	1/21/2014	5/6/2014
26. Traffic on Southbound CRB	12/4/2017	11/23/2017	6/3/2018	11/22/2018
27. Begin Tolling	12/4/2017	11/23/2017	6/3/2018	11/22/2018
30. Issue RFP MD/HI/SR14	12/1/2012	12/5/2012	5/27/2013	10/14/2013
32. Award DB MD/HI/SR14	3/3/2014	3/7/2014	7/23/2014	1/27/2015
35. Traffic on Northbound CRB	5/6/2020	2/13/2020	9/9/2020	3/13/2021
41. Apply for Entry to FD	4/1/2012	4/1/2012	4/1/2012	6/24/2012
43. Approval to enter FD	1/31/2013	1/31/2013	6/4/2013	10/21/2013
45. Apply for FFGA	10/1/2013	10/1/2013	10/1/2013	10/24/2013
46. Letter of No Prejudice	1/31/2013	1/31/2013	6/4/2013	10/21/2013
47. FFGA Approved	7/2/2014	7/2/2014	7/2/2014	10/24/2014
52a. Issue RFP for LRT Park-and-Ride	3/3/2015	3/3/2015	3/3/2015	6/25/2015
52c. Award LRT Park-and-Ride DB	10/3/2015	10/3/2015	10/3/2015	1/24/2016
66. LRT Revenue Operations Date	12/6/2019	2/8/2020	9/5/2020	3/27/2021
67. Overall Project Complete	11/6/2021	8/16/2021	3/12/2022	9/13/2022

Notes:
1. FD = Final Design
2. FFGA = Full-Funding Grant Agreement
3. LRT = Light Rail Transit

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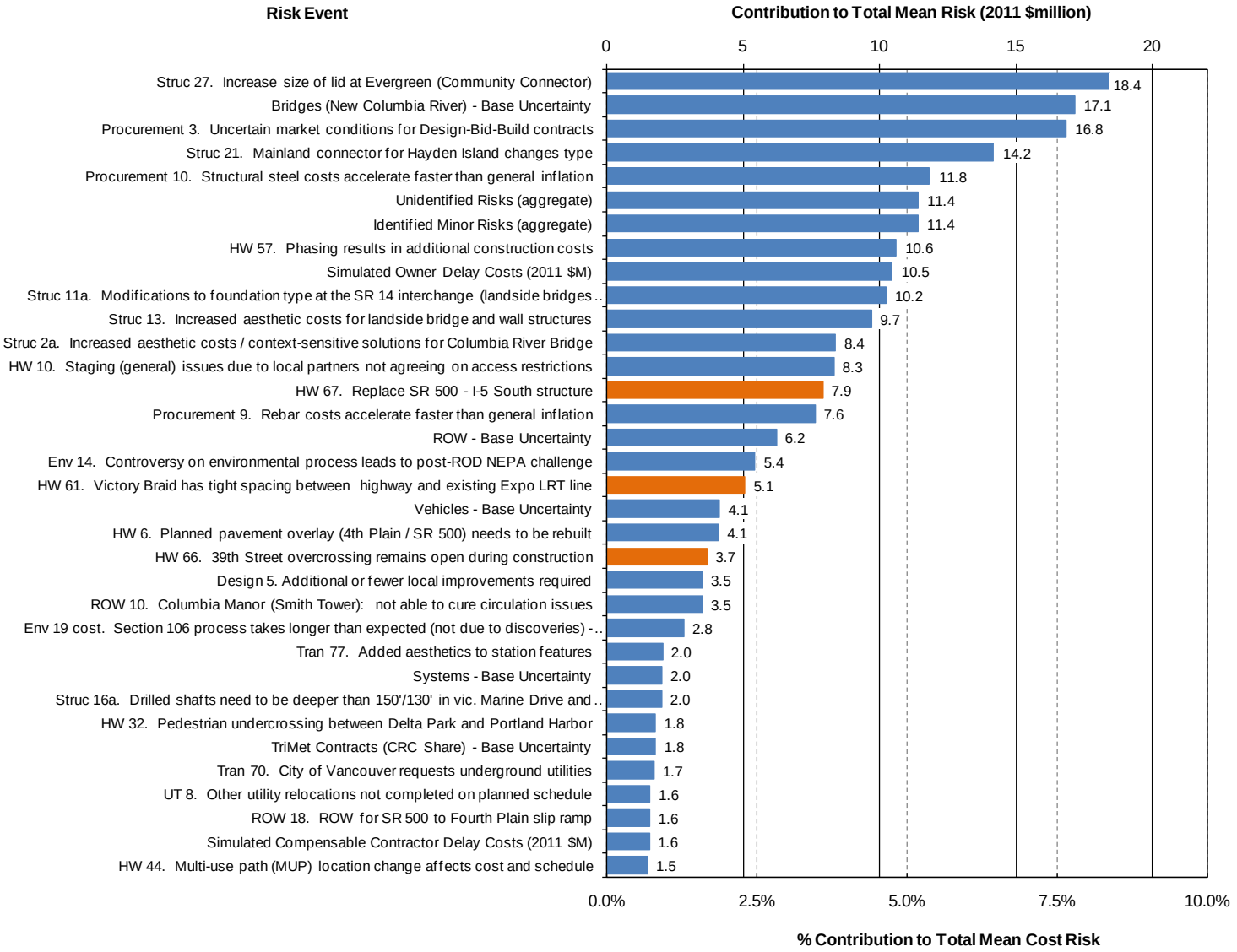
Figure 4-9. Contribution to Total Mean Cost Risk (in 2011 dollars) for the Full Build FEIS Alternative
(brown bars highlight differences from the Phase 1 alternative)



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4.3.3 Comparison of Build Alternatives Under Baseline Funding Scenario

Figure 4-10 summarizes the difference in costs (in YOE dollars) of the two build alternatives under the Baseline Funding scenario. Overall uncertainty associated with the cost of the two build options is similar as the highest cost risks and opportunities are common to both build scenarios. Results in Figure 4-10 include previous costs of $120.35 million, in addition to base uncertainty, inflation, and cost and schedule risk and opportunity.

As mentioned in previous sections, schedule results are virtually identical for both build alternatives. Differences in risks and opportunities have also been addressed in previous sections.

Figure 4-10. Comparison of Build Options Under Baseline Funding Scenario

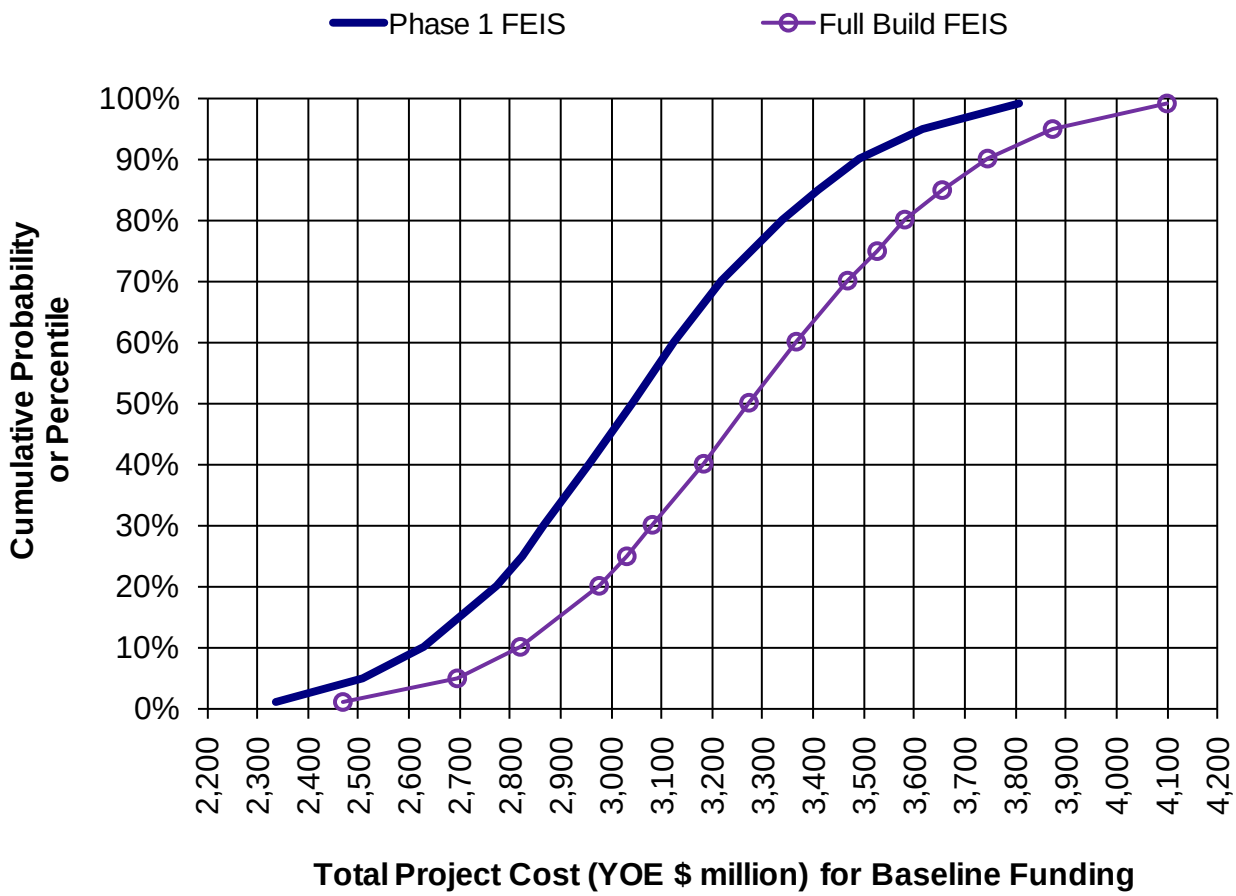


Table 4-4 summarizes uncertainty in the completion dates for key project milestones shown on the flow chart (Figure 2-1). The 60th and 90th percentiles for these milestones are presented for both the Phase 1 FEIS and Full Build alternatives, for the Baseline Funding scenario.

Table 4-4 Comparison of Uncertainty in Major Schedule Milestones for Baseline Funding

	60th Percentile		90th Percentile	
Activity Number / Milestone	**Phase 1 FEIS**	**Full Build FEIS**	**Phase 1 FEIS**	**Full Build FEIS**
6. ROD	2/18/2012	2/20/2012	6/21/2012	6/23/2012
22. Issue RFP CRB	10/31/2012	10/31/2012	3/21/2013	3/23/2013
24. Award DB CRB	1/19/2014	1/21/2014	5/3/2014	5/6/2014
26. Traffic on Southbound CRB	5/30/2018	6/3/2018	11/3/2018	11/22/2018
27. Begin Tolling	5/30/2018	6/3/2018	11/3/2018	11/22/2018
30. Issue RFP MD/HI/SR14	5/22/2013	5/27/2013	10/2/2013	10/14/2013
32. Award DB MD/HI/SR14	7/17/2014	7/23/2014	1/20/2015	1/27/2015
35. Traffic on Northbound CRB	9/3/2020	9/9/2020	2/26/2021	3/13/2021
41. Apply for Entry to FD	4/1/2012	4/1/2012	6/21/2012	6/24/2012
43. Approval to enter FD	6/4/2013	6/4/2013	10/17/2013	10/21/2013
45. Apply for FFGA	10/1/2013	10/1/2013	10/18/2013	10/24/2013
46. Letter of No Prejudice	6/4/2013	6/4/2013	10/17/2013	10/21/2013
47. FFGA Approved	7/2/2014	7/2/2014	10/18/2014	10/24/2014
52a. Issue RFP for LRT Park-and-Ride	3/3/2015	3/3/2015	6/19/2015	6/25/2015
52c. Award LRT Park-and-Ride DB	10/3/2015	10/3/2015	1/19/2016	1/24/2016
66. LRT Revenue Operations Date	9/1/2020	9/5/2020	3/23/2021	3/27/2021
67. Overall Project Complete	3/6/2022	3/12/2022	8/29/2022	9/13/2022

Notes:
1. FD = Final Design
2. FFGA = Full-Funding Grant Agreement
3. LRT = Light Rail Transit

4.4 Delayed Funding

In addition to the Baseline Funding scenario, a Delayed Funding scenario consisting of a nominal "one-cycle" delay in each of three major funding approvals was modeled. The funding delays were defined by the following differences from the Baseline Funding scenario:

- Tolling / bonding authority (Milestone 8): 7/1/2013 (versus Baseline = 4/1/2012)
- State construction funding (Milestone 9): 4/1/2014 (versus Baseline = 7/1/2013)
- Federal Discretionary Funds (Milestone 9a): 10/1/2014 (versus Baseline = 10/1/2013)

Figure 4-11 compares cost differences (in YOE dollars) between the Delayed Funding and Baseline Funding scenarios for the Phase 1 FEIS build alternative. Table 4-5 summarizes the differences in cost (at the 60th and 90th percentiles) between the two funding scenarios for both build alternatives.

As can be seen in Figure 4-11 and Table 4-5, the effect of a one-cycle delay has a $53 million impact on anticipated Phase 1 FEIS project cost at the 60 percent confidence level. The primary impacts of a funding delay are to add approximately one year of inflation and one year of WSDOT overhead costs (pre-construction) to the project. Construction inflation has been calculated using WSDOT's cost inflation tables (Table 2-1), which averages about 1.7 percent per year during the period in which delay occurs. Inflation would have a larger impact on costs if the delay was longer and/or if uncertainty in inflation rate were considered.

Figure 4-11. Effect of a Nominal One-Cycle Funding Delay on Phase 1 FEIS Cost

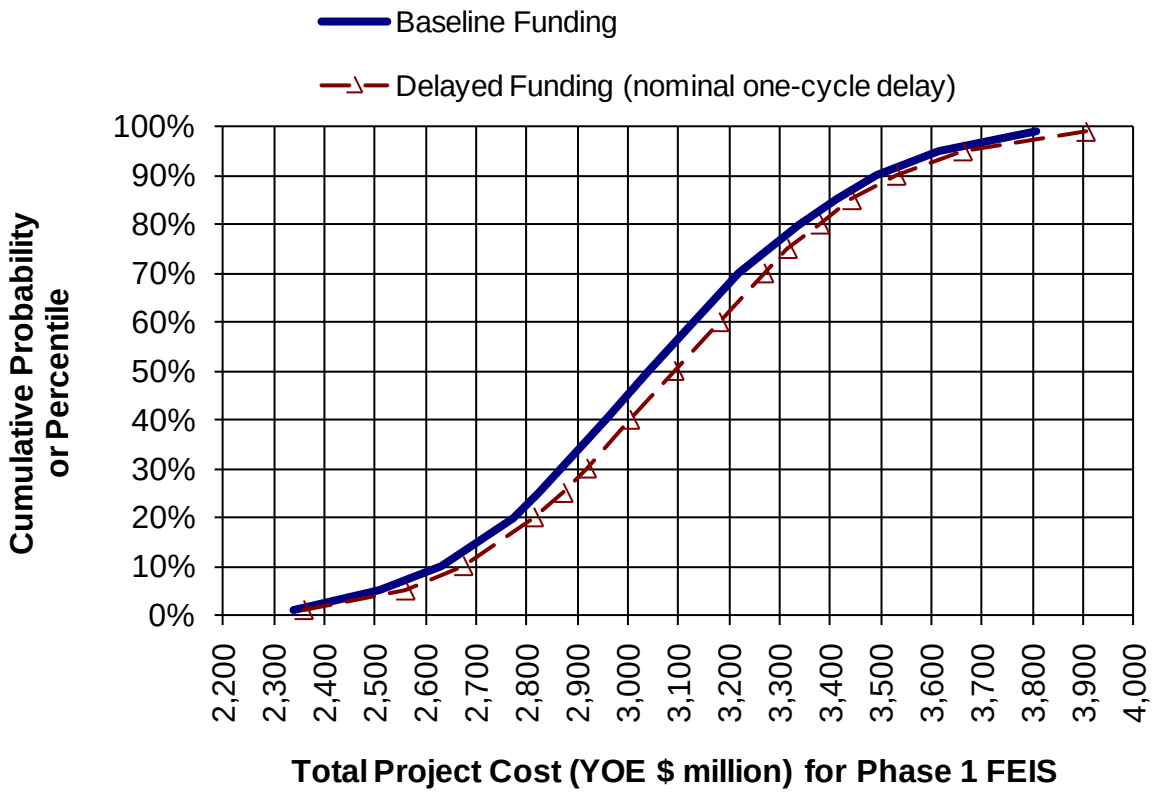


Table 4-5 Comparison of Year-of-Expenditure Costs for the Delayed and Baseline Funding Scenarios. Costs include $120.35 million in previous expenditures

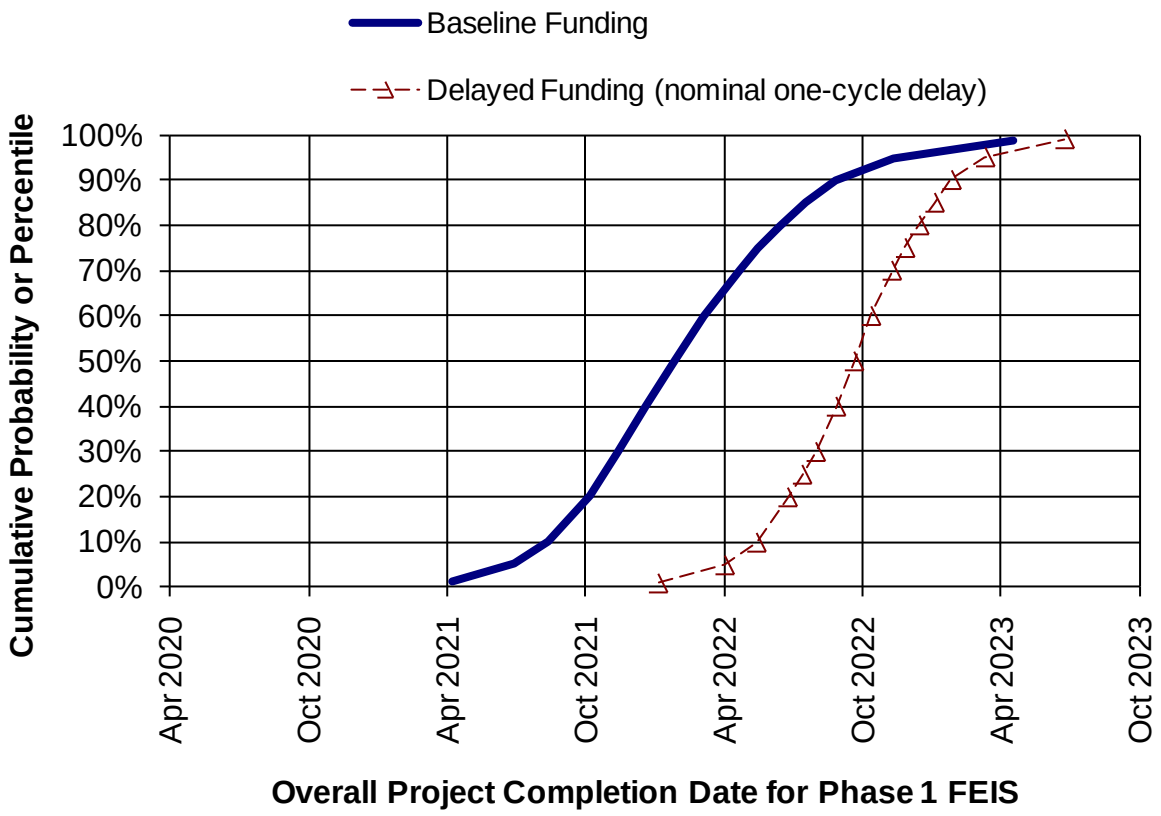
	60th Percentile			90th Percentile		
Build Alternative	**Baseline Funding (YOE $ million)**	**Delayed Funding (YOE $ million)**	**Difference (YOE $ million)**	**Baseline Funding (YOE $ million)**	**Delayed Funding (YOE $ million)**	**Difference (YOE $ million)**
Phase 1 FEIS	3,126.458	3,179.394	52.936	3,490.615	3,529.472	38.857
Full Build FEIS	3,365.075	3,421.695	56.620	3,746.463	3,788.155	41.692

Notes:

1. For any particular percentile, costs for the Delayed Funding scenario are greater than for the Baseline Funding scenario for two fundamental reasons:
    a. Additional agency overhead costs for staffing during the funding delay. Based on conversations at the workshop, it is assumed that the project overhead would continue at about the same rate as the Baseline Funding scenario (i.e., the team would stay busy during the delay). This rate was provided by the team at $2.2 million / month during pre-construction.
    b. Additional inflation due to "pushing out" construction costs as the result of the funding delay. Note that this additional inflation was based on WSDOT cost inflation table rates during the timeframe of the delay, which average about 1.7 percent per year.
2. Even though the individual funding milestones are delayed by between 9 and 15 months, the aggregate impact to the overall schedule ranges from between 7 and 12 months. The aggregate impact is less than the maximum individual funding delay because the funding delays "soak up" or eclipse potential delays to early project activities like the FEIS and Record of Decision. In essence, the funding delays create float on these early project activities, meaning delays to these activities have less influence on the overall schedule (and particularly higher percentiles) than in the Baseline Funding Scenario.

A one-year funding delay results in a project delay of about seven months at the 60 percent confidence level. As described in the notes for Table 4-5, the project delay is less than a full year because the delay in funding actually creates float for other early critical path project activities (e.g., FEIS, ROD, RFQ/RFP development). As a result, the impact from schedule risks on these activities early in the project is diminished by this funding-delay float. Because the impact of these schedule risks tends to manifest as increased completion dates at higher percentiles for the Baseline Funding scenario (see the Baseline Funding CDF in Figure 4-12), that uncertainty is reduced and the Delayed Funding CDF appears "clipped" at higher percentiles, as illustrated in Figure 4-12.

Figure 4-12. Effect of a Nominal One-Cycle Funding Delay on Phase 1 FEIS Schedule



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Appendix A
Workshop Participants

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Appendix B
Basis of Estimate

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BASIS OF CAPITAL COST ESTIMATE

May 2011 CEVP

May 18, 2011

Columbia River CROSSING

Title VI

The Columbia River Crossing project team ensures full compliance with Title VI of the Civil Rights Act of 1964 by prohibiting discrimination against any person on the basis of race, color, national origin or sex in the provision of benefits and services resulting from its federally assisted programs and activities.

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ACRONYMS

CEVP	Cost Estimation Validation Process
CRC	Columbia River Crossing
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
ODOT	Oregon Department of Transportation
TriMet	Tri-County Metropolitan Transit District of Oregon
WSDOT	Washington State Department of Transportation

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1. Introduction

1.1 Background

The Columbia River Crossing (CRC) is a bi-state multi-modal project focused on improving safety, reducing congestion, and increasing mobility of motorists, freight, transit riders, bicyclists and pedestrians along a five-mile section of the I-5 transportation corridor connecting Portland (Oregon) and Vancouver (Washington). It is being sponsored by the following four agencies:

- Oregon Department of Transportation (ODOT)
- Washington State Department of transportation (WSDOT)
- Tri-County Metropolitan Transit District of Oregon (TriMet)
- Clark County Public Transit Benefit Area Authority

There are also a number of other local, state and federal agencies that have varying levels of influence over project development and design. They include the cities of Portland and Vancouver, Oregon Department of Environmental Quality, Washington State Department of Ecology, Federal Highway Administration, Federal Transit Administration, Coast Guard, National Marine Fisheries Service, and Environmental Protection Agency.

The project extends from Victory Boulevard in north Portland to the I-5/SR 500 interchange in north Vancouver, and includes the I-5 bridges across the Columbia River and North Portland Harbor (a side channel of the Columbia River) and six interchanges that connect I-5 to three state highways and several arterial roads. To provide a physical context, there is extensive urban development both sides of I-5, and an airfield (Pearson Airfield) and a national historic reserve (Fort Vancouver) is located east of I-5 and north of the Columbia River. The corridor also provides a route for major utility infrastructure, especially communications. From an environmental perspective, the area is rich in history and the Columbia River contains several species listed under the Endangered Species Act.

A Draft Environmental Impact Assessment was published in June 2008 and the Federal Transit Authority has funding for preliminary engineering under its New Starts program. A Locally Preferred Alternative (LPA) has been adopted and includes:

- Full replacement of the bridges over the Columbia River to provide for freeway, transit, pedestrian, and bicycle traffic. The existing bridges will be removed.
- Five reconfigured interchanges with additional auxiliary lanes connecting the new bridges and improved or replaced interchanges. Improvements to a sixth interchange (at SR 500) are assumed to be phased and are not included in the Base Cost Estimate.
- Extension of existing light rail transit (LRT) from the terminus at Expo Center, across Hayden Island, the Columbia River, and through downtown Vancouver with a terminus near Clark College, including park-and-rides, stations, and other related improvements.
- Bridges across the North Portland Harbor between Hayden Island and the Portland mainland for freeway, transit, pedestrian, and bicycle traffic and dozens of landside

bridges replaced or improved for mainline freeway, grade-separated crossings, or related to individual interchanges.

- Pedestrian and bicycle connections to bridge crossings.
- Expansion of TriMet's maintenance facility at Ruby Junction and construction of a new operations center, a portion of both will be paid for by the CRC project, and improvements to the LRT tracks on the Steel Bridge in Portland, which will be funded entirely by the CRC project. All three will be designed and constructed by TriMet.

The Final Environmental Impact Assessment is scheduled to be completed and Record of Decision expected to be issued in 2011.

The current base cost estimate assumes the following construction delivery methods:

- Design-build for bridges across the Columbia River.
- Design-build for the Marine Drive, Hayden Island and SR 14 interchanges.
- Design-bid-build for the Mill Plain, Fourth Plain and SR 500 interchanges.
- Design-bid-build for the transit guideway and associated improvements (note that a GCCM delivery method is also being considered for transit construction in Washington).
- Design-build for the park and ride structures.

Currently, the project is at the conceptual level of design development with some elements being more advanced than are others. The bridges across the Columbia River and North Portland Harbor as well as land-side bridges in Oregon are at about the five percent level of design while the transit infrastructure and bridges in Washington are at about the 20 percent level of design. The 30 percent level of design is scheduled be completed in early 2012 for highway and transit elements that would be constructed using a design-bid-build or GCCM delivery method. All major features are fairly well defined; for example, areas of bridges, the length of highway lanes, the length of guideway and number of stations are known with a reasonable degree of certainty. While highway and transit alignments and profiles have been developed, they are still subject to change.

Consistent with prior estimates, approximately 60 percent of the capital cost can be attributed to bridges, about 55 percent of which comprises the bridges across the Columbia River and North Portland Harbor; an important note when reviewing the cost estimates.

A number of changes have occurred since the prior CEVP update in October 2010 as a result of design development and stakeholder input. The more significant of these are:

1. The FEIS is in the final stages of production and many of the potential environmental constraints and mitigation requirements are better defined.
2. Geotechnical exploration work was undertaken throughout the project corridor. Preliminary foundation recommendations have been provided for all bridges.

3. The governors of Washington and Oregon selected a deck truss for the Columbia River Bridges. The overall horizontal alignment of the main river crossing is virtually unchanged.

4. A mix of contracting approaches is now being proposed compared with a single design-bid-build method assumed for prior CEVPs.

1.2 Purpose of Report

This *Basis of Capital Cost Estimate* report describes the methodology used to develop the capital base cost estimate for the Cost Estimate Validation Process (CEVP) scheduled in May 2011. The current CEVP builds on the in-depth CEVP workshops conducted earlier. WSDOT defines the Base Cost as the cost, in today's dollars, that can most reasonably be expected if no significant problems occur, with typically small uncertainty or variance. As such, the base cost includes a level of change orders typically expected during construction. In essence it is the sum of all costs excluding escalation, contingencies and risk events; an important point to note when reviewing the cost estimates.

Uncertainty and risk events are defined prior to and during the CEVP. Monte Carlo probabilistic modeling will be used to assess schedule and cost impacts, including escalation.

The methodology presented in this report provides a reliable and consistent basis for calculating and comparing estimated capital costs.

1.3 Project Alternatives

Base cost estimates were prepared for the Locally Preferred Alternative (LPA):

- Full-Build
  - Five southbound and northbound highway lanes across the Columbia River.
  - Two deck truss bridges across the Columbia River. The LRT guideway would be located on the lower level of the southbound bridge and the bike-pedestrian path would be located on the lower level of the northbound bridge.
  - New ramp bridges over North Portland Harbor.
  - Reconfigured interchanges at Marine Drive and Hayden Island in Portland, and SR 14, Mill Plain Boulevard and Fourth Plain Boulevard in Vancouver.
  - New bridges across I-5 at Evergreen Blvd, 29th Street and 33rd Street (all in Vancouver).
  - At-grade LRT guideway from the existing TriMet LRT station at the Expo Center to North Portland Harbor.
  - A combined local access-LRT bridge across North Portland Harbor.
  - Elevated LRT guideway across Hayden Island with structures across Tomahawk Island Drive and Hayden Island Drive, embankment in between.

  - At-grade LRT guideway through Vancouver to a terminus located near Clark College. The route comprises a couplet arrangement with the northbound track on Broadway Street and the southbound track on Washington Street, and an east-west double guideway along 17th Street west of I-5 and McLoughlin Blvd east of I-5 to the terminus.
  - Three park and ride structures located in Vancouver on Columbia Street near the SR 14 interchange, in the Mill Plain area and near Clark College.
  - A combined bike-pedestrian path that connects the existing pathway system at the Marine Drive interchange in Portland to downtown Vancouver.
  - Local road improvements at the Marine Drive and Hayden Island interchanges in Portland, and SR 14 interchange in Vancouver.
- Phase 1 (same as the Full-Build except for the following)
  - The flyover ramp from eastbound Marine Drive to northbound I-5 at the Marine Drive interchange would be phased and constructed to a later date.
  - Most of the SR 500 interchange would be phased and constructed at a later date.

1.4 Estimate Classification

As project designs are developed and refined, the level of detail provided in the capital cost estimates increases to reflect the level of design development. This cost estimate prepared is considered a Conceptual Level or Class 4 estimate as defined by the Association for the Advancement of Cost Engineering (AACE) and American Society of Testing and Materials (ASTM). Due to the nature and size of this project, the WSDOT Cost Estimate Validation Process (CEVP) is being used to determine the range of the potential effect of risk and uncertainty on base cost and schedule.

2. Methodology

This section discusses basic capital cost estimating procedures and assumptions used to develop capital cost estimates. Compared with the October 2009 CEVP, the library of unit and composite costs has been updated and quantities have been re-estimated.

The development of the current capital cost estimates comprised the following five general steps.

2.1 Identify Project Elements

The project cost estimate was divided into the following major categories:

- Marine Drive interchange.
- Hayden Island interchange including the approach spans for bridges over the Columbia River.
- SR 14 interchange including the approach spans for bridges over the Columbia River, Evergreen Boulevard bridge over I-5 and adjacent community connector.
- Mill Plain interchange including the I-5 bridge over McLoughlin Boulevard.
- Fourth Plain interchange including the 29th Street bridge over I-5.
- SR 500 interchange including the 33rd Street bridge over I-5
- Bridges over North Portland Harbor.
- Removal of existing bridges across the Columbia River.
- New bridges over the Columbia River.
- Transit guideway in Oregon.
- Transit guideway in Washington.
- Park and ride structures.
- Project elements to be designed and constructed by TriMet.

A list of project elements was developed for each category that was comprehensive enough to adequately define all aspects of project construction while reflecting the level of design development and quantities that could be readily measured. These elements, which comprised items such as highway pavement, bridges, ramps, LRT guideway and parking structures, provided the basis for the project cost library; a compilation of unit, composite and lump sum costs.

2.2 Develop Cost Library

The cost library comprises unit, composite, and lump sum costs and percentages. Costs presented in the library are in Q1 2011 dollars, and are mainly based on data available from WSDOT, ODOT and TriMet. Cost data provided by TriMet was accepted on an as-is basis; these mainly comprised items that would be constructed by TriMet (such as the operations and

maintenance facilities) or items that provide a known level of finish (such as LRT stations). Unit and lump sum costs are generally slightly higher or the same as the Q1 2010 costs used for the prior CEVP.

2.2.1 Unit Costs

Unit costs are defined as the basic construction elements such as excavation, fill, concrete, asphalt, and reinforcing steel. These elements usually represent the greatest level of breakdown in a construction cost estimate (at the 100 percent level of design) and will frequently comprise the items listed in the schedule of quantities in construction bid documents.

A comprehensive list of unit costs was developed from WSDOT and ODOT data for bids received from November 2005 through 2010. To ensure that unit costs are appropriate for the CRC project, data were only used from contracts with three or more bidders and where the lowest bid was greater than $10 million.

Bid data were provided by WSDOT and ODOT in the form of Excel and DAT files. Unit costs were extracted and for three ODOT contracts, data were converted from metric to U.S. units of measure. Although a number of ODOT line items were contracted as lump sums, agency staff had provided estimated quantities and unit prices. These were also added to the data set.

Median unit costs were determined for each bid line item on a bid-by-bid basis. Median values were used because they are considered to "best reflect the bidders' collective assessment"[1] [2] of likely costs and to be relatively immune to the effect of outliers sometimes found in bid data[3].

This approach worked well for the WSDOT bids where there is only one line item for each specific item of work, regardless of where that work might be performed within the project. For example, there would be only one line item and one associated unit cost for an MSE retaining wall even though there might be a number of such walls in different locations. In contrast, ODOT bids are split into major project elements that, in some cases, resulted in different unit costs for the same pay item. Using the prior example, there could be separate line items for each MSE wall and, potentially, different unit costs. To overcome this problem, the average of the individual median unit costs was used for that pay item.

Based on an analysis of bids, using median prices would result in a cost estimate that would be, on average, approximately 5 percent higher than the lowest bid. This difference is similar to the percentage used by WSDOT as an allowance for contractor claims during construction; further supporting the argument that median prices are a good reflection of final construction costs.

---

[1] *Risk Assessment in Competitive Procurement* by Larry Crowley. Journal of Construction Engineering and Management. June 1995.

[2] *Using Bidding Statistics to Predict Completed Construction Cost* by Michael Wright and Trefor Williams. Engineering Economist. Summer 2001.

[3] *Robust Statistical Estimators for Use Within Competitive Bid Data* by Larry Crowley. Journal of Construction Engineering and Management. March 1997.

WSDOT and ODOT construction cost indices (CCIs) provided a useful basis for escalating unit prices to Q1 2011 dollars. Median unit costs were escalated using the ratio of historic and projected CCIs available from each agency, and then averaged.

2.2.2 Composite Costs

Parametric costs used in the detailed estimates (for example, costs per linear foot of highway or guideway) are comprised of composite costs that include elements such as guideway construction, highway lanes and stormwater pipes. Composite costs were built up from historic unit costs or estimated labor, equipment and material costs, and quantities for typical arrangements or layouts. For example, the per-unit-length composite cost for the I-5 mainline was built up from quantities estimated from a typical cross-section and costs of activities required to construct the pavement. These activities included excavation, sub-base, and asphalt concrete pavement, among other unit costs. Allowances, typically 10 percent, were included in these costs to cover minor unmeasured items that are known to exist at final design but were not quantified at this level of design. These allowances were based on estimator judgment and experience.

2.2.3 Contractor-Style Built-Up Costs

Cost estimates for the bridges across the Columbia River and their approach spans were developed using a contractor-style estimating approach. This approach allows for the consideration of mobilization, equipment costs, crew requirements, bond, fee, contractor risk, and materials (supply, fabrication, delivery, erection, etc) as opposed to relying on historical bid data for material quantities. An allowance of two percent was included to cover minor unmeasured items; a value that reflects the degree of confidence in foundation quantities.

2.2.4 Lump Sums

Lump sum costs are typically developed based on quantity take-offs from general layouts of facilities such as park and ride structures and water quality ponds. Right-of-way costs, while presented as lump sums, were based a parcel-by-parcel evaluation of potential impacts. The partial and full acquisitions proposed in the draft FEIS were used as the basis for this estimate. Right-of-way costs include acquisition (right-of-way purchase, temporary construction easements and staff time), relocation and demolition. A 30 percent allowance was added to acquisition costs for potential condemnation.

Other lump sum costs such as the LRT stations and substations were based on costs adopted by TriMet. These lump sum costs represent known standards of construction and finish, standards that will likely be adopted for the CRC project.

2.2.5 Percentages

Percentages are based on historical sources (for example, mobilization, traffic control, temporary erosion and sediment control and construction staging) or prevailing experience (for example, final design).

2.3 Measure Quantities

The capital cost estimates are based on quantities generated from the computer-aided design and drafting model for the entire project. This comprehensive project-wide approach coupled with the use of stationing to define locations or beginning and end points minimized the likelihood of either duplicating or missing project elements.

Elements measured include areas of bridges, length of highway and LRT guideway, exposed area of retaining walls and number of stations, and number of LRT vehicles. Beginning and end stationing were provided for linear elements and bridges

2.4 Prepare Cost Estimate

An Excel workbook was developed for the capital cost estimate. The estimate for each alternative was organized under the main packages described in Section 2.1. Each package was subdivided into major elements such as pavement, earthwork, and bridges for interchanges, and by major FTA Standard Cost Categories (guideway, tracks, stations, etc.) for LRT.

Cost items that could be directly related to a package, including lump sums and percentages, were listed on a line by line basis and subtotaled for that package and cost grouping. Sales tax was added on a line-by-line basis for items located in Washington State. Unit and composite cost items were based on estimated or measured quantities.

2.5 Data Validation

Many of the costs in the project cost library were developed from recent bid data as described in Section 2.2; specifically recent contractors' bid information or schedule of values or engineer's estimates prepared for highway and light rail projects in the region. As such, they are “self-validated” against available sources of cost information. They also include contractor or supplier mark-ups for overhead and profit. Prior CEVP estimates for other projects, and consultant and national databases were used where regional data were not available or to provide confirmation of regional unit costs.

Historical competitive bid data for comparable work is a reliable source, particularly if consistent levels of construction have been maintained in the region within the past several years. Recent information is more reliable because it does not require significant escalation assumptions. Contract as-built prices are the most comprehensive sources because they include the total cost of construction at construction closeout and acceptance.

Quantities were checked by the team providing those data, and those teams also verified the quantities input into the base cost estimate spreadsheets. The contractor-style costs were validated by independent estimates developed using a similar approach.

2.6 Assumptions

Major assumptions made when developing the cost estimate include:

- Market Adjustment Factor, escalation, risk and uncertainty are not included in the base cost estimate. They will be developed as part of the CEVP. The Market Adjustment Factor is above and beyond the typical contractor mark-ups and current but normal escalation factors. It covers the potential influence of an abnormal bidding environment such as a lack of competition among contractors (contractors being busy or selectively bidding jobs), competition for construction personnel that requires contractors to pay wage premiums to retain key workers and management staff, and abnormal increases or decrease in fuel and material costs.
- Labor unit prices reflect a burdened rate and include items such as workers compensation, unemployment taxes, social security, fringe benefits, and medical insurance. The average of the Bacon Davis rates for Oregon and Washington were used (note that the rates for Washington have increased since the prior CEVP while those for Oregon have not).
- Unit costs reflect anticipated construction costs and include the contractor's or supplier's mark-ups for overhead and profit.
- This cost estimate currently reflects a mix of design-bid-build and design-build contracts in a competitive bidding environment with a minimum of four bidders.
- Sales tax, while not applicable for work performed in Oregon, is included on construction in Washington State (as the design advances and scope detail increases, some items may be identified as being exempt from sales tax per WAC 458-20-171).
- Potential additional costs for aesthetic treatments would be included as part of CEVP.
- Dewatering for construction work within areas away from the Columbia River and North Portland Harbor (including Hayden Island) is assumed to be a minor cost item.
- Soil conditions are adequate for the work performed and over-excavation is not required.
- Imported construction materials such as fill and concrete are available in sufficient quantities from local suppliers, and that waste material can be disposed of locally.
- The existing Columbia River Bridge foundations will be removed to the “mud line.”
- All material will be new and that there will be “Buy America” requirements.

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3. Bridges

As stated in Section 1.1, approximately 60 percent of the capital construction cost can be attributed to bridges. For that reason, the development of costs for these structures warrants a separate discussion.

3.1 Columbia River Bridges

For the purposes of the cost estimate, main highway and transit bridges over the Columbia River are assumed to be deck truss structures.

Each of the bridges would have seven spans with main spans of approximately 465 feet and an overall length of approximately 2,900 feet. A conceptual structural analysis was performed for the two proposed bridges over Columbia River and foundation layouts were developed for the Columbia River Bridge assuming 10-foot diameter drilled shafts with permanent casings extending to the Troutdale Formation. Available geotechnical data provides a significant degree of confidence in the number, size and depth of drilled shafts. Although the bridge type has changed since the prior CEVP, the foundations will be similar.

Material quantities for the construction cost estimate were determined and a contractor bid-type approach, using the calculated quantities, was used to develop overall costs.

3.2 Landside Bridges

A matrix of landside bridge data has been developed that includes information such as the proposed type of bridge, nature of modification (widening, new, or replacement,) superstructure area, length, width, foundation depth. The data in the matrix reflects the results of recent geotechnical investigations and current knowledge of foundation conditions.

Although presented as lump sums in the base cost estimate, the individual cost of most bridges in Washington are based on an estimate of quantities of items such as concrete and steel. These estimates were based on TS&L drawings prepared for each structure and recommended foundation depths. Most bridges in Oregon were estimated using the unit costs used for the prior CEVP.

Material quantities for the construction cost estimate for the approach spans on each side of the bridges across the Columbia River were determined using the results of conceptual structural analyses. A contractor bid-type was used to develop the estimates similar to that described in Section 3.1.

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Appendix C

Risk/Opportunity Register

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								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
101	Toll1b	0	Agreements	Excluded	Tolling authority for I-5 is delayed		**Excluded - funding risks being modeled as separate scenarios.** Expect FHWA will grant tolling authority if State approves because it's just for the main bridge (minor risk). WSDOT will pursue tolling authority during the 2012 legislature (ends March 2012). Tolling authoirty will be critical to pursue Federal funding (1/3 of project funding), however, Legislators will be uncomfortable granting tolling authority (which will provide the required 1/3 local funding) unless other funding mechanisms are in place for CRC. Federal piece won't come without state funding. Five of nine local (Clark County) legislators oppose tolling. Significant risk that tolling won't be approved in Washington. AUthority to toll already exists in Oregon.	25%	0.0	0.0	0.0	**$0.0**	12.0	18.0	24.0	**4.5**
131	Agreements 15	1	Agreements	Apply to both 30 and 43 (perf corr)	Railroad agreement term sheets take longer than assumed (delaying construction)	Based on the progression of this project and past projects, the probability is closer to 25%. Reduce probability from 50% to 35%.	Delay in getting railroad term sheets delays entry into FTA final design. Essentially need term sheet by the end of 2011.	35%	0.0	0.0	0.0	**$0.0**	1.0	4.0	8.0	**1.5**
56	Agreements 21	0	Agreements	Apply to both 22 and 43 (perf corr)	Consensus issues between WSDOT and ODOT on partial design package for River Bridge design build	Have design Approval in WA, do not have design acceptance in OR.	Differences between ODOT and WSDOT specifications will be difficult to resolve (will there be different specs that apply to different states). FTA and FHWA also involved as Transit will run across bridges. FTA will view unresolved differences between WSDOT and ODOT as a technical capacity issue and that could delay approvals. May need TS&L for all Oregon bridges to get Design Approval (DAP). Current staff level doesn't account for getting TS&L for all Oregon bridges. Cost risk is minor. Delays to Boxes 30 and 43 are perfectly correlated. Risk is independent of similar risk for interchange	25%	0.0	0.0	0.0	**$0.0**	1.0	4.5	6.0	**1.0**

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Agreements 18		Agreements	Apply to both 30 and 43 (perf corr)	Consensus issues between WSDOT and ODOT on partial design package for Hayden Island design build	Have design Approval in WA, do not have design acceptance in OR.	Differences between ODOT and WSDOT specifications will be difficult to resolve (will there be different specs that apply to different states). FTA and FHWA also involved as Transit will run across bridges. FTA will view unresolved differences between WSDOT and ODOT as a technical capacity issue and that could delay approvals. May need TS&L for all Oregon bridges to get Design Approval (DAP). Current staff level doesn't account for getting TS&L for all Oregon bridges. Cost risk is minor. Delays to Boxes 30 and 43 are perfectly correlated. Risk is independent of similar risk for CRB.	40%	0.0	0.0	0.0	**$0.0**	1.0	2.0	3.0	**0.8**
	Agreements 17		Agreements	21	Delays getting agreements on aesthetics with partner agencies		Partner agencies will want to be involved with hiring architects and getting feedback on aesthetic elements of project. This could affect completing development of the RFP. Cost issues with aesthetics are captured elsewhere.	20%	0.0	0.0	0.0	**$0.0**	1.0	3.5	6.0	**0.7**
95	Agreements 16	0	Agreements	45	Delay to agreements with the City of Portland	Other issues with bridge are captured in the Iconic bridge construction (Struc21). Having difficultly deciding who will own and operate the bridge, however the assumption is the bridge will be built. Not quantified.	Agreements include: TriMet and City over mainland connector ownership and operation; ROW agreements; O&M agreements; mainland connector; ODOT O&M agreements; Since last CEVP continuing discussions with the City of Portland have progressed making delay less likely. Aesthetics agreements excluded.	20%	0.0	0.0	0.0	**$0.0**	0.0	2.0	6.0	**0.5**

Risk Register - CRC								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Agreements 20		Agreements	42	Milwaukee project doesn't go forward and would lead to no cost sharing		If Milwaukee project doesn't happen, all costs associated with Ruby Junction end up as part of CRC project	10%	5.0	5.0	5.0	**$0.5**	0.0	0.0	0.0	**0.0**
	Design 5		Agreements	34	Additional or fewer local improvements required		Project team believes that the existing assumptions for local improvements are conservative. Have captured MUP, trails, expanded lid at Evergreen, aesthetics for bridge detour improvements elsewhere. Could be forced to add waterfront park on Hayden Island; or waterfront park in Vancouver; 7th Street overcrossing.	10%	20.0	25.0	30.0	**$2.5**	0.0	0.0	0.0	**0.0**
	Agreements 19		Agreements	Minor	Cost allocation agreement for SHTB is necessary to avoid shifts in cost allocation		Agreement between, CRC, FHWA, FTA need to allocate costs of bridge between the various agencies	Minor								
	Agreements 2		Agreements	Minor	Delay in agreements with resource agencies		Team says unlikely. MOA and 404 are covered in environmental risks. BO is in place.	Minor								
	Agreements 3		Agreements	Minor	Owner issues managing overall project (capacity)		Aside from what was captured under procurement risks. WSDOT capable of staffing up to meet the demand	Minor								
99	Agreements 7	0	Agreements	Minor	Delay to ODOT/WSDOT agreement		There is a chance that there will be challenges getting agreement on finance plan, particular tolling finance and governace. Could affect FTA FFGA application. Not being modeled	Minor								
	Design 1		Agreements	Excluded	Uncertainty in project scope to be built (e.g., full vs. phased build		This uncertainty is treated by comparing separate model scenarios (i.e., so can compare full vs. phased build results).	Excluded								
	Design 10		Agreements	Minor	Add or remove an interchange from the project		Project team says not likely; significantly vetted.	Minor								
	Design 11		Agreements	Minor	Significant change in transit concept / design for the project		Unlikely for any major change in concept. Note: mutually exclusive with risk above.	Minor								
	Design 2		Agreements	Minor	Change in project alternative (e.g., to cable-stayed bridge)		The governors of Washington and Oregon have just directed the composite deck truss. The possibility of any other major alternative is therefore excluded from this CEVP, but could be added as a second model scenario later	Minor								

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Design 3		Agreements	Minor	Significant change in project alignment for assumed alternative		A straightened alignment for the deck truss is possible, but not likely.	Minor								
	Design 4		Agreements	Minor	Transit is removed from the project		Very unlikely - the project needs FTA funds to continue.	Minor								
	Design 9		Agreements	Minor	Significant change in project limits (other than captured under phased-build scenarios)		Unlkely	Minor								
	Construction 8		Construction	Evenly split between 33 and 34	Accelerate construction of HI / SR14/MD DB contract		Relative to the base duration of 76 months, there is an opportunity for the contractor to complete the HI/SR14/MD contract sooner and within the base cost assumptions. Cost changes shown as % of base DB contract cost. -5% on low end, -3% most likely, -1% high end. Duration changes are -3 months each to 33 and 34 (affects both).	60%	-40.0	-25.0	-8.0	**-$14.8**		-3.6		**-1.4**
	Construction 4		Construction	19	Interface / coordination issues between DB and DBB contractors		For example, between HI DB and MD DBB (main concern--but no longer applicable since MD now included in HI/14 package - reduced maximum delay to 2 months) or between SR 14 DB and Mill Plain DBB. The physical interfaces (structure-structure) might not be the big issue; timing of the interfaces (completion dates) could be.	50%	0.0	0.0	0.0	**$0.0**	1.0	1.5	2.0	**0.8**
	Construction 7		Construction	25	Accelerate construction of CRB DB contract		Relative to the base duration of 47-53 months, there is an opportunity for the contractor to complete the CRB contract sooner and within the base cost assumptions. Cost changes shown as % of base DB contract cost.-5% on low end, -3% most likely, -1% high end.	15%	-27.0	-16.0	-5.0	**-$2.4**		-5.0		**-0.5**

Risk Register - CEVP								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Construction 1		Construction	Excluded	Existing river bridge fails before or during construction of the new bridge is complete		While always some small possibility, this would fundamentally change the project, so excluded from the CEVP	Excluded								
	Construction 10		Construction	Minor	Rapid construction of jump span		For example, build offline and roll in (SPMT). Minor direct cost impact (a wash), but savings in schedule for the jump span, but perhaps not for the overall duration of Activity 33.	Minor								
	Construction 11		Construction	Minor	Mainland connector to Hayden Island is built before SB NPH ramp bridges.		Available room for construction of SB ramp bridges over NPH is limited. Risk is getting "hemmed in". However, building ramp bridges early has other benefits. Cost of changing from steel plate girder is included in base uncertainty.	Minor								
	Construction 2		Construction	Minor	Significant change in construction sequencing / phasing (if not captured separately as part of different model		Captured largely through other opportunities in this register and the base duration uncertainty for the DB contracts.	Minor								
	Construction		Construction	Minor	Issues demolishing existing bridge over river		Team feels that the demolition is really nothing unusual, and the base is adequate to cover the cost.	Minor								
	Construction 9		Construction	Minor	River traffic accidents could lead to schedule delay and associated costs.		Could include ships colliding with construction equipment or temporary structures, coffer dams, etc. Most likely minor possibility of impact to the project.	Minor								
	Constuction 5		Construction	Minor	Claims from change orders (if not captured under separate risks)		Base costs include some allowance for change orders and claims (2% of construction for DB, 4% overall for DBB). Minor additional here. Excludes differing site conditions for foundations.	Minor								
	Construction		Construction	Minor	Differing site conditions for foundations		This is separate from the claims allowance above. Perhaps 2% of base deep foundation costs for the project, which is still relatively minor.	Minor								

								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
9	Env14	0	Environmental	4	Controversy on environmental process leads to Post-ROD NEPA challenge	Likelihood of a challenge is high, and it may result in delay. May delay ROW acquisition through injunction.	Increase risk. Recent interaction with PEAC and parties involved with bridge type selection push the likelihood of challenge is almost 100%. The likelihood of a delay resulting from the challenge depends on the outcome from this set of potential (mutually-exclusive) outcomes: A) 10% chance that challenge leads to supplemental EIS delaying Activity 4 by 12 months at cost of $1.6M / month (i.e., $19M); B) 70% chance of no supplemental EIS (no delay) but cost to fight challenge of $200-300k/month for 12 months (i.e., $3M); or C) 20% chance that there is no cost or schedule delay.	see left				**$4.0**				**1.2**

Risk Register - CEVP								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Env40		Environmental	2	Other delay to FEIS (separate from issues captured under Env19)		Note: this is not the first draft of the FEIS. Potential delays from things like 4F, additional discipline studies required, additional alternatives must be analyzed, impacts greater than anticipated, delays in review comments. At this point, completing the Finance chapter in the EIS might also be an issue (note: results from this CEVP feed that chapter...). Note that the project is currently conducting a NEPA re-evaluation in response to the recent decision on bridge type (to be submitted this week). Otherwise, high pressure internally for the team to deliver. The reviewing agencies have indicated a month is enough to review, but it's uncertain how significant their requested changes will be. Note that this risk and risk Env19 could both occur.	50%	0.0	0.0	0.0	**$0.0**	1.0	1.0	3.0	**0.8**
8	Env13b	0	Environmental	2	Supplemental EIS (SEIS) required "Pre-ROD"	Reduce probability from 60% to 10%. Have talked through a lot of changes that have occurred and are getting close to issuing the final. Discussions on refinements and good understanding of refinements. Refinements have stayed within existing footprint. Have already incroporated some things in for changes for NEPA review. Consensus over the LPA.	Composite Truss Bridge is within DEIS footprint. Team is submitting NEPA re-eval since DEIS (this week). This risk is that the re-eval requires a supplemental EIS, with subsequent FEIS and comment period. Note that could still have to do post-ROD supplemental EIS as captured in separate risk Env14. The magnitude of cost and schedule impacts are independent.	10%	1.0	2.0	3.0	**$0.2**	3.0	6.0	9.0	**0.6**
19	Env_Minor	0	Environmental	Minor	All Minor Environmental Risks	Changes would be minor, design on the fly, additional mitigation. No change.	Nothing has changed on this risk.	Minor	1.0	5.5	10.0	**$0.0**	0.0	0.0	0.0	**0.0**
1	Env1	1	Environmental	25	New Endangered Species Act listing during construction	No change. Lamprey likely an issue. This risk deals with the unknown listings.	Lower Risk to 10%. Contining the tracking of ESA listing developments through agency coordination and contact. Any listings likely will be addressed by project before the ESA listing is official. Project has already incorporated impact minimization measures that can be used if lamprey or streaked horned lark are listed.	10%	0.0	0.0	0.0	**$0.0**	1.0	3.0	6.0	**0.3**

Risk Register - CEC																	
		Risk Information						Pre-Response Risk Quantification									
									Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)				
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
14	Env19	0	Environmental	1	Section 106 process itself takes longer than expected (not due to discoveries), delaying FEIS	Probability increases 40 to 75%, costs may increase due to mitigation. Have a catch-all in the base for environmental mitigation of $22 million (additional $8 M for hazmat). Have 2 natural resource mitigation sites (off-site) at cost of $15 million total (9 on WA, 6 on OR).	Added some mitigation cost to the base, but risk for more. Focus is now to negotiate an agreement on the 2 outstanding issues: archaeological mitigation for the Curation Facility and the Lid. Cost impact here excludes the Lid, which was addressed separately in the Lid risk. Cost risk: 40% chance of base; 50% chance of +$3M, 10% chance of + $5.7M. By agreeing to mitigate (Curation facility and Lid), schedule risk is probably reduced. Independent (residual) schedule risk: 20% chance of 1-2 month delay.	see left				**$2.1**				**0.3**

								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
6	Env11	0	Environmental (ROW review)	Evenly split between 10, 20, 28 and 51	Hazardous Materials - Liability associated with property acquisition	Nothing has changed on this risk. One new property identified with tanks, but this current risk would cover it.	No change to this risk. Project should conduct Phase I and II hazardous materials indentification as early as possible prior to acquisition. Deliverables: Phase I and Phase II Environmental Assessments	10%	10.0	10.0	10.0	**$1.0**	1.0	2.0	4.0	**0.2**
	Env42		Environmental	3	Delay to Record of Decision		Separate from delays to completing FEIS. Gaining local buy-in to FEIS could delay the ROD, including potential extension to comment period.	25%	0.0	0.0	0.0	**$0.0**		1.0		**0.2**
	Env36		Environmental	Minor	Delay in USCG permit / agreement		Can apply for permit as soon as have ROD. Project has been communicating with USCG, and primary interest is maintaining navigable channel. The project has been able to do this in current design. Some chance for a delay, but in light of what's been done so far, likely minor schedule impact.	Minor								
10	Env15	0	Environmental	Independently applied to 29 and 33	Environmental regulations change	Impact on schedule may be less. There is a low probability of a risk that will impact the schedule. Will be aware of any significant rule changes. No change in risk quantification. More likely to impact Post-ROD than Pre-ROD at this point.	No change in risk. Potential of rule changes during project is likely; however the risk of schedule or cost impacts is low due to on-going agency coordination to get out in front of upcoming issues.	20%	0.0	0.0	0.0	**$0.0**	1.0	2.0	3.0	**0.4**
11	Env16	0	Environmental	1	Interagency coordination / agreements Pre-ROD	EPA Sole Source Aquifer Approval is done, potential for other EPA risk. Risk is lower than last CEVP, reduce probability to 10%.	Decrease risk. All regulatory permitting will occur Post-ROD	5%	0.0	0.0	0.0	**$0.0**	1.0	2.0	3.0	**0.1**
12	Env16b	0	Environmental	Evenly split between 4 and 5	Interagency coordination / agreements Post-ROD	EPA Sole Source Aquifer Approval is done, No other change to this risk.	No change in risk. Potential of conflicting conditions requiring renegotiation or redesign is likely; however on-going agency coordination should mitigate additional risk.	25%	0.0	0.0	0.0	**$0.0**	1.0	2.0	3.0	**0.5**
13	Env18	0	Environmental	4	Tribal consultation	Reduce probability from 50% to 20%. There has been a lot more coordiation with the tribes.	Increase risk. Recent interaction with CRITFC and tribes indicate issues with project; despite on-going coordination and communication. Likely a demand for additional mitigation.	30%	0.1	1.0	2.0	**$0.3**	1.0	2.0	3.0	**0.6**
	Env37		Environmental	Minor	Challenge to major permit, such as 404 Permit		There is some opposition to the project with threats to sue, but not under the 404 permit specifically. Given the amount of time between ROD and start of construction, unlikely to significantly affect schedule.	Minor								

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
2	Env2	0	Environmental	25	New listed species shows up in the project area.	Eliminated schedule impact. Reduce probability to 5% from 10%. Low risk.	Lower Risk to 2%. Contining the tracking of ESA listing developments through agency coordination and contact. Any listings likely will be addressed by project before the ESA listing is official.	2%	0.2	0.2	0.2	**$0.0**	0.0	0.0	0.0	**0.0**
15	Env21	0	Environmental	2	Contentious park/historic area leads to schedule impact delaying 4F approval	No change in this risk.	Decrease risk. The resources eligible for designation have been agreed upon	10%	0.0	0.0	0.0	**$0.0**	2.0	2.0	2.0	**0.2**
16	Env23	0	Environmental	Independently apply to 33 and 34	Inadvertent discovery of human remains	Even with an inadvertant discovery plan, there is still a risk for delay. Add cost impact of $1 to $5M.	Nothing has changed on this risk.	30%	0.5	0.5	0.5	**$0.2**	0.5	1.8	3.0	**0.5**
17	Env25	0	Environmental	25	Contractor not following the terms and conditions of permits (either volitionally or negligently)	Nothing has changed on this risk.	Nothing has changed on this risk.	10%	0.0	0.0	0.0	**$0.0**	0.3	1.6	3.0	**0.2**
18	Env29	0	Environmental	5	Negative community impacts expected (potential civil rights title VI lawsuit or environmental justice issues)	Revise risk to a cost risk, remove 2 month delay.	Nothing has changed on this risk.	25%	0.3	0.6	1.0	**$0.2**	0.0	0.0	0.0	**0.0**
3	Env3	0	Environmental	N/A	Obtaining a jeopardy determination, depending on the determination could cause large schedule effects	Revise probability to 1%, have worked with the agencies, very low probability risk.	Revise risk to 0%. NMFS has isued BO for project on 1/19/11. Have determined LAA, but not jeopardy.	0%	0.0	0.0	0.0	**$0.0**	6.0	12.0	18.0	**0.0**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
21	ENV30	0	Envronmental	25	Section 7 consultation in-water work windows are less restrictive on pile driving than the base schedule assumes.	This is an opportunity. Test pile could show there is more frequent pile driving than assumed. Assumptions are conservative. 1 more month of driving could gain 6 to 12 months of schedule savings.	Lower opportunity to 5%. Recent completion of the Test Pile Program has validated project team's conservative estimates for take. Unlikely to get in-water work windows longer than what is in BO	5%	0.0	0.0	0.0	**$0.0**	-12.0	-9.0	-6.0	**-0.5**
22	ENV31	0	Envronmental	Evenly split between 33 and 34	Unexpected cultural resources may be encountered	Will likely find a lot of common items on Vancouver side, which will likely not be significant and will not cause a delay. There is a chance of finding something that might cause a delay. $0.5 million cost impact at most for cataloging.	Increase risk from 20% to 30%. Cost and schedule remain the same	30%	0.1	0.3	0.5	**$0.1**	0.3	0.6	1.0	**0.2**
23	ENV32	0	Envronmental	Evenly split between 33 and 34	Environmental impacts of demolition/excavation/ dewatering work project-wide (underground). Applies	High risk, low cost, low delay.	Nothing has changed on this risk. Should EPA approve CRC Focused Environmental Assessment Work Plan, risk could be reduced	40%	0.2	1.1	2.0	**$0.4**	0.3	0.6	1.0	**0.3**
24	ENV33	0	Right of Way	Apply independently to 10, 20, 28 and 51	Unknown or unresolved relocation for right of way acquisition	Property owner can delay acquisition through legal channels, resulting in additional costs and delays. This is a risk because project is currently not yet into the acquisition process; havent talked to property owners. This may be driven by design changes; likelihood of significant design changes is low. Risk may be minimal, more of a schedule risk than a cost risk.	No change for this risk.	10%	0.0	0.0	0.0	**$0.0**	3.0	6.0	9.0	**0.6**
25	ENV34	0	Envronmental	25	Marine Mammal Monitoring	Very low risk now, less than 10%, that will need monitoring beyond what is currently planned.	No change in risk. Project did marine mammal monitoring during test pile project. NMFS was OK with monitoring effort. Very low probability that construction would be restricted	5%	0.0	0.0	0.5	**$0.0**	0.3	0.6	1.0	**0.0**
	Env38		Environmental	Minor	Additional or less wetland, floodplain, or other mitigation required		Current mitigation is at a ratio of 10:1, versus lower requirements (e.g., 3:1). Minimal impact to river level from piers.	Minor								
	Env39		Environmental	Minor	Significant permitting delay (other than captured separately)		Expect some delays in local land-use permitting, but sufficient time during permitting process (18 month base vs. 12 month process) to accommodate these. Otherwise, don't anticipate any significant permitting delays.	Minor								

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Env43		Environmental	Minor	Contractor's plan re: foundations in the river differs from what's approved in BO		This is an ESA issue. Contractor might propose a plan for installing river foundations (e.g., coffer dams at all piers) that's different than approved in the Biological Opinion from NMFS. Based on previous industry experiences, requested changes are likely to be relatively minor, which would not trigger new consultation.	Minor								
33	Geo11	0	Geotech	33	Marine Dr. NPH Ground improvements	Have opportunity for reduced ground improvement costs due to geotechnical investigation and the possibility of using foundation elements to resist loads. Potential environmental concerns for ground improvements near water (Risk if stone columns is no longer accepted, may need to go to more costly ground improvement). Some potential impacts, based on current WSDOT thinking: Limiting work to the fish windows for stone columns, installing curtains, use air injection as preferred method and visually monitor. More expensive method might have a smaller footprint. Probability is driven by environmental decision.	Although numerical modeling has not been compelted for Marine Drive/NPH, results from the numerical modeling for the Columbia River Bridge inidcate that reduced ground improvements will be needed at Marine Drive. -- Potential that vibratory ground improvement methods and stone columns may be disallowed either because of potential to damage adjacent property or because of environmental issues. This could result in need to go to more expensive ground improvement methods (e.g. grouting). Other methods could cost double what is assumed in base. Increasing size of GI area could also ptentially extend Corps approval time by 3 months (50% chance conditioned on the 40% chance of change makes this a minor schedule risk)	40%	-3.0	0.0	5.0	**$0.1**	0.0	0.0	0.0	**0.0**
4	Env4	0	Environmental (Construction review)	25	Section 7 consultation in-water work windows are more restrictive than the base schedule assumes.	Probabilty is much lower than 50% now; reduce to 10%. Schedule has been revised. Old schedule assumed year round work. Old schedule may have been optimistic, new schedule is more realistic. Base schedule now has 7 month restriction for just pile driving. Risk is that all work is restricted. More restrictive work windows would likely only cut into the edges of the current windows. Only a month or 2 per season, with an overall impact of up to a year over the full construction period.	ESA consultation completed with in-water pile driving allowed 9/15 through 4/15. Most other in-water work allowed year-round. Continue coordination with ODFW, WDFW, and others (tribes) that may also be able to curtail in-water work through permitting.Continued coordination and justification needed to ensure other agencies agree with NMFS and USFWS on work window. May need additional information on white sturgeon, lamprey, etc.	10%	0.0	0.0	0.0	**$0.0**	3.0	6.0	12.0	**0.7**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
32	Geo10	0	Geotech	33	Hayden Island Ground improvements	Have opportunity for reduced ground improvement costs due to geotechnical investigation and the possibility of using foundation elements to resist loads. Potential environmental concerns for ground improvements near water (Risk if stone columns is no longer accepted, may need to go to more costly ground improvement). Some potential impacts, based on current WSDOT thinking: Limiting work to the fish windows for stone columns, installing curtains, use air injection as preferred method and visually monitor. More expensive method might have a smaller footprint. Probability is driven by environmental decision.	Recent geotechncial numerical modeling suggests that extensive ground improvements will be much lower than initially anticipated. Method/type of ground improvements, if/where needed, is still uncertain. --- Potential that vibratory ground improvement methods and stone columns may be disallowed either because of potential to damage adjacent property or because of environmental issues. This could result in need to go to more expensive ground improvement methods (e.g. grouting). Other methods could cost double what is assumed in base. Increasing size of GI area could also potentially extend Corps approval time by 3 months (50% chance conditioned on the 25% chance of change makes this a minor schedule risk)	25%	-5.0	0.0	10.0	**$0.2**	0.0	0.0	0.0	**0.0**
	Env41		Environmental	N/A	Lack of tribal agreement could lead to delay in 106 process and BO		This is included under Env 19.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
88	HW50	1	Highway	29	HI elevated transit station becomes at-grade	Increased cost for R/W but cost savings from eliminating grade separation structure. Potential schedule delays, 3 to 6 months for environmental and design. Cost impact would likely be a wash.	HI to have elevated station; risk is having to move to at-grade. Lower probability to 25%.	25%	0.0	0.0	0.0	**$0.0**	3.0	4.5	6.0	**1.1**

Risk Register - CRC								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
62	HW25	0	Highway	Evenly split between 14 and 17	Changes in staging result in additional design costs	Current phasing assumes the full project is being built. Potential for 6 months delay in design and $5 million cost impact in design costs. Schedule impact is covered in the funding delay risk	This is not a scenario question (e.g., Phase 1 FEIS vs. Full Build); it's the possibility for temporary work required if staging within the scenario is not as assumed in the base. It's becoming less likely this would be	25%	3.0	4.0	5.0	**$1.0**	0.0	0.0	0.0	**0.0**
	Env44		Environmental / Construction	N/A	Archeological discoveries could lead to stop work during construction		Covered under Env 31.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
	Env45		Environmental / Permits	N/A	Concerns about contrator compliance with permitting requirements for in water work.		This is already covered in Env25. Delete this risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
5	Env7	0	Environmental	25	Terms and conditions of the Biological Opinion and other approval cannot be met by the project during construction	No change in this risk. Nothing has changed on the project that would change this. Project has better idea of terms and conditions, however contractor may still not be able to meet them.	Lower risk to 10%. Recent completion of the Test Pile Program has validated project team's conservative estimates for take.	10%	5.0	5.0	5.0	**$0.5**	1.0	2.0	3.0	**0.2**
83	HW45	0	Highway	33	Replacement of Victory overcrossing for Phase 1	Cost impact of $30 million to replace the bridge.	Base assumes widening.	15%	20.0	25.0	30.0	**$3.8**	0.0	0.0	0.0	**0.0**
53	HW_Minor	0	Highway	Minor	Allowance for Minor Scope items for Highway, Structures and Design Risks	Accounts for: Overcrossing amenities, added sidewalks, added trail, etc.	(modeling note: not modeled separately; this is intended to be like our Minor Risks, so we'll model separately as we always do)	Minor								
31	Geo4	0	Geotech	Evenly split between 33 and 34	Sole source aquifer that underlies this region may be impacted by pile driving and shafts, possible cross contamination of aquifers to drinking water aquifers	No change in this risk.	Have met with EPA and discussed focused environmental assessments. Reduced risk.	5%	2.0	5.0	10.0	**$0.3**	0.0	0.0	0.0	**0.0**
82	HW44	1	Highway	33	Multi-Use Path (MUP) location change affects cost and schedule	50% probability.	<u>Conditional on risk Struc 21</u>. Currently shown sharing the mainland connector; instead might move to the far-east bridge (MD-to-I-5-North bridge). Does the mainland connector bridge get narrower? This risk is conditional on the risk for the mainland connector bridge type changing (risk Struc21). If the structure type for the mainland connector bridge does not change (risk Struc21 DOES NOT occur), then 75% chance for $3M to $10M additional cost ($10M if can't reduce mainland connector bridge width; $3M if can.). If the mainland connector structure type does change (risk	see left; value at right is conditional on Struc21 <u>not</u> occurring				**$4.9**	0.0	0.0	0.0	**0.0**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
63	HW57	0	Highway	Evenly split between 16 and 19	Phasing results in additional construction costs	Schedule impact is covered in the funding delay risk (Fund8). Cost impact is for constructing the project twice (temporary and final).	Perfectly correlated with risk HW25 above (i.e., if HW25 occurs, so does this one). The temporary work itself doesn't increase duration; the phasing that's accomplished by the temporary work is separate. Team assumes the need for temporary work would be known in advance, which minimizes schedule impact.	25%	10.0	30.0	50.0	**$7.5**	0.0	0.0	0.0	**0.0**
169	HW2	0	Highway (Bridge Review)	33	Multi-use bike/ped path design requires more access points than planned	Still a risk. Risk impact only accounts for elevators and stairs. Not yet included in the base since ADA ramps will be provided. No additional information currently. Risk remains the same.	No change for this risk.	10%	2.0	3.5	5.0	**$0.4**	0.0	0.0	0.0	**0.0**
70	HW32	0	Highway - COP	34	Pedestrian undercrossing between Delta Park and Portland Harbor	Adds an additional span, which becomes more complex. Assume 80' x 100' additional.	For example, add an extra span on east side of freeway; City would like it "wide open".	20%	3.0	6.5	10.0	**$1.3**	0.0	0.0	0.0	**0.0**
98	HW10	0	Highway (Construction, Organizational/Agreements Review)	33	Staging (general) issues due to local partners not agreeing on access restrictions	Still do not have an agreement with the City. Potential closures will be required to build the bridge. Still a risk, no change.	Project partners (not contractor interfaces). Costs are for making detour improvements to mitigate for various closures. For example, City doesn't agree on closure from SR 14 to Ctiy Center.	60%	5.0	10.0	15.0	**$6.0**	0.0	0.0	0.0	**0.0**
128	HW24b	0	Highway (ROW review)	28	IAMP (Interchange Access Management Plan) does not allow a deviation for site access on Hayden Island	IAMP process has been put on hold. No change in this risk.	Many deviations required for the proposed HI interchange. IAMP isn't needed prior to ROW acquisition.	10%	5.0	7.5	15.0	**$0.9**	0.0	0.0	0.0	**0.0**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
71	HW33	0	Right of Way	10	Additional ROW may be required and or change in alignment	There is development going in, may require widening to the north. Would need to acquire bank. This should not impact schedule. ROW base cost uncertainty is -20%/+10% (accounts for valuation, not number of parcels).	No change for this risk.	10%	0.2	0.4	0.5	**$0.0**	0.0	0.0	0.0	**0.0**
81	HW43	1	Highway	53	P&R access design changes would require design changes, increase in cost and delay to schedule	Additional 1 to 3 months of design time, $100k cost for redesign.	No change for this risk.	30%	0.1	0.1	0.1	**$0.0**	1.0	2.0	3.0	**0.6**
185	HW66	0	Hwy	16	39th Street overcrossing remains open during construction		Full build only. Assumes build temporary bridge to one side only. Conditional cost and schedule impact uncertainties are independent of one another (higher cost does not necessarily imply longer time).	90%	2.0	3.0	4.0	**$2.7**	3.0	6.0	9.0	**5.4**
181	HW62	0	HWY	33	Potential to reconstruct Victory Blvd. under I-5 to meet clearance requirements		Conditional cost and schedule impact uncertainties are independent of one another (higher cost does not necessarily imply longer time).	20%	1.0	3.0	5.0	**$0.6**	1.0	2.0	3.0	**0.4**
186	HW67	0	Hwy	16	Replace SR 500-I-5 South Structure	Cost to construct. Cannot be combine with 149	Full build only. Base does not replace this structure (assumes can deviate the shoulders and avoid building the bridge). Do not combine with ROW 18.	30%	15.0	20.0	25.0	**$6.0**	0.0	0.0	0.0	**0.0**
89	HW51	0	Highway	Retire	FAA restrictions limit construction flexibility	Accounted for in previous analysis, not discussing bridge risks in this session.	This is a constraint, not a risk. Suggest it is removed.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
90	HW52	1	Highway - Opportunities	N/A	Early construction finish	There is no indication of early finish to construction. Design build options for some packages could accelerate some construction, however delays are related to funding, political reasons, therefore DB may not add much acceleration. Low likelihood, not	No change for this risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
93	HW55	0	Highway - Opportunities	N/A	Close staging site available	Not quantified.	No change for this risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
94	HW56	1	Highway - Opportunities	N/A	Delivery type provides flexibility and cost savings	Not quantified.	No change for this risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
180	HW61	1	HWY/Geotech	34	Victory braid has tight spacing between highway and existing Expo LRT Line		Full Build only. Building in tight space between existing bridge and LRT, which might have impacts. Conditional cost and schedule impact uncertainties are independent of one another (higher cost does not necessarily imply longer time).	50%	5.0	8.0	10.0	**$3.9**	1.0	2.0	3.0	**1.0**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Procurement 6		Procurement	Apply independently to #21 and #29	Owner issues managing/delivering Design-Build procurement - delay issuing RFP		For example, from issues with joint Oregon/Washington AG review of the procurements; inadequate staffing causes delays such as in issuing RFP, approving Alternative Technical Concepts, or contractor design or submittals; or other delays from HQ.	50%		0.0		**$0.0**		3.0		**1.0**
51	HW6	0	Highway (Construction Review)	16	Planned pavement overlaying needs to be rebuilt instead only overlaying	Mainline area has a total cost of $1.6 million for overlay in the current base cost estimate. Cost impact revised to discrete distribution: low end of	No change for this risk.	60%	1.0	2.0	10.0	**$1.9**	0.0	0.0	0.0	**0.0**
	Procurement 7		Procurement	Apply independently to #23 and #31	Owner issues managing/delivering Design-Build procurement - review of proposals and responding to questions		For example, inadequate staffing causes delays such as in issuing RFP, approving Alternative Technical Concepts, or contractor design or submittals (i.e., design delays); or other delays from HQ.	50%		0.0		**$0.0**		1.0		**0.3**
	Procurement		Procurement	Apply indepdendently to #21 and #29	Issues related to bidders meeting DBE goals			25%		0.0		**$0.0**		1.0		**0.2**
184	HW65	0	HWY	16	Threat - Obstructions to 5S-500 Alignment construction		No change for this risk.	30%	0.5	1.0	2.0	**$0.3**	0.5	1.0	2.0	**0.3**
102	Procurement 11	0	Procurement	25, 33, 34 and 53 (see breakdown in cost quantification)	**Uncertain market conditions: Design-Build contracts**	Good outreach, interest from several big companies. The outreach has helped to reduce this risk. Beginning to look into contracting strategies. Keep the likelihood the same, reduce the cost impact by half.	Excludes steel. CCI is in base. Competition is high and will likely remain high the next few years. Range could be -10% to + 5% of base cost for River crossing and interchanges (moderately correlated between activities since procurement times are similar). Assume no delay impacts here (captured elsewhere). Moderately positively correlated between DB contracts. Independent from DBB market conditions.	100%	Activity 25: -$55.0M; Activity 33: -$40M; Activity 34: -$40M; Activity 53: -$14.0M.	NOTE: did not use these values in model; instead, simulated based on base-uncertainty-adjusted base.	Activity 25: +27.5M; Activity 33: +$20M; Activity 34: +$20M; Activity 53: +$7.0M.	**-$37.5**	0.0	0.0	0.0	**0.0**

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	Procurement 10		Procurement	16, 19, 25, 33, and 34 (see breakdown in risk quantification)	**Structural steel costs accelerate faster than general inflation**		Steel costs are very variable over time. Model as 100% chance of triangular distribution with minimum = -15%, mode = +0%, and maximimum = +30% ($2.00/lb to $2.90/lb). This cost uncertainty is separate from base cost uncertainty, CCI inflation, and market conditions risks captured separately. Independent of market conditions risks. Moderately positively correlated with other steel-specific uncertainties.	100%	Activity 16: -$0.2M; Activity 19: -$0.6M; Activity 25: -$15.0M; Activity 33: -$4.2M; Activity 34: -$1.9M		Activity 16: +$0.7M; Activity 19: +$2.0M; Activity 25: +$48.0M; Activity 33: +$14.0M; Activity 34: +$6.3M	**$16.4**	0.0	0.0	0.0	**0.0**
182	HW63	0	HWY/Structures		Threat - Victory Phased Scenario and Full Build Scenario - Base assumes widening of structure, may need to do full replacement		Duplicate of record 83, HW45. So delete this item? Zeroed out probability instead of deleting.	0%	0.0	0.0	0.0	**$0.0**	2.0	3.0	4.0	**0.0**
183	HW64	0	HWY/Structures		Threat - Victory Phased Scenario and Full Build Scenario - Base assumes widening of structure, may need to do full replacement		Duplicate of record 83, HW45. So delete this item? Zeroed out probability instead of deleting.	0%	8.0	10.0	15.0	**$0.0**	6.0	8.0	12.0	**0.0**
	Procurement 3		Procurement	16, 19, 54, and 56 (see breakdown in risk quantification)	**Uncertain market conditions: Design-Bid-Build contracts**		Excludes steel. CCI is in base. Competition is high and will likely remain high the next few years. Range is higher than for D/B because these contracts are scheduled to be let further out. Could be -10% to + 20% of base for DBB contracts with +5% most likely values. Weakly correlated among DBB contracts. Not correlated with DB market conditions.	100%	Activity 16: -$10.0M; Activity 19: -$4.0M; Activity 54: -$16.0M; Activity 56: -$4.5M.	Activity 16: +5.0M; Activity 19: +$2.0M; Activity 54: +$8.0M; Activity 56: +$2.0M.	Activity 16: +$20.0M; Activity 19: +$8.0M; Activity 54: +$32M; Activity 56: +$9.0M.	**$17.0**	NOTE: did not use these values in model; instead, simulated based on base-	0.0	0.0	**0.0**
	Procurement 9		Procurement	16, 19, 25, 33, and 34 (see breakdown in risk quantification)	**Rebar steel costs accelerate faster than general inflation**		Steel costs are very variable over time. Model as 100% chance of triangular distribution with minimum = -20%, mode = +20%, and maximimum = +60%% ($.65/lb to $1.20/lb). This cost uncertainty is separate from base cost uncertainty, CCI inflation, and market conditions risks captured separately. Independent of market conditions risks. Moderately correlated with other steel-specific uncertainties.	100%	Activity 16: -$0.2M; Activity 19: -$0.1M; Activity 25: -$2.0M; Activity 33: -$1.8M; Activity 34: -$2.0M		Activity 16: +$0.8M; Activity 19: +$0.6M; Activity 25: +$9.5M; Activity 33: +$5.5M; Activity 34: +$6.5M	**$8.6**				
	Procurement 1		Procurement		Uncertainty in construction cost inflation rate		The project team has selected the WSDOT CCI tables to determine YOE costs. However, being deterministic, these tables ignore uncertainty in annual inflation rate.	Excluded								

Risk Register - CRC								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Procurement 2		Procurement		Significant change in project delivery method and/or contract packaging		Base assumes two DB contracts (CRB and SR14/HI) and several DBB contracts. There are other possibilities, such as SR14/CRB/HI as one DB contract, or SR14, CRB, and HI as three separate DB contracts. May model these later.	Excluded								
	Procurement 4		Procurement	Minor	Bid protest		For example, WSDOT doesn't have the right RFQ process or doesn't follow its RFQ process, such as short-listing too many; claim of conflict of interest, such as from consultants; sore losers blame WSDOT. Potential delay on the order of a few weeks to a few months (Oregon – 1 month max), but unlikely to occur. Minor.	Minor								
	Procurement		Procurement	Minor	Bonding issues		Group assessed that as defined in the base (i.e., two separate DB contracts), contractors would not have any problems securing bonds.	Minor								
130	RW4	0	Right of Way	28	Floating home owners file legal appeal over relocation plan and court delays relocation	Risk may have dimished a bit but it has not gone away. Floating home owners have not come forward with legal appeal to date; however lawsuit would likely come at the point of filing the environmental document. Reduced probability from 25% to 20%.	No change for this risk. Cost would be covered within the base allowance for condemnation costs	20%	0.0	0.0	0.0	**$0.0**	6.0	9.0	12.0	**1.8**
	Procuremer		Procurement		Limited availability of critical equipment or labor (if not included under market		Team says not likely.					**$0.0**				**0.0**
129	RW2	1	Right of Way	20	Delay getting possession and use of all necessary properties for Columbia River Bridge	No change. Risk still valid.	Base: Approximately 20 months from ROD / Approved Plan / Funding (all three need to occur) to obtain occupancy for contractor. Final ROW activities will extend a few months beyond this. Some risk that relocation for the hotel will take longer than anticipated, delaying possession and use.	25%	0.0	0.0	0.0	**$0.0**	3.0	4.5	6.0	**1.1**
	ROW 22		Right of Way	33 and 54 independen tly	Late changes in design affect ROW schedule (if not captured separately)		No significant changes in anticipated ROW requirements are expected prior to design-build. However, there is potential for late identification of required utility relocations (and, therefore, required easements or new property for relocation). Risk likely higher on Hayden Island. Could happen before or during D/B. Cost impacts likely minor.	50%				**$0.0**	1.0	1.5	2.0	**0.8**

Risk Register - SR2								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	ROW 1		Right of Way	Excluded	Uncertainty in ROW cost inflation rate		The project team has selected the WSDOT CPMS tables to determine YOE costs, consistent with WSDOT Instructional Letter IL 4071.01. However, being deterministic, these tables ignore uncertainty in annual inflation rate. Market conditions are considered to be flat for the next couple of years.	Excluded								

Risk Register - CRC								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
146	ROW15	0	ROW-OR	10	Opportunity to not acquire Ross Island Sand and Gravel		Acquisition is now in the base. Opportunity to get deviation through IAMP to provide access without this property, so might not have to acquire.	30%		-1.2		**-$0.2**				
138	ROW14	1	ROW-WA	6	Agreement between FHWA and FTA on shared parcels	There needs to be an agreement between FHWA and FTA on who pays what for acquired parcels that are used for transit and highway. This is parallel to ROW6	No change for this risk. Needs to be done before ROD so that purchase of ROW can begin immediately thereafter.	25%	0.0	0.0	0.0	**$0.0**	3.0	4.5	6.0	**1.1**
135	ROW4	0	ROW-WA	10 and 51, Perf Corr	Lack of appraisers	There is a short timeline on the project for acquisition. There is a limited pool of appraisers. Potential delay to the project. Other projects will compete for appraisers.	No change for this risk. May not be as severe a problem on the Washington side as other state projects will be winding down before start of CRC project, adding pool of State employees and private contractors. More of a risk to subsequent procurements rather than initial procurements (first in, first out). Therefore, only the two later ROW activities (10 and 51) would be affected. Impacts both Activities 10 and 51 if it occurs (perfectly correlated).	25%	0.0	0.0	0.0	**$0.0**	3.0	4.5	6.0	**1.1**
137	ROW6	1	ROW-WA	51	Agreements or Term Sheets not in place to allow acquisition process to begin	WSDOT acquiring on behalf of Ctran. Delays in agreements lead to delays in acquisitions. Primarily will impact transit acquisition. Term sheets need to be in place prior to FTA approval, which is needed to move into final design.	Risk relates to reluctance of CTRAN / City of Vancouver to exercise eminent domain authority to acquire property in a timely fashion; WSDOT does not believe that WSDOT has eminent domain rights for property that will not be used for highways. Only affects Washington transit right-of-way.	25%	0.0	0.0	0.0	**$0.0**	3.0	4.5	6.0	**1.1**
133	ROW2	0	ROW-WA	Independently to 10, 28, and 51	Additional Condemnation	Typically a schedule risk, rather than a cost risk. Typically 10 to 15% probability. Base cost already has a 20% premium for condemnation.	Base includes 30% allowance for condemnations. Could apply to any properties other than the Columbia River Bridge properties (which are addressed separately).	15%	0.0	0.0	0.0	**$0.0**	3.0	6.0	9.0	**0.9**
139	ROW7	0	ROW-WA	28	Acquisition from federal agencies including, USA, Western Federal Lands, and National Parks	Low risk as long as all of the components are in place by 2012. Have 2 years in schedule to get this in place.	No change for this risk.	10%	0.0	0.0	0.0	**$0.0**	1.0	3.0	6.0	**0.3**

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
149	ROW18	0	ROW-WA	14	ROW for SR 500 to Fourth Plain Slip Ramp	Base assumes ramp is not included in the project. City may request the ramp. COV desires to maintain this connection, but it was not provided because it does not seem to be a heavy movement and to provide the connection would require add'l r/w and the replacement of the 500-5s bridge. Cost impact of $20 to $40 million for cost of ramp and parcels.	Base assumption is no slip ramp. If a slip ramp is added to the project at SR-500, there would be additional ROW required and associated cost and schedule impacts. Schedule impact assumes decision is made early enough to not impact ROW acquisition schedule. Conditional cost and schedule impact uncertainties are independent of one another (higher cost does not necessarily imply longer time).	5%	20.0	30.0	40.0	**$1.5**	1.0	2.0	3.0	**0.1**
142	ROW10	0	ROW-WA	51	Columbia Manor (Smith Tower); not able to cure circulation issues	Working closely with Columbia Manor on this, so it should be a low risk. Acquisition of Columbia Manor would be around $15 to $20 million. May be able to put parking spots across the street - need to see if this is a viable solution. Discrete risk with 50% probability of additional $5 million; 5% probability of additional $20 million full cost to acquire, 45% no impact.	No change for this risk. Discrete risk with 50% probability of additional $5 million; 5% probability of additional $20 million full cost to acquire, 45% no impact.	**See left**				**$3.5**				
147	ROW16	0	ROW-OR	10	Additional acquisition due to ground improvements.	Additional $1.75 million cost impact for full acquisition and relocation.	No change for this risk.	10%	1.8	1.8	1.8	**$0.2**	0.0	0.0	0.0	**0.0**
148	ROW17	0	ROW-OR	20	Additional acquistion costs for Thunderbird	Cost impact assumes 50% increase in acquisition costs. Base already assumes 30% premium. Assume incremental 20% premium at the upper end. Schedule delays captured in ENV33.	No change for this risk.	25%	1.0	2.0	3.0	**$0.5**	0.0	0.0	0.0	**0.0**
141	ROW9	0	ROW-WA	Deleted	Red Lion acquisition and relocation	May take time for them to find replacement property. Base cost has $125,00 for relocation, likely only covers relocation of restaurant. Relocating restaurant may result in business damages that require full acquisition. Schedule delays captured in ENV 33.	Schedule impacts now covered in Columbia River Bridge Property Acquisition risk (RW 2). Delete.	Replaced								
175	Struc31	0	Structures	Evenly split between 33 and 34	Land-based foundations: Permanent test shaft/pile program (on land) to reduce foundation costs	Savings of $1 to $2 million per pier, 16 piers total.	Opportunity for drilled shaft/driven pile program (which by code allows use of less conservative design parameters, regardless of the investigation outcome) to reduce depth of land-based shafts or piles. Opportunity assumes 10' shallower shafts/piles on the land-based bridges. Also reduces constructability risks.	90%	-40.0	-30.0	-25.0	**-$27.8**	0.0	0.0	0.0	**0.0**

SR 14 Replacement - CEVP																
		Risk Information						Pre-Response Risk Quantification								
									Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
28	Struc11	0	Structures	Evenly split between 33 and 34	Modifications to foundation sizes at the SR14 interchange (mainline bridges, only)	Unit costs in the base estimate are what were developed in the last CEVP. Have done a lot of geotechnical research at SR-14 interchange, which shows we can use spread footings. Likelihood won't change, but the cost can be reduced based on the number of shafts that will change to spread footings. In base, have assumed spreadfootings for all but 1 of the SR-14 footings. Revised cost impact downward to $10 to $30 million due to spread footings.	This risk is being modified to represent the potential for change in foundation sizes at the SR 14 interchange mainline bridges. Previous risk was that shafts would increase to D+3 in WA. Current base estimate assumes D+2 shafts for SR14 mainline approach bridges. Opportunity assumes a change in 50% of mainline approach bridge foundations from drilled shafts to spread footings.	30%	-15.0	-10.0	-5.0	**-$3.0**	0.0	0.0	0.0	**0.0**

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
40	Struc23	0	Structures	Retire	Risk that Phase II seismic retrofit is required for North Portland Harbor mainline bridge.	Cost impact of around $60 million for seismic retrofit.	Retire this risk. ODOT director says retrofit will not be done, bridge to be replaced at some point	0%	50.0	60.0	70.0	**$0.0**	0.0	0.0	0.0	**0.0**
29	Struc16a	0	Structures	Evenly split between 33 and 34	Drilled shafts need to be deeper than 150'/130' in the vicinity of Marine Drive and Hayden Island, respectively, due to differing geotechnical conditions. Opportunity to use piles on Hayden Island and Marine Drive.	Base foundation assumptions have changed since last CEVP due to further geotechnical explorations. Updated base cost now to reflect 150' drilled shaft foundations all throughout OR. Have an opportunity on the low end to use piles instead of deep foundations, at high end risk of deeper drilled shafts (210') - could need to go deeper in silty area. Cost impact revised to reflect range of an opportunity to a threat.	Based on recent geotechnical information shafts are not expected to be installed deeper than approximately 130 feet at Hayden Island and 150 feet at Marine Drive. This item reflects uncertainty in what will ultimately be done at both locations (assumed the same), characterized as a continuous distribution: switch to <=130' piles (savings), install shafts similar to assumed in base, or have to install longer/deeper shafts (increased cost).	15%	5.0	10.0	15.0	**$1.5**	0.0	0.0	0.0	**0.0**
59	Struc2a	0	Structures	25	Increased aesthetic costs/context sensitive solutions for CRB	Still a high probability risk, but a lower impact now for minor aesthetic elements. Revised cost imapct from $5 to $15 to $5 to $10.	No change for this risk. Includes all aesthetic design features and treatments for the Columbia River Bridge. Base has some aesthetics included in the base unit rates, which were developed from past projects that also included aesthetics. Time impact most likely to affect developing RFQ/RFP. However, there is only a minor chance of a time impact and any time impact could likely be mitigated via addendum during the deisgn process.	50%	5.0	12.5	20.0	**$6.3**	0.0	0.0	0.0	**0.0**
	Struc11a		Structures	Evenly split between 33 and 34	Modifications to foundation type at the SR14 interchange (landside bridges, only)		This risk is being added to represent the potential for change in foundation sizes at the SR 14 interchange landside bridges. Current base estimate assumes shafts for 5N-14 E bridge. All other SR 14 bridges are assumed to be on spread footings. Risk assumes landside bridge foundations change from spread footings to drilled shafts.	75%	8.0	10.0	12.0	**$7.5**				**0.0**
38	Struc21	1	Structures	33	Mainland connector to Hayden Island changes type from the base assumption (steel plate girder).	Cost impact can be 2 to 3 times the current base cost.	Bridge selection will go through City of Portland design approval process. Extreme cost would be a cable-stayed bridge at $45m extra. Low end might be $10m extra for weathered steel or other non-typical elements. Cable-stayed bridge unlikely. Possible that the multi-use path get separated from this bidge and suspended below bridge. That option probably has little cost impact. Potential (mutually-exclusive) outcomes: A) 30% chance of base; B) 10% chance of $45M extra; or C) 60% chance of $10M extra. No time impact (not critical to the overall activity)	**See left**				**$10.5**				**0.0**

Risk Register - CRC								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
177	HW58	1	Structures	Minor	Threat - Demo a portion of MD Structure and MD interchange to accommodate flyover phase	This accounts for the "throw away" of going from Phase 1 to OR Full Build	High likelihood that demo will be required, but potential additional cost is now expected to be minor.	Minor								
	Struc28a		Structures	Minor	Risk of design complexities and increased bid costs for the composite truss structure	New Risk Added May 2011	Captured either in base uncertainty, aesthetics risk for CRB, or market conditions for DB contract.	Minor								
60	Struc13	0	Structures	Evenly split between 16, 19, 33 and 34	Increased aesthetic costs for landside bridge and wall structures	Revise cost impact. Low side is 0.5% premium, upper end is 2% premium on base cost. Base cost of $63 million walls, 425 million in walls, plus 50% for soft costs for $750 million total base costs.	No change to this risk; risk was assessed as % of base, which has been updated.	75%	4.0	10.0	15.0	**$7.4**	0.0	0.0	0.0	**0.0**
	Struc29a		Structures	Deleted	Additional aesthetics required for the CRB (composite deck trusses)		Same as / captured under Struc2a - Delete	Delete								
34	Struc18	0	Structures	16	Wall type north of Fourth Plain (west side) could change from tie-back soldier pile to secant pile.	Base estimate assumes soldier pile, may need to change to secant pile. Fairly low risk, already assuming secant piles in pinch point. Should not have a schedule impact.	No change in this risk.	10%	1.0	1.5	2.0	**$0.2**	0.0	0.0	0.0	**0.0**
35	Struc19	0	Structures	Evenly split between 16, 19, 33 and 34	Conflicts with existing bridge foundations will require structure modifications in the field.	Potential premium from contractor for having to rebid the job during construction due to change in foundation. $500,000 cost impact for each case where this happens. There are 50 structures. Likely to hit 1 or 2	No change in this risk.	10%	1.0	3.0	5.0	**$0.3**	0.0	0.0	0.0	**0.0**
36	Struc20	0	Structures	34	Amenities on top of Community Connector structure are greater than assumed in base costs.	Base cost has approximately $40 million total for Connector. Cost impact for additional amenities above what is planned (beaver dam, fountain, etc).	No change in this risk.	25%	5.0	5.0	5.0	**$1.3**	0.0	0.0	0.0	**0.0**
	Struc34		Structures	Minor	Hayden Island structures shortened by creating new fills		Potential to shorten structures by switching to fills in some areas. Possibly several hundred feet of structures could be removed. Potential $10M savings on structures side. However, this option only likely to work if lightweight fill were used. More ground improvement likely needed for this option. Height of fills required makes this option iffy. Savings likely minor as a result of all these issues.	Minor								

								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Struc35		Structures	Minor	Columbia River Bridge - Increase span lengths to remove a pier		Could potentially increase span length to remove one pier. However, potential savings would be offest by needing bigger foundations at piers and larger structural members for the bridge. Many geometric constraints (height of bridge increases because truss deck become deeper, grades change because of bridge height, potentially changing interchange configurations at either end) make this change unlikely to be cost-effective.	Minor								
41	Struc24	0	Structures	33	Risk that seismic retrofit is required for Post Hospital.	Could reduce the amount of vibration by specifying means and methods to the contractor. High likelihood of doing something, with wide range of potential cost impacts. Low end to excavate around foundation and reinforce; cost impact of $200k with 75% probability. High end for drilled micro piles: $5	Low end assumes excavating around foundation with minor reinforcement prior to installing secant piles. High end assumes seismic retrofit of Post Hospital building based on COV estimate for the work.	95%	0.3	0.8	1.0	**$0.7**	0.0	0.0	0.0	**0.0**
43	Struc25	1	Structures	N/A	Threat for the use of drilled shafts at discrete locations in WA rather than spread footing	Base currently assumes spread footings, risk of going back to drilled shafts. 50% chance that all footings will need to go back to drilled shafts. This does not include the footings approaches (they are already assumed to be drilled shafts	No longer applies. Combined with Struc11 and Struc11a. Retire risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
	Struc37		Structures (Design)	19	Opportunity to change from SPUI to TUDI at Mill Plain interchange		Change driven by equivalent performance from less-expensive structures. Cost savings $4.5M base savings (raw costs; add 35% markup on top of that); no time impact	50%	0.0	-4.5	0.0	**-$2.3**	0.0	0.0	0.0	**0.0**
	Struc40		Structures (Design)	33	Opportunity to change from SPUI to TUDI at Marine Drive interchange		Change driven by equivalent performance for less-expensive structures	35%	0.0	-6.0	0.0	**-$2.1**	0.0	0.0	0.0	**0.0**
	Struc41		Structures (Design)	Minor	Significant change in design of CRB's composite deck truss		Excludes aesthetics. Currently at low level of design, so possibility of changes (e.g., form of the design, such as structural members). Covered by base uncertainty.	Minor				**$0.0**				**0.0**

Risk Register - SR 14																			
		Risk Information						Pre-Response Risk Quantification											
									Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)				
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
37	Struc27	0	Structures (Design)	34	Increase size of lid at Evergreen (Community Connector)	Cost of lid is $40 million in current base estimate. Doubling the size may result in more than doubling the cost due to fire code. Risk accounts for increasing size up to the threshold, but not requiring additional costs for ventilation and fire supression (fire code). Do not anticipate a schedule impact.	Local pressures could result in lengthening the lid. Lid could get to as much as about 600 feet (south end of post hospital) - this would result in a cost that would be double the base cost plus fire safety upgrades. Three potential (mutually-exclusive) outcomes: A) 20% chance of staying with base assumption (300 feet long); B) 60% chance of increasing the length by about 50% ($13m extra), or C) 20% chance of doubling the base length plus F/L/S ($29M extra). No time impact (doesn't control).	**See left**				**$13.6**				
	Design 6		Structures (Design)	Minor	Significant change in configuration of Hayden Island interchange		Team feels this island has been significantly vetted. However, it still sounds like there's significant uncertainty - covered under base-cost uncertainties? Not much choice to do other things. Could get more efficient in a d/b contract. Minor impact	Minor								
44	Struc26	1	Structures		Opportunity for the use of spread footings for WA approaches at discrete locations in WA	Risk assumes 50% chance of all of the drilled shafts becoming spread footings.	No longer applies. Combined with Struc11 and Struc11a. Retire risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
187	Struc33	0	Hwy	N/A	Risk of widening victory bridge in Phase 1	Cannot be combine with 183 and 182	Base assumes widening.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
	Design 7		Structures (Design)	Minor	Significant change in configuration of SR 14 interchange		Team feels there is little uncertainty left in the design - there are a lot of constraints and the design has been vetted significantly. Lots of physical constraints - this design is	Minor								
61	Struc14	0	Structures		Opportunity for reduction in noise walls in OR	Most of noise walls are on the WA side (60 to 70 percent). When noise study is updated, may be able to eliminate 50% of the noise walls in OR.	Opportunity realized. Noise walls no longer planned in OR. Retire risk.	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
	Design 8		Structures (Design)	Minor	Significant change in configuration of Fourth Plain interchange		Team feels there is little uncertainty left in the design - unlikely to see a significant change. Minor changes possible - minor impact	Minor								

SR 167/SR 509 - EIS								Pre-Response Risk Quantification										
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Struc36		Structures	25	River foundations: Don't need to case drilled shafts all the way to Troutdale formation		Could use oscillator and segmented casing to get casing down into Troutdale formation. Oscillator could allow casing to be removed. Would require changing test program to mob an oscillator rig, which is not currently planned.. Contractor would probably need to do their own test shaft to get design values for uncased shaft. Could save 100 feet of casing per hole.	80%		-20.0							**0.0**
	Struc38		Structures (Design)	Minor	Increase in profile required for composite deck truss, to provide required navigational		Profile would need to be raised 5-10' over the river, which likely would not modify length of structures and touchdown point at SR14/HI. Minor cost impact, no schedule	Minor									
	Struc39		Structures (Design)	Minor	Economy-of-scale benefit for large number of structures not captured in base unit prices		This was captured in base-cost uncertainty ranges (and their correlations) for DB structures. Also considered to be separate issue from market conditions.	Minor									

								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
54	Traf2	0	Traffic	2	Changes to current travel demand modeling parameters	Low risk, have spent last year reducing this risk. Reduce probability from 10% to 5%. Have already revisited this 3 times with the same results, will likely not revisit this.	2035 time period or changes to model standard practices lead to a new model runs required; Pre-ROD leads to delays. No change for this risk. Likelihood is low here because this could also be captured under FEIS delay or challenges (i.e., would be done as part of those consequences).	5%	0.0	0.0	0.0	**$0.0**	3.0	4.5	6.0	**0.2**
	Tran81		Transit	56	Civil to sytems Turnover risk		Risk that Contractor does not complete civil works correctly so transit systems contractor is delayed while work is re-done. Risk is higher at CRC and NPH bridges. General civil construction delays are captured elsewhere. Minor cost impact. Schedule impact could be one to three months	50%					1.0	2.0	3.0	**1.0**
105	Tran22	1	Transit	Excluded	Full Funding Grant Agreement (FFGA) delayed	No change in risk.	**Excluded - funding risks being modeled as separate scenarios.** See May 2011 Update Comments for Tran 17. Could be affected by reauthorization bill.	30%	0.0	0.0	0.0	**$0.0**	1.0	3.0	6.0	**1.0**
47	SW21	0	Environmental (Design)	Evenly split between 33 and 34	Incorporating Low Impact Development opportunities as design work progresses.	Keep - but recategorize and cover under the Design Risks. This opportunity is becoming more likely that project will be required to look at low impact	No change for this risk.	75%	-1.0	0.0	1.0	**$0.0**	0.0	0.0	0.0	**0.0**
46	SW23	1	Stormwater	Retire	Insufficient data available on existing drainage systems on Hayden Island	Keep - but recatigorize and cover under the Design Risks. Nothing has changed on this risk.	Risk has been addressed	0%	0.0	0.0	0.0	**$0.0**	0.0	0.0	0.0	**0.0**
188	SW26		Stormwater	Evenly split between 16, 19 and 33	Low infiltration rates	Risk of low infiltration rates triggering use of stormfilter cartridges for treatment of stormwater	No change for this risk.	50%	2.0	2.0	2.0	**$1.0**				**0.0**
189	SW27		Stormwater	Evenly split between 33 and 34	Lack of downstream conveyance capacity	Downstream conveyance has not been analyzed for pipe capacity with added flows from new pavement areas	No change for this risk.	40%	1.0	1.0	1.0	**$0.4**				**0.0**
190	SW28		Stormwater	33	USACE does not allow use of existing pipes in levees during construction	USACE must approve use of pipes through levees during construction. If not approved, will need two pump stations to route stormwater to the outfall.	No change for this risk.	50%	1.0	1.0	1.0	**$0.5**				**0.0**
20	SW7	1	Environmental	30	Changes in the BMP selection over the multi-year design process.	Keep - but recatigorize and cover under the Environmental Risks. Very low probability of agencies approving new BMP technology. Reduce probability from 75% to 5%.	Nothing has changed on this risk.	5%	0.0	0.0	0.0	**$0.0**	1.0	2.0	3.0	**0.1**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
103	Tran17	1	Transit	Excluded	CTRAN tax increase for O&M does not pass after one ballot measure	Revised risk to 6, 12, 18 month delay.	**Excluded - funding risks being modeled as separate scenarios.** CTRAN vote now to occur in 2012 - after application for Final Design. This is in essence a funding risk for the project. It is not anticipated this will impact Final Design, however if the vote in 2012 were to fail, it would have a negative impact on FTA FFGA approval. Back up plan to be prepared should the C-TRAN vote fail. Would need to either pass in a subsequent vote or find a new revenue stream in order to demonstrate that revenues are available to operate the transit system. This would delay submittal of the FFGA by 6-12 months. Six months would be more likely.	10%	0.0	0.0	0.0	**$0.0**	6.0	6.0	12.0	**0.7**
	Tran83		Transit	48A	City of Vancouver permit delays		City of Vancouver has never permitted light rail previously. This could potentially result in delays to receiving permits	20%					1.0	3.5	6.0	**0.7**
	Tran82		Transit	Affects both 54 and 56, perf corr	Late delivery of owner-furnished materials		Owner furnishes materials such as track and attachment materials. If those materials were to arrive late, this could trigger contractor delays. There is float available in the schedule. Most OFMs are in Washington. One possible scenario is a six-month delay at a 5% chance.	5%					1.0	3.5	6.0	**0.2**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Tran101		Transit	53	Additional or fewer LRT stations or Park-and-Rides		Team says stations very unlikely to change. Plan is well established. Potential opportunity to reduce size of a park-and-ride or eliminate a park and ride if FTA approves.	10%	-50.0	-35.0	-20.0	**-$3.5**				**0.0**
	Tran102		Transit	64	Purchase more or fewer LRT vehicles under this project		Base assumes 19 vehicles. Team says this is unlikely to change. Small chance to eliminate 1 or 2 vehicles.	10%	-8.0	-6.0	-4.0	**-$0.6**				**0.0**
120	Tran65	1	Transit	51	Funeral Home Acquisition	May not need to acquire funeral home (opportunity). Potential savings of $500,000.	Has been idenitified to be analyzed for mitigation along with other accesses impacted by side-running. Minor risk	25%	-0.5	-0.5	-0.5	**-$0.1**	0.0	0.0	0.0	**0.0**
	Tran78		Transit	N/A	City requires ground floor retail / architectural features could lead to added		Included in base case. Retire risk									
	Tran79	0	Transit	Replaced	Community objections could have impacts on transit schedule.		Covered by CTRAN vote and other permit issues. Retire risk	Replaced								
121	Tran68	1	Transit	51	Bank Access Mitigation	May need to acquire bank access. May be able to have access to parking and drive thru go over transit tracks (would require additional discussions).	Driving over the tracks can be assumed as a mitigation strategy until the access analysis is completed.	100%	0.2	0.2	0.2	**$0.2**	0.0	0.0	0.0	**0.0**
113	Tran58	1	Transit	53	City of Vancouver Design Approval Processes	Cost impacts for VMS to inform commuters of number of spots available at P&R.	The COV now does all design approval in house. They have conducted a pre-pre evaluation and changes and discussions are ongoing. Minor risk	25%	1.0	1.5	2.0	**$0.4**	0.0	0.0	0.0	**0.0**
118	Tran63	1	Transit	Evenly split between 53 and 54	Parking Mitigation	Have conducted study that shows they have ample parking. Cost to pay for parking mitigation is not currently included in the base cost. Cost impact of 200 spaces at $20,000, for total of $4 million.	Parking mitigation currently being developed. An analysis is being conducted to see how many City parking spaces are being replaced within the impacted corridors due to park and rides shared use opportunities. Construction of park-and-rides will reduce number of spaces requiring mitigation. Assume 75 spaces need to be mitigated at $30k / space	20%	2.3	2.3	2.3	**$0.5**	0.0	0.0	0.0	**0.0**
	Tran80		Transit	Evenly split between 54 and 56	Conflicts and interfaces with other major construction projects could lead to contractor conflicts (e.g. unrelated utility / street work)		Potential conflicts could lead to claims. Hayden Island and McLoughlin Bridge are particular risks given close quarters. Civil/structural overlap periods are pretty small and pretty localized.	20%	0.0	2.5	5.0	**$0.5**	0.0	0.0	0.0	**0.0**

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
107	Tran54	1	Transit	54	Changes in technologies (esp. communications and signaling)	Minor issues, system will be new on WA side. Systems base cost of $75 million. Cost impact of $2 to $10 million is too high. High end of $2 million. Revise cost impact to $0.5 to $2 million.	Compatibilty issue with existing light rail no longer an issue as there is a commitment to be compatible with existing TriMet systems. Possible issues with Vancouver signals.	50%	0.5	1.0	2.0	**$0.5**				**0.0**
125	Tran70	1	Transit	54	City of Vancouver requests underground utilities	Need to make connections to each building if utilities are relocated underground.	Undergrounding of utilities will be included on the cost pressures list or betterments. Should be addressed in agreements with COV. No change	25%	3.0	5.0	7.0	**$1.3**	0.0	0.0	0.0	**0.0**
	Tran77		Transit	58	Added aesthetics to station features		There is a significant chance that Hayden Island and City of Vancouver areas will probably both require more architectural improvements than those provided in the base case.	50%	1.0	3.0	5.0	**$1.5**	0.0	0.0	0.0	**0.0**
109	Tran_Minor	1	Transit	Minor	All Minor Transit Risks	Examples of minor risks: Comments from public process resulting in expectations above project scope (aesthetics, upgraded bus shelters); Redesign at HI (captured in another risk); Future station accounted for on 17th Avenue; Removing operator break room -- Trimet wants new break room; CCTV at bus stops; intrusion detection at	Inclusion of relief turns still being explored, hoping for a decision before Final Design application. Break room may need to be moved to east end of terminus platform. Possibility of public rest room inclusion because of Marshall Center concerns.	Minor								
106	Tran42	1	Transit	54	Construction days/hours are less limited than assumed in the base schedule	No change in risk.	No Change in Risk. LRT Washington construction schedule assumes regular hours. There is a siginificant chance that extended work hours could be approved	25%	0.0	0.0	0.0	**$0.0**	-3.0	-2.0	-1.0	**-0.5**
	Tran103		Transit	N/A	Significant change in LRT vehicle price		Base case has +/-10% cost risk. TriMet confirmed that competitive bidding for Milwaukie vehicle procurement includes the ability to add at least 19 vehicles for CRC. This significantly reduces the chance of a significant change in LRT vehicle price	Minor								
	Tran104		Transit	Minor	Interface issues between civil and systems contractors		Minor issue	Minor								
	Tran105		Transit	Minor	Delays in system testing or start-up		For example, communications, training (issue exists primarily on the Washington side). Very unlikely - minor risk.	Minor								

Risk Register - CAC								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Tran106		Transit	N/A	Delays in LRT vehicle delivery or acceptance		For example, manufacturing defects, testing problems. TriMet has experience with similar orders and vehicles. **TriMet will check on time risk. Retire, risk covered in Transit SW 3.**	Replaced								

Risk Register - CRC								Pre-Response Risk Quantification								
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
104	Tran21	1	Transit		FTA approval to enter into Final Design delayed	No change in risk.	Delays could occur due to capital funding shortages (tolling and bonding authority) - risk covered elsewhere. Need to make sure that other risk description captures impacts to FTA FD approval process.	Replaced								
112	Tran57	1	Transit		C-TRAN Review Panel for HCT	Risk not quantified. Need additional information.	We need to identify the scope of the HCT panel, if the group will only review the BRT project we can retire this risk. Hoping that previous bridge presentation to HCT panel will cover this review. Roll this issue into light rail vote in Vancouver	Replaced								
119	Tran64	1	Transit		Crossing Gates	Crossing gates are now included in the base. Not a risk.	Included in base costs but a decision has yet to be made at the touchdown with 5th St. Minor risk	Minor								
123	Tran67	1	Transit	Minor	OCS decision impacting utilities		Feed to OCS poles could impact utilities. There is uncertainty until utility mapping is complete. Minor issue	Minor								
	Tran71		Transit		Rail Crossing approvals could lead to a requirement for special signaling.		Team does not think additional gates will be needed. Retire risk.	Retire								
	Tran72		Transit	Minor	Unforeseen site conditions in the guideway		Minimize by utilities mapping. Contamination or fills are potential issues. Obstructions and contamination are covered elsewhere. Minor risk	Minor								
	Tran73		Transit	Minor	Uncertain market conditions for Track: Steel material price fluctuations		Most issues relate to materials prices, particularly steel prices, particularly if Buy-American waivers contnue to be unavailable. Assumes potential increase in material prices of 50%, and potential decrease of 15%. Assessments are minor cost change.	Minor	Activity 54: -$0.3M; Activity 56: -$0.2M		Activity 54: +$1.0M; Activity 56: +$0.7M					
	Tran74		Transit	N/A	Embedded Track		Opportunity as TriMet currently assumes embbeded track. Potential to switch from t-rail to girder rail could save money. Not quantified.	Excluded								
	Tran75		Transit	N/A	Uncertain market conditions for Track: Special (switches, turnout)		Combined into one category with other track for steel fluctuations.	Replaced								

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
	Tran76		Transit	N/A	Track: Special (switches, turnout) - exceeds escalation		Combined into one category with other track for steel fluctuations.	Replaced								
	Tran84	0	Transit	N/A	City of Portland Design Approval		Covered under Struc21.									
	UT16		Utilities	54	Delay relocating Qwest lines		Qwest lines conflict with light rail in Vancouver. Qwest has said relocation will take four years. Line is parallel to track and the track will cover utility vaults.. CRC meeting with Qwest. Qwest will not relocate prior to ROD. WSDOT can't reimburse pre-ROD. Qwest franchise agreements with Vancouver have expired. WSDOT lookng for way to incentivize Qwest to move. Delay is assessed relative to current early 2016 start of Task 54. Might also mitigate by paying to move. Minor cost and not modeled	30%					6.0	9.0	12.0	**2.7**
	UT15		Utilities	N/A	Service connection of utilities to indiviidual customers		Other project experience shows utilities paid for service connections.									
	UT19		Utilities	33	NPH utility relocation delays		Many utilities in NPH. Gas line and water line are particular issues. Cost of relocating NPH utilities will belong to CRC. Gas and water line need to be relocated prior to contractor starting. Jump span would be early on in the project.	30%				**$0.0**	2.0	4.0	6.0	**1.2**
48	UT8	1	Utilities	Evenly split between 16, 19, 33, 34, 54 and 56	Other utility relocations not completed on planned schedule	Keep - but recategorize and cover under the Construction Risks. No change to this risk (except the activities impacted). Use 50% on delay as tied up to	Meeting regularly with utility companies to reduce this risk. This is a cost for all other utilites not called out specifically.	30%	3.0	4.0	5.0	**$1.2**				**0.0**
	UT17		Utilities	Minor	Undergrounding of overhead utilities on McLoughlin would increase costs		City may ask project to undeground utilities on McLoughlin. Minor cost and schedule risk	Minor								
	UT18		Utilities	Minor	Utility relocation will be difficult in congested downtown area.		May find unanticipated utilities and run into unanticipated costs. Mitigating by surveying. Residual risk is minor.	Minor								
49	UT13	1	Utilities (Design)	Minor	Utility owners argue a project impact where none has been identified - South Side	Keep - but recatigorize and cover under the Design Risks. The $2 million cost impact based on 10% of the overall utility relocation.	Ongoing subsurface utility work reduces this risk to 10% probability. Utility owners may attempt to argue that there is an impact to their utility while CRC does not believe there is an impact. Minor residual risk,	Minor								

Risk Register - CRC																	
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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
50	UT9	1	Utilities (Design)	Minor	Utility owners argue a project impact where none has been identified - North Side	Have had more discussions on WA side than OR side. Lower risk than on OR.	Ongoing subsurface utility work minimizes this risk.	Minor								

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1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
170	Struc14b	0	Structures		Further development of river crossing structure reveals additional design complexities with added cost. (e.g.--connections, web member detail changes)	Further project development has reduced this risk; however no decisions have been made to finalize design of these elements. Superstructure base cost is around $300 million. Upper end cost impact is 10% increase in superstructure costs ($30 million). No change in risk quantification.	This risk is assciated with the Open Web Box Girder. Retire Risk.	10%	10.0	20.0	30.0	**$2.0**	0.0	0.0	0.0	**0.0**
172	Struc28	0	Structures		Increase bid costs due to complexity of the construtibility of the structure	Check what reductions in productivity have been incorported into the base cost.	Associated with the Open Web Box Girder. Retire Risk	50%	1.0	5.0	10.0	**$2.6**	0.0	0.0	0.0	**0.0**
173	Struc29	0	Structures		Additional modificiations to the structural elements of the open-web box bridges are required soley for aesthetic purposes	Good chance form will change. Cost impact of 5 to 15 million.	This risk is assciated with the Open Web Box Girder. Retire Risk.	50%	5.0	10.0	15.0	**$5.0**	0.0	0.0	0.0	**0.0**
174	Struc30	0	Structures		River crossing structure becomes constant width from piers 2 to 7	50/50 chance of this. Cost threat but schedule savings of up to a season.	This was associated with the Open Web Box Girder to eliminate complexity. It was investigated and found to have little benefit. Retire risk.	50%	0.0	15.0	25.0	**$7.1**	-12.0	-6.0	0.0	**-3.0**
30	Con1	0	Construction / Geotech		Saving money from the pile shaft test program (pertains to river crossing).	Cost impact accounted for in lower bound of Struct16a. Test pile program could give information about production rates that could be a threat or opportunity to the schedule. Base schedule assumes 9 days per shaft. Accounted for in Struc30 and Struc31.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
58	D_Minor	0	Design		All Minor Design Risks	Accounted for in HW_minor (combined all minor into 1 category for design, highway and structures)		50%	2.0	4.0	6.0	**$2.00**	-2.0	0.0	4.0	**0.2**
57	D14	0	Design		New projects may delay approval process	Risk retired.		10%	0.0	0.0	0.0	**$0.00**	1.0	2.0	3.0	**0.2**

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97	D4	0	Design		Final 10 vs. 12 decision is delayed	Closed - This risk has occurred. Decision was made		10%	0.0	0.0	0.0	**$0.00**	1.0	2.0	3.0	**0.2**
27	Env20	0	Environmental		Possible Section 4F archaeological during preconstruction	The timeframe in which this issue would have presented itself has passed.		10%	0.0	0.0	0.0	**$0.00**	6.0	6.0	6.0	**0.6**
26	ENV35	0	Envronmental		Local land use permitting delays	Covered in ENV 16b: Interagency coordination / agreements Post-ROD.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
45	Geo14	0	Geotech		Ground improvements	Further geotechnical investigation has changed this risk. Risk retired.		10%	5.0	30.0	35.0	**$2.67**	0.0	0.0	0.0	**0.0**
52	HW21	0	Highway		Local Road construction (Marine Drive)	This has been realized. Covered in base cost. Risk retired.		75%	1.0	1.0	1.0	**$0.75**	0.0	0.0	0.0	**0.0**
64	HW26	0	Highway		early CDN-4P construction requires detour alignment or closures or design change	Covered in HW57		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
65	HW27	0	Highway		early LRT construction may require interim MD construction	Covered in HW57		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
66	HW28	0	Highway		early LRT construction may require certain mainland connector, LRT, MUP arrangement	Covered in HW57		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
67	HW29	0	Highway		early construction of elements may require detours or staging alignments such as the 5S-4P ramp	Covered in HW57		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
78	HW40	0	Highway		Parks mitigation may require additional design, cost of mitigation and delay	This is covered under environmental mitigation for 106.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
79	HW41	0	Highway		Redevelopment prior to construction may require design changes, additional cost and or r/w impacts	Covered in minor catchall for HW.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
80	HW42	0	Highway		P&R design - size and location changes would cause design changes and delay construction and could increase cost	Recent changes are captured in the base cost.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
84	HW46	0	Highway		O'xing tie-in extents increase requires more intersection rebuild, ADA rebuild	Captured in minor catch all		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
85	HW47	0	Highway		Pavement design requires rebuild instead of overlay	covered in another risk item.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**

Risk Register - CAC								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
86	HW48	0	Highway		5N-HI change from 1 lane to 2 lane off	covered in another risk item.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
87	HW49	0	Highway		Design or redesign because of sound walls	Base cost uncertainty is +/-20% for sound walls. Captured in the base cost uncertainty.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
68	HW30	0	Highway - COP		Cross section elements may increase in width - s/w, bike lanes, planters	Uncertainty in local road improvements. Some of this is covered in the base uncertainty for roadway (+/-20%); paving (+/-10%). And Bridges (+/-30%). Also covered in minor catchall.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
69	HW31	0	Highway - COP		Additional features may be added to project: paths, parks, trails, etc.	Safety & security covered in base costs. This is covered in the minor catch all category for Highway Risks.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
72	HW34	0	Highway - COP		Detours and closures may require redesign of elements if determined to be unacceptable	Covered in HW57		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
73	HW35	0	Highway - COV		Cross section elements may increase in width - s/w, bike lanes, planters	Uncertainty in local road improvements. Some of this is covered in the base uncertainty for roadway (+/-20%); paving (+/-10%). And Bridges (+/-30%). Also covered in minor catchall.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
74	HW36	0	Highway - COV		Additional features may be added to project: paths, parks, bridge aesthetics, trails, etc.	Uncertainty in local road improvements. Some of this is covered in the base uncertainty for roadway (+/-20%); paving (+/-10%). And Bridges (+/-30%). Also covered in minor catchall.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
75	HW37	0	Highway - COV		BNSF berm access may require additional r/w, cost	Covered in other BNSF risk.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
76	HW38	0	Highway - COV		Detours and closures may require redesign of elements if determined to be unacceptable	Covered in HW57		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
77	HW39	0	Highway - COV		Trimet coordination may cause delay or design changes	Covered in other coordiation, interagency coordination		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
91	HW53	0	Highway - Opportunities		Delay MUP construction in Portland	Not likely.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
92	HW54	0	Highway - Opportunities		Pull widening off NPH	Have done this already.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
168	HW14	0	Highway (Bridge Review)		Extent of community connection south of Evergreen Blvd. is undetermined	$25 M of the cost is now in the base cost. Risk of being longer than planned. Accounted for in a different risk (Struc27). Risk retired.		95%	30.0	40.0	50.0	**$38.00**	0.0	0.0	0.0	**0.0**
167	HW1a	0	Highway (Bridge Review)		Multi-use bike/ped path design is required to be wider or narrower than planned	The Multi-use path will need to accommodate fire/life/safety which will dictate the width of the bridge. This will be reflected in the base cost. Risk retired.		10%	-2.0	0.0	10.0	**$0.13**	0.0	0.0	0.0	**0.0**
143	ROW11	0	ROW-OR		Real Estate Valuation consultant availability	Covered in lack of appraisers risk (ROW4).		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**

								Pre-Response Risk Quantification								
		Risk Information							Cost Risk Information ("Raw", Current Millions $)				Schedule Risk Information (Months)			
Record #	Risk ID	Impacts Transit	Functional Assignment	Activity Number (From Schedule Flowchart)	Threat/ Opportunity Events	November 2010 Update Comments	May 2011 Update Comments	Probability of Occurrence (%)	Low Cost	Most Likely Cost	High Cost	Simple Expected Value Cost	Low Schedule	Most Likely Schedule	High Schedule	Simple Expected Value Schedule
1	11	14	16	17	18	21	22	27	28.0	29.0	30.0	31	36.0	37.0	38.0	39.0
144	ROW12	0	ROW-OR		Substantial increases in actual r/w acquistion cost.	Base estimate has a +10% ($11 million) upper end. Until appraisers get in to appraise properties, there is a lot of uncertainty around the acquisition costs. Adjust the base cost uncertainty range to -10%/+20%. Accounted for in the base uncertainty.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
145	ROW13	0	ROW-OR		Unanticipated relocation costs	Accounted for under the base cost uncertainty for relocation.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
132	ROW1	0	ROW-WA		Design changes	Additional acquisition accounted for in HW33.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**
134	ROW3	0	ROW-WA		Offsite parcels not identified	Have identified two sources to acquire office mitigation parcels. Should be suffcient amount of property available to acquire. Cost for acquiring these sites is accounted for in the base.		0%	0.0	0.0	0.0	**$0.00**	0.0	0.0	0.0	**0.0**

Appendix D

Flow Chart Logic

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ID	Activity	Duration	Predecessor	Successor	Constrained Start Date (Baseline Funding Scenario)	Constrained Start Date (Delayed Funding Scenario)
1	Pre ROD Permits	6	None	2 (FF), 3		
2	Prepare FEIS	5	1 (FF)	3 (S+3),		
3	Prepare ROD	4	1, 2 (S+3)	6		
4	CRB Post ROD Permitting	12	6	24		
5	Other Post ROD Permitting	18	6	15, 18, 32		
6	ROD	MS	3	4, 5, 10, 20, 28, 41, 51		
7	ROW Funding	MS	None	10, 20, 28, 51	7/1/2011	7/1/2011
8	Toll/Bond Auth.	MS	None	24, 32, 41, 45	4/1/2012	7/1/2013
9	Constr. Funding	MS	None	15, 18, 24, 32	7/1/3013	4/1/2014
9a	Fed. Disc. Funds	MS	None	15, 18, 24, 32, **45**	10/1/2013	10/1/2014
10	Other ROW App and Acqu	24	6, 7, **39 (S+8)**	15, 18	7/1/2012	7/1/2012
11	**MD DELETED**					
12	**MD DELETED**					
13	**MD DELETED**					
14	4P/SR500 Design and PS&E	18	None	15	7/1/2016	7/1/2016
15	ABA 4P/SR500 Design and PS&E	4	5, 9, 9a, 10, 14	16		
16	4P/SR500 Construction	22	15	67		
17	Mill Plain Design and PS&E	18	None	18	7/1/2016	7/1/2016
18	ABA Mill Plain Design and PS&E	3	5, 9, 9a, 10, 17	19		
19	Mill Plain Construction	30	18	67		
20	CRB ROW App and Acqu	24	6, 7, **39 (S+7)**	24 (S+20)		
21	CRB Develop RFQ/RFP	12		22	6/1/2011	6/1/2011
22	CRB Issue RFP	MS	21, 39	23		
23	CRB Receive / Review Proposals	9	22	24		
24	CRB Award D/B	MS	4, 8, 9, 9a, 20 (S+20), 23, 46	25		
25	CRB Design / Construction	50	24	26, 36, 56 (FF)		
26	Traffic on SB	MS	25, 33	27, 34, 60		
27	Begin Tolling	MS	26			
28	MD/HI/SR14 ROW App and Acqu	24	6, 7, **39 (S+14)**	32 (S+20)	7/1/2012	7/1/2012
29	MD/HI/SR14 Develop RFQ/RFP	18		30	6/1/2011	6/1/2011
30	MD/HI/SR14 Issue RFP	MS	29, 39,	31		
31	MD/HI/SR14 Receive / Review Proposals	9	30	32		
32	MD/HI/SR14 Award D/B	MS	5, 8, 9, 9a, 28 (S+20), 31, 46	33		
33	MD/HI/SR14 Design / Construction (Stage 1-3)	41	32	26, 56 (S+16 to 75% complete)		
34	MD/HI/SR14 Design / Construction (Stage 4-7)	36	26	35 (S+29), 67		
35	Traffic on NB	MS	34 (S+29)	38, 67		
36	CRB Demo Exist Bridges Design and PS&E	9	25	37		
37	CRB ABA Demo Exist Bridges	3	36	38		
38	CRB Demo Exist Bridges Construction	18	35, 37	67		
39	Agreements - IGA's, Tolling Ops, Transit Ops, BNSF, Utilities	18	None	22, 30, 43 (S+6), 47, **51, 10 (S+14), 20 (S+14), 28 (S+14)**		
40	TR Develop 30% Plans	6	None	41		
41	TR Apply for Final Design	MS	6, 8, 40	42		
42	TR Advanced Preliminary Engineering	10	41	43		
43	TR FTA Final Design Approval	MS	39 (S+6), 42	44, 45, 46, 48		
44	TR Final Design	18	43	55, 63, 57, 59, 61		
45	TR Apply for Full Funding Grant Agreement	MS	8, 43, **9a**	47 (9 mo between)	10/1/2013	10/1/2013
46	TR Letter of No Prejudice	MS	43	24, 32,		
47	TR FTA Full Funding Grant Agreement	MS	39, 45 (S+9),	49, 52, 55, 57, 59, 61, 63,		
48	TR LRT Washington Ad/Bid/Award (CM/GC)	6	43	48a,		
48a	TR Final Design LRT Washington	15	48	54		
49	TR LRT Ruby Junction Ad/Bid/Award	3	47	50		
50	TR LRT Ruby Junction Construction	15	49	64 (FF)		
51	TR Transit ROW App and Acqu	24	6, 7, 39 (F-S)	54 (S+20), 55,	12/1/2012	12/1/2012
52	TR LRT Park and Ride Develop RFP/RFQ	8	47	52a		
52a	TR Issue RFP	MS	52	52b		
52b	TR Receive / Review Proposals	7	52a	52c		

ID	Activity	Duration	Predecessor	Successor	Constrained Start Date (Baseline Funding Scenario)	Constrained Start Date (Delayed Funding Scenario)
52c	TR Award D/B	MS	52b	53		
53	TR LRT Park and Ride Design/Construction	24	52c	58		
54	TR LRT Washington	36	48a, 51 (S+20)	58, 62		
55	TR LRT Oregon Ad/Bid/Award	3	44, 47, 51	56	2/1/2016	push out same amount as 25 under funding delay
56	TR LRT Oregon	18	25 (FF), 33 (S+16 to 75% complete), 55	58, 62		
57	TR LRT Finishes Ad/Bid/Award	3	44, 47	58	8/1/2017	push out same amount as 25 under funding delay
58	TR LRT Finishes	12	53, 54, 56, 57, 60 (FF+3.5)	65		
59	TR LRT on CRB Ad/Bid/Award	3	44, 47	60	8/1/2017	push out same amount as 25 under funding delay
60	TR LRT on CRB Construction	9	26, 59	58 (FF+3.5), 62 (FF+4)		
61	TR LRT Systems Ad/Bid/Award	3	44, 47	62	3/1/2017	push out same amount as 25 under funding delay
62	TR LRT Systems Construction	18	54, 56, 60 (FF+4), 61	65		
63	TR LRV Procurement Ad/Bid/Award	3	47	64		
64	TR LRV Procurement	48	63, 50 (FF)	65		
65	TR LRT Start Up Time	6	58, 62, 64	66		
66	TR LRT Revenue Operations Date	MS	65	67		
67	Project Complete	MS	16, 19, 34, 35, 38, 66			

Appendix E

Selected Model Results in Tabular Format

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Baseline Funding Scenario, Phase 1 Build Alternative - Activity Start and End Dates

Activity Number	Activity Name	Start Date			End Date		
		10th Percentile	60th Percentile	90th Percentile	10th Percentile	60th Percentile	90th Percentile
0	Previous Costs	5/1/2011	5/1/2011	5/1/2011	5/31/2011	5/31/2011	5/31/2011
1	Pre ROD Permits	5/1/2011	5/1/2011	5/1/2011	7/1/2011	7/1/2011	8/18/2011
2a	Prepare FEIS (1 of 2)	5/1/2011	5/1/2011	5/1/2011	7/31/2011	9/11/2011	11/4/2011
2b	Prepare FEIS (2 of 2)	7/31/2011	9/11/2011	11/4/2011	9/30/2011	11/19/2011	3/12/2012
3	Prepare ROD	7/31/2011	9/11/2011	11/4/2011	11/30/2011	1/18/2012	3/15/2012
4	CRB Post ROD Permitting	11/30/2011	2/19/2012	6/23/2012	11/30/2012	3/11/2013	12/1/2013
5	Other Post ROD Permitting	11/30/2011	2/19/2012	6/23/2012	6/1/2013	8/21/2013	12/24/2013
6	ROD	11/30/2011	1/18/2012	3/15/2012	11/30/2011	2/19/2012	6/23/2012
7	ROW Funding	7/1/2011	7/1/2011	7/1/2011	7/1/2011	7/1/2011	7/1/2011
8	Toll/Bond Auth.	4/1/2012	4/1/2012	4/1/2012	4/1/2012	4/1/2012	4/1/2012
9	Constr. Funding	7/1/2013	7/1/2013	7/1/2013	7/1/2013	7/1/2013	7/1/2013
9a	Fed. Disc. Funds	10/1/2013	10/1/2013	10/1/2013	10/1/2013	10/1/2013	10/1/2013
10	Other ROW App and Acqu	7/1/2012	7/1/2012	7/1/2012	7/3/2014	7/28/2014	1/22/2015
11	MD DELETED	5/1/2011	5/1/2011	5/1/2011	5/1/2011	5/1/2011	5/1/2011
12	MD DELETED	5/1/2011	5/1/2011	5/1/2011	5/1/2011	5/1/2011	5/1/2011
13	MD DELETED	5/1/2011	5/1/2011	5/1/2011	5/1/2011	5/1/2011	5/1/2011
14	4P/SR500 Design and PS&E	7/1/2016	7/1/2016	7/1/2016	1/1/2018	1/1/2018	1/1/2018
15	ABA 4P/SR500 Design and PS&E	1/1/2018	1/1/2018	1/1/2018	5/3/2018	5/3/2018	5/3/2018
16a	4P/SR500 Construction	5/3/2018	5/3/2018	5/3/2018	3/4/2020	3/4/2020	3/4/2020
16b	4P/SR500 Construction (extension)	3/4/2020	3/4/2020	3/4/2020	3/4/2020	3/4/2020	3/4/2020
17	Mill Plain Design and PS&E	7/1/2016	7/1/2016	7/1/2016	1/1/2018	1/1/2018	1/1/2018
18	ABA Mill Plain Design and PS&E	1/1/2018	1/1/2018	1/1/2018	4/2/2018	4/2/2018	4/2/2018
19a	Mill Plain Construction	4/2/2018	4/2/2018	4/2/2018	10/3/2020	11/9/2020	11/30/2020
19b	Mill Plan Construction (extension)	10/3/2020	11/9/2020	11/30/2020	10/3/2020	11/9/2020	11/30/2020
20a	CRB ROW Appraisal and Acquisition (1 of 2)	11/30/2011	2/19/2012	6/23/2012	8/1/2013	12/15/2013	4/19/2014
20b	CRB ROW Appraisal and Acquisition (2 of 2)	8/1/2013	12/15/2013	4/19/2014	12/1/2013	4/16/2014	8/19/2014
21	CRB Develop RFQ/RFP	6/1/2011	6/1/2011	6/1/2011	6/1/2012	9/5/2012	10/25/2012
22	CRB Issue RFP	10/31/2012	10/31/2012	10/31/2012	10/31/2012	10/31/2012	3/21/2013
23	CRB Receive / Review Proposals	10/31/2012	10/31/2012	3/21/2013	8/1/2013	9/2/2013	1/8/2014
24	CRB Award D/B	10/1/2013	1/18/2014	5/4/2014	10/1/2013	1/18/2014	5/4/2014
25a	CRB Design / Construction	10/1/2013	1/18/2014	5/4/2014	9/21/2017	3/4/2018	7/9/2018
25b	CRB Design / Construction (extension)	9/21/2017	3/4/2018	7/9/2018	9/21/2017	3/4/2018	7/9/2018
26	Traffic on SB	11/18/2017	5/23/2018	11/9/2018	11/18/2017	5/23/2018	11/9/2018
27	Begin Tolling	11/18/2017	5/23/2018	11/9/2018	11/18/2017	5/23/2018	11/9/2018
28a	MD/HI/SR14 ROW Appraisal and Acquisition (1 of 2)	7/1/2012	7/1/2012	7/1/2012	3/3/2014	5/3/2014	1/16/2015
28b	MD/HI/SR14 ROW Appraisal and Acquisition (2 of 2)	3/3/2014	5/3/2014	1/16/2015	7/3/2014	9/2/2014	5/18/2015
29	MD/HI/SR14 Develop RFQ/RFP	6/1/2011	6/1/2011	6/1/2011	12/1/2012	3/7/2013	6/1/2013
30	MD/HI/SR14 Issue RFP	12/1/2012	3/7/2013	6/1/2013	12/1/2012	5/20/2013	10/3/2013
31	MD/HI/SR14 Receive / Review Proposals	12/1/2012	5/20/2013	10/3/2013	10/3/2013	3/8/2014	7/22/2014
32	MD/HI/SR14 Award D/B	3/3/2014	7/20/2014	1/20/2015	3/3/2014	7/20/2014	1/20/2015
33a	MD/HI/SR14 Design / Construction (Stage 1-3) (1 of 2)	3/3/2014	7/20/2014	1/20/2015	7/4/2015	1/13/2016	7/31/2016
33b	MD/HI/SR14 Design / Construction (Stage 1-3) (2 of 2)	7/4/2015	1/13/2016	7/31/2016	6/17/2017	3/5/2018	10/18/2018
33c	MD/HI/SR14 Design / Construction (Stage 1-3) (extension)	6/17/2017	3/5/2018	10/18/2018	6/17/2017	3/5/2018	10/18/2018
34a	MD/HI/SR14 Design / Construction (Stage 4-7) (1 of 2)	11/18/2017	5/23/2018	11/9/2018	2/11/2020	8/29/2020	3/4/2021
34b	MD/HI/SR14 Design / Construction (Stage 4-7) (2 of 2)	2/11/2020	8/29/2020	3/4/2021	9/11/2020	3/31/2021	10/3/2021
34c	MD/HI/SR14 Design / Construction (Stage 4-7) (extension)	9/11/2020	3/31/2021	10/3/2021	9/11/2020	3/31/2021	10/3/2021
35	Traffic on NB	2/11/2020	8/29/2020	3/4/2021	2/11/2020	9/3/2020	2/26/2021
36	CRB Demo Exist Bridges Design and PS&E	9/21/2017	3/4/2018	7/9/2018	6/23/2018	12/3/2018	4/9/2019
37	CRB ABA Demo Exist Bridges	6/23/2018	12/3/2018	4/9/2019	9/22/2018	3/5/2019	7/10/2019
38	CRB Demo Exist Bridges Construction	2/11/2020	8/29/2020	3/4/2021	8/13/2021	3/1/2022	9/4/2022
39a	Agreements - IGA's, Tolling Ops, Transit Ops, BNSF, Utilities, Etc. (1 of 3)	5/1/2011	5/1/2011	5/1/2011	10/31/2011	10/31/2011	10/31/2011
39b	Agreements - IGA's, Tolling Ops, Transit Ops, BNSF, Utilities, Etc. (2 of 3)	10/31/2011	10/31/2011	10/31/2011	7/1/2012	7/1/2012	7/1/2012
39c	Agreements - IGA's, Tolling Ops, Transit Ops, BNSF, Utilities, Etc. (3 of 3)	7/1/2012	7/1/2012	7/1/2012	10/31/2012	10/31/2012	10/31/2012
40	TR Develop 30% Plans	5/1/2011	5/1/2011	5/1/2011	10/31/2011	10/31/2011	10/31/2011
41	TR Apply for Final Design	4/1/2012	4/1/2012	6/23/2012	4/1/2012	4/1/2012	6/23/2012
42	TR Advanced Preliminary Engineering	4/1/2012	4/1/2012	6/23/2012	1/31/2013	1/31/2013	4/24/2013
43	TR FTA Final Design Approval	1/31/2013	1/31/2013	4/24/2013	1/31/2013	6/8/2013	10/18/2013
44	TR Final Design	1/31/2013	6/8/2013	10/18/2013	8/3/2014	12/9/2014	4/20/2015
45	TR Apply for Full Funding Grant Agreement	10/1/2013	10/1/2013	10/18/2013	10/1/2013	10/1/2013	10/18/2013
46	TR Letter of No Prejudice	1/31/2013	6/8/2013	10/18/2013	1/31/2013	6/8/2013	10/18/2013

Baseline Funding Scenario, Phase 1 Build Alternative - Activity Start and End Dates

Activity Number	Activity Name	Start Date			End Date		
		10th Percentile	60th Percentile	90th Percentile	10th Percentile	60th Percentile	90th Percentile
47	TR FTA Full Funding Grant Agreement	7/2/2014	7/2/2014	10/20/2014	7/2/2014	7/2/2014	10/20/2014
48	TR LRT Washington Ad/Bid/Award (CM/GC)	1/31/2013	6/8/2013	10/18/2013	8/2/2013	12/8/2013	4/19/2014
48a	TR Final Design LRT Washington	8/2/2013	12/8/2013	4/19/2014	11/2/2014	4/6/2015	8/28/2015
49	TR LRT Ruby Junction Ad/Bid/Award	7/2/2014	7/2/2014	10/20/2014	10/2/2014	10/2/2014	1/19/2015
50	TR LRT Ruby Junction Construction	10/2/2014	10/2/2014	1/19/2015	1/2/2016	1/2/2016	4/21/2016
51a	TR Transit ROW App and Acqu (1 of 2)	12/1/2012	12/1/2012	12/1/2012	8/3/2014	12/9/2014	3/21/2015
51b	TR Transit ROW App and Acqu (2 of 2)	8/3/2014	12/9/2014	3/21/2015	12/3/2014	4/10/2015	7/21/2015
52	TR LRT Park and Ride Develop RFP/RFQ	7/2/2014	7/2/2014	10/20/2014	3/3/2015	3/3/2015	6/21/2015
52a	TR Issue RFP	3/3/2015	3/3/2015	6/21/2015	3/3/2015	3/3/2015	6/21/2015
52b	TR Receive / Review Proposals	3/3/2015	3/3/2015	6/21/2015	10/3/2015	10/3/2015	1/20/2016
52c	TR Award D/B	10/3/2015	10/3/2015	1/20/2016	10/3/2015	10/3/2015	1/20/2016
53	TR LRT Park and Ride Design/Construction	10/3/2015	10/3/2015	1/20/2016	10/4/2017	10/4/2017	1/21/2018
54	TR LRT Washington	11/14/2014	4/21/2015	9/4/2015	12/19/2017	8/3/2018	3/21/2019
55	TR LRT Oregon Ad/Bid/Award	2/1/2016	2/1/2016	2/1/2016	5/2/2016	5/2/2016	5/2/2016
56a	TR LRT Oregon (1 of 2)	5/2/2016	5/2/2016	5/2/2016	6/18/2017	8/5/2017	9/18/2017
56b	TR LRT Oregon (2 of 2)	6/18/2017	8/5/2017	9/18/2017	11/12/2017	3/8/2018	7/9/2018
57	TR LRT Finishes Ad/Bid/Award	8/1/2017	8/1/2017	8/1/2017	10/31/2017	10/31/2017	10/31/2017
58a	TR LRT Finishes (1 of 2)	2/4/2018	8/17/2018	3/21/2019	10/21/2018	5/3/2019	12/5/2019
58b	TR LRT Finishes (2 of 2)	11/19/2018	6/21/2019	12/31/2019	3/6/2019	10/5/2019	4/16/2020
59	TR LRT on CRB Ad/Bid/Award	8/1/2017	8/1/2017	8/1/2017	10/31/2017	10/31/2017	10/31/2017
60	TR LRT on CRB Construction	11/18/2017	5/23/2018	11/9/2018	8/20/2018	2/21/2019	8/11/2019
61	TR LRT Systems Ad/Bid/Award	3/1/2017	3/1/2017	3/1/2017	5/31/2017	5/31/2017	5/31/2017
62a	TR LRT Systems Construction (1 of 2)	2/1/2018	8/17/2018	3/21/2019	4/4/2019	10/18/2019	5/21/2020
62b	TR LRT Systems Construction (2 of 2)	4/10/2019	10/30/2019	5/24/2020	8/10/2019	2/29/2020	9/23/2020
63	TR LRV Procurement Ad/Bid/Award	7/2/2014	7/2/2014	10/20/2014	10/2/2014	10/2/2014	1/19/2015
64	TR LRV Procurement	10/2/2014	10/2/2014	1/19/2015	10/5/2018	10/5/2018	1/22/2019
65	TR LRT Start Up Time	8/10/2019	2/29/2020	9/23/2020	2/9/2020	8/30/2020	3/25/2021
66	TR LRT Revenue Operations Date	2/9/2020	8/30/2020	3/25/2021	2/9/2020	8/30/2020	3/25/2021
67	Project Complete	8/14/2021	3/1/2022	9/4/2022	8/14/2021	3/6/2022	8/29/2022
68	Project Controls 2014+	1/1/2014	1/1/2014	1/1/2014	8/14/2021	3/1/2022	9/4/2022