Columbia River Crossing

May 2010 CEVP Workshop Final Report

Errata – *August 26, 2010*

The May 2010 Cost Estimate Validation Process (CEVP) Workshop Final Report includes three incorrect references to structure type.

The risks, costs and schedule associated with the open web box girder concept were estimated and validated through a CEVP update process in September 2009 for both the LPA Full Build and the LPA Phase 1 scenarios.

This report is based on an open web box girder bridge type for the Columbia River bridges. The risk profile, cost estimates and construction schedule information and assumptions used to conduct the CEVP modeling associated with the bridges over the Columbia River are all based on an open web box girder bridge type. Risk information was developed and quantified by CEVP subject matter experts.

Errors are listed below with the necessary corrections.

Page 3-11, number 5:

> The main river crossing structure is assumed to be segmental concrete.
>
> **Correction:** The main river crossing structure is assumed to be **open web box girder**.

Page 4-1, number 3:

> The main river crossing structure will be segmental concrete.
>
> **Correction:** The main river crossing structure will be **open web box girder**.

Page 4-6, bullet 3 under heading *Columbia River Bridges:*

> The methodology of construction for the main crossing and type of construction; including segmental concrete superstructure and ten-foot diameter driven piles was discussed in depth.
>
> **Correction:** The methodology of construction for the main crossing and type of construction; including **open web box girder** superstructure and ten-foot diameter driven piles was discussed in depth.

CEVP WORKSHOP

Final Report

May, 2010

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. For questions regarding WSDOT's Title VI Program, you may contact the Department's Title VI Coordinator at (360) 705-7098. For questions regarding ODOT's Title VI Program, you may contact the Department's Civil Rights Office at (503) 986-4350.

Americans with Disabilities Act (ADA) Information

If you would like copies of this document in an alternative format, please call the Columbia River Crossing (CRC) project office at (360) 737-2726 or (503) 256-2726. Persons who are deaf or hard of hearing may contact the CRC project through the Telecommunications Relay Service by dialing 7-1-1.

¿Habla usted español? La informacion en esta publicación se puede traducir para usted. Para solicitar los servicios de traducción favor de llamar al (503) 731-4128.

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ACRONYMS

CCI Construction Cost Index

CEVP Cost Estimation Validation Process

CM Construction Management

CRA Cost Risk Assessment

CRC Columbia River Crossing

FEIS Final Environmental Impact Study

LPA Locally Preferred Alternative

LRV Light Rail Vehicle

PE Preliminary Engineering

ROW Right of Way

SME Subject Matter Expert

NOTE TO READERS

The risk based estimating process employed by Washington State Department of Transportation (WSDOT) through its Cost Risk Assessment (CRA) and Cost Estimate Validation Process (CEVP®) workshops is iterative in nature and represents a "snapshot in time" for that project and under the conditions known at that point in time.

Additionally, CEVP® normally deals with identifiable and quantifiable project-type risks – i.e. those events that can occur in planning, design, bidding, construction and changed conditions. CEVP® could also consider the larger, more difficult risks – political and management continuity and "acts of God" that can have very high impact in cost and schedule – but at this point, these types of risks have not generally been included. This is an area for review and development – in particular, how to characterize such events in a useful manner for better management of the 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).

The estimate should be a well organized, easy to follow history from the first estimate at the beginning of the planning phase through the preparation of the final estimate. The basis of estimate document concisely states the purpose of the estimate (i.e. cost study, project options, scoping estimate, etc.), the project scope, pricing basis, allowances, assumptions, exclusions, cost risks and opportunities, and any deviations from standard practices.

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

Columbia River Crossing

April 2010

Columbia River Crossing
Route I-5
LPA Phase 1 Scenario

Project Description

The Columbia River Crossing (CRC) project is a comprehensive, long-term transportation solution that addresses congestion, safety and mobility problems on I-5 between Portland and Vancouver. Co-sponsored by the Oregon and Washington departments of transportation, the project will replace the Columbia River Bridge, extend light rail to Vancouver, improve highway, interchanges and pedestrian and bicycle facilities between State Route 500 in Vancouver and Columbia Boulevard in Portland.

Project Benefits

- Reduced collision rates through the project area
- Reduced travel times between Portland and Vancouver
- Improved transit options between Portland and Vancouver
- Improved accessibility to the I-5 corridor in the vicinity of the Columbia River Bridge
- Increase bridge durability and reduced susceptibility to earthquakes

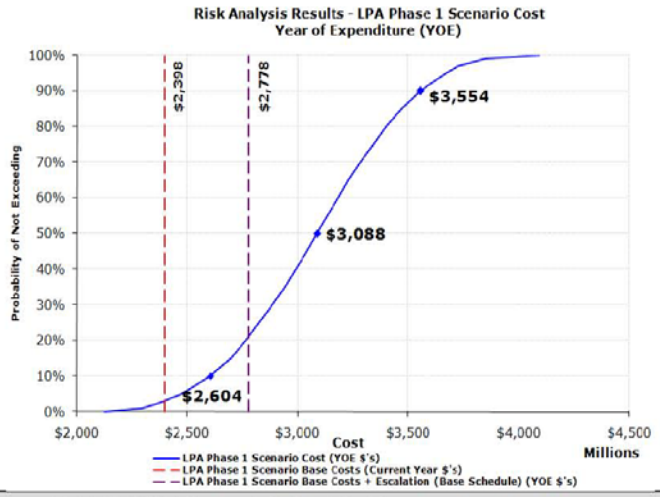
Key Assumptions

- Costs are escalated annually by WSDOT recommended escalation factors.
- Design is about 10% complete
- The Record of Decision is expected in December, 2010

Project History (key dates)

- 2001-2002: Bi-state partnership recommends fixing the bottleneck on I-5 at the Columbia River
- 2005: Task Force formed to advise project development; Notice of Intent; Purpose and Need
- 2006-2007: Alternatives analysis
- 2008: Draft Environmental Impact Statement published (May); Locally Preferred Alternative adopted by local project partners (July)
- 2009-present: Design development of Locally Preferred Alternative; preparation of the Final Environmental Impact Statement (expected in 2010)

CEVP® LPA Phase 1 Cost Range (Opinion of LPA Phase 1 Scenario cost range as of April 2010 project analysis)



CEVP® LPA Phase 1 Schedule Range - 10th / 50th / 90th %-tile

LPA Phase 1 Scenario Completion: Jun-2019 / Feb-2030 / Jan-2021

Key LPA Phase 1 Scenario Cost Risks

Risks

- Drilled shaft diameters have to move to D+3 in WA
- Extent of community connection south of Evergreen Blvd. is undetermined
- Section 7 consultation in-water work windows more restrictive than planned
- SEIS/additional environmental analysis is required "Pre-ROD"
- Market risk: potentially only one bidder leads to higher bid costs
- Increase in aesthetic costs/context sensitive solutions for the main river crossing
- Aesthetic costs for land side bridge structures

Opportunities

- Opportunity for use of spread footing or shallower shafts at locations in WA

Key LPA Phase 1 Scenario Schedule Risks

Risks

- FTA approval to enter into final design is delayed
- ODOT or WSDOT funding shortfalls occur
- Section 7 consultation in-water work windows more restrictive than planned
- SEIS/additional environmental analysis is required "Pre-ROD"
- Insufficient data available on existing drainage systems on Hayden Island
- FTA approval to enter PE is delayed

Level of Project Design: Low | Medium | High

April 2010

Washington State Department of Transportation

Columbia River Crossing

April 2010

Columbia River Crossing
Route I-5
LPA Scenario

Project Description

The Columbia River Crossing (CRC) project is a comprehensive, long-term transportation solution that addresses congestion, safety and mobility problems on I-5 between Portland and Vancouver.

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- Reduced collision rates through the project area
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- 2001-2002: Bi-state partnership recommends fixing the bottleneck on I-5 at the Columbia River
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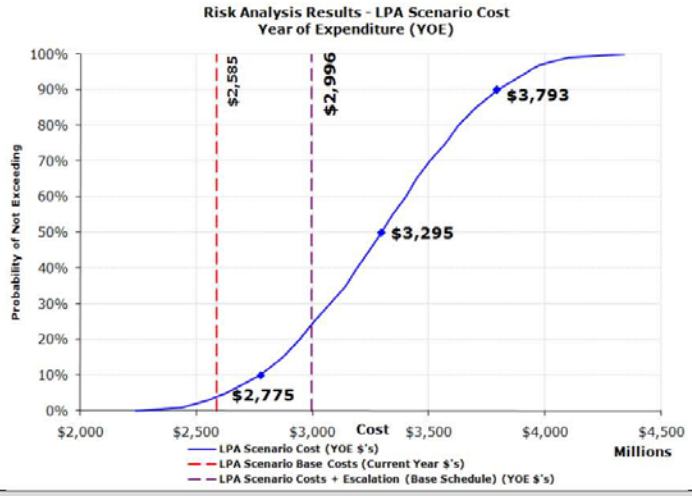
- 2008: Draft Environmental Impact Statement published (May); Locally Preferred Alternative adopted by local project partners (July)
- 2009-present: Design development of Locally Preferred Alternative; preparation of the Final Environmental Impact Statement (expected in 2010)

CEVP® LPA Scenario Cost Range (Opinion of LPA Scenario cost range as of April 2010 project analysis)



CEVP® LPA Schedule Range - 10th / 50th / 90th %-tile

LPA Scenario Completion: Oct-2019 / May-2020 / Feb-2021

Key LPA Scenario Cost Risks

Risks

- Drilled shaft diameters have to move to D+3 in WA
- Extent of community connection south of Evergreen Blvd. is undetermined
- Section 7 consultation in-water work windows more restrictive than planned
- SEIS/additional environmental analysis is required "Pre-ROD"
- Market risk: potentially only one bidder leads to higher bid costs
- Increase in aesthetic costs/context sensitive solutions for the main river crossing
- Aesthetic costs for land side bridge structures

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- Opportunity for use of spread footing or shallower shafts at locations in WA

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- FTA approval to enter into final design is delayed
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- FTA approval to enter PE is delayed

Level of Project Design: Low | Medium | High

April 2010

Washington State Department of Transportation

1. EXECUTIVE SUMMARY

A Cost Estimate Validation Process (CEVP®) workshop was held September 28-30, 2009 for the Columbia River Crossing project as part of an undertaking to investigate various means to defer scope and value engineer portions of the Columbia River Crossing project in an effort to define a more economically feasible project. The CEVP built upon data developed within the previous Columbia River Crossing CEVP (workshop held February 2-6, 2009). The overall objectives of the CEVP were to update, validate, and quantify uncertainty and risk in the Columbia River Crossing cost and schedule.

This chapter presents the results of the CEVP analysis including costs, schedule, and key risks for the project scenarios under analysis; the Locally Preferred Alternative (LPA) Phase 1 Scenario, and the LPA Scenario.

1.1 Model Results

Figures on the following pages detail the CEVP risk analysis results. These results reflect all the information gathered at the workshop and provided by all parties involved and represent outcomes based on this “snapshot-in-time” information. All results presented are pre-mitigated in nature as no mitigation measures were investigated at the workshop. It should be understood that if at a future date, mitigation strategies for key risks are developed and followed, the realized outcomes would potentially be lower cost and/or earlier completion dates than those generated in this analysis.

Results presented in this section include: LPA Phase 1 Scenario costs and completion dates, LPA Scenario costs and completions dates, and top cost and schedule risk factors for both the LPA Phase 1 Scenario and the LPA Scenario. Additional model output, such as, LPA Phase 1 Scenario and LPA Scenario cost build up tables are contained within Appendix D.

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Figure 1-1. Probabilistic LPA Phase 1 Scenario Cost

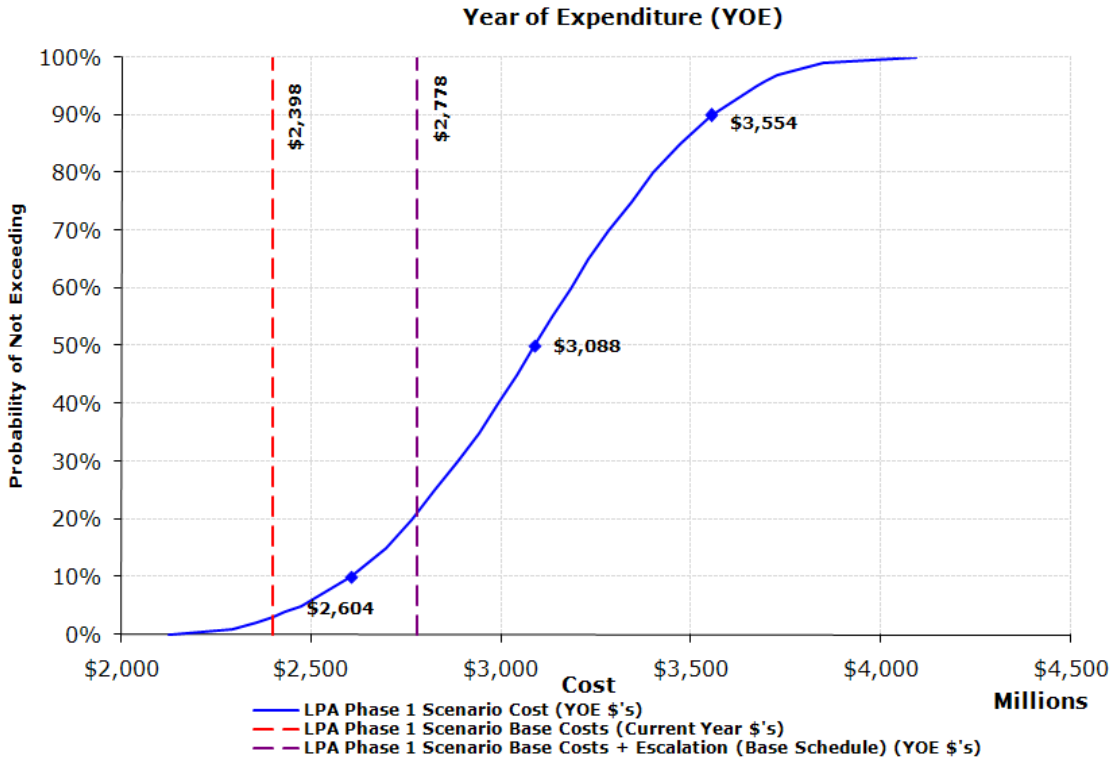

Figure 1-1 details the probabilistic LPA Phase 1 Scenario cost results. The overall probabilistic LPA Phase 1 Scenario costs are described by the blue "S-curve" that represents all possible values the LPA Phase 1 Scenario costs could take, expressed in year-of-expenditure (YOE) dollars. The range of potential LPA Phase 1 Scenario costs represents the base cost, base uncertainty (uncertainty in the base quantities and unit prices) and risk event impacts (threats and opportunities) for the cost and schedule. The output indicates the best opinion of the total LPA Phase 1 Scenario cost range by the workshop participants at the time of the analysis.

As indicated in the figure above, overall LPA Phase 1 Scenario costs are expected to not exceed $2,604 Million with a 10% probability. In other words, there is a one in ten chance that this scenario's costs will be lower than $2,604 Million. Furthermore, there is also one chance in ten that the overall scenario's costs could exceed $3,554 Million. Taken together these results indicate that the LPA Phase 1 Scenario costs will fall between $2,604 Million and $3,554 Million with an 80% level of confidence. The median level of LPA Phase 1 Scenario costs occurring 50% of the time, is projected to be $3,088 Million.

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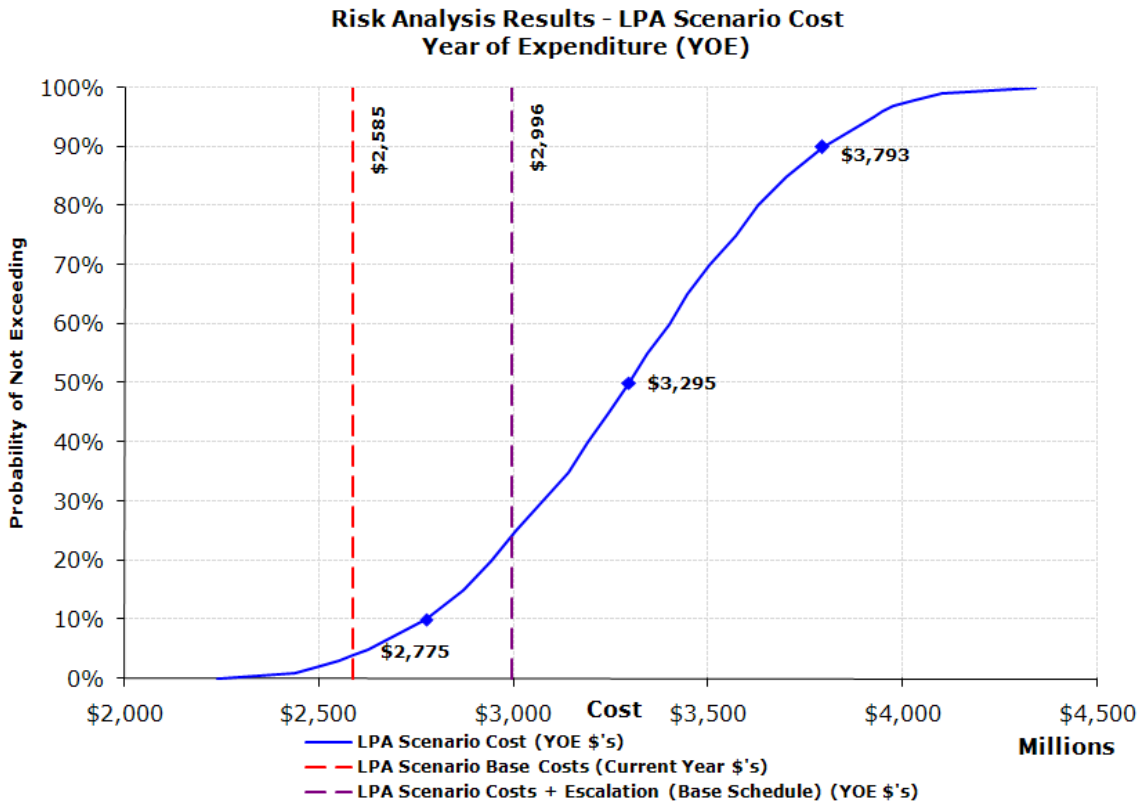
Figure 1-2. Probabilistic LPA Scenario Cost



Exhibited in Figure 1-2, above, are the probabilistic LPA Scenario cost results. The overall probabilistic LPA Scenario costs are described by the blue "S-curve" that represents all possible values the scenario's costs could take expressed in year-of-expenditure (YOE) dollars. The range of potential LPA Scenario costs represents the base cost, base uncertainty (uncertainty in the base quantities and unit prices) and risk event impacts (threats and opportunities) for the cost and schedule. The output indicates the best opinion of the total LPA Scenario cost range by the workshop participants at the time of the analysis.

The figure above reveals that overall LPA Scenario costs are expected to not exceed $2,775 million with a 10 percent probability. In other words, there is a one in ten chance that this scenario's costs will be lower than $2,775 million. Furthermore, there is also one chance in ten that the overall scenario's costs could exceed $3,793 million. Stated another way, these results indicate that the LPA Scenario costs have an 80 percent chance of falling between $2,775 million and $3,793 million. The median level of LPA Scenario costs occurring 50 percent of the time, is projected to be $3,295 million.

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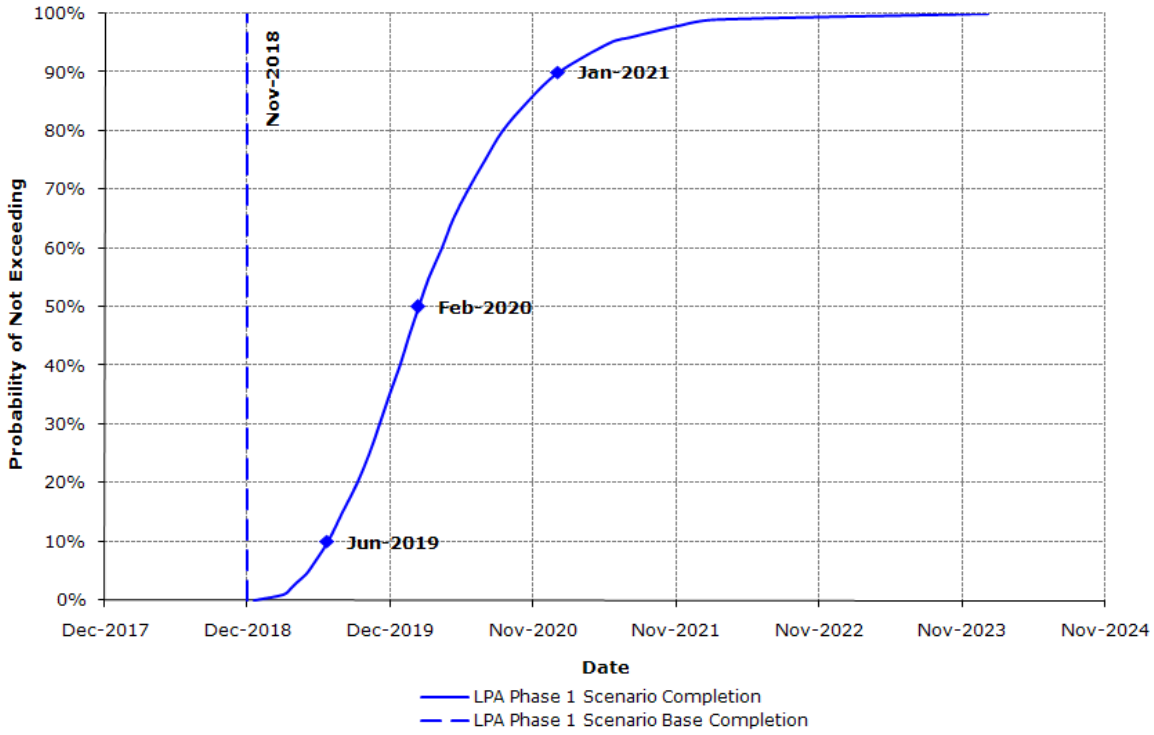
Figure 1-3. Probabilistic LPA Phase 1 Scenario Completion Date



Probabilistic LPA Phase 1 Scenario completion date distributions are shown in Figure 1-3, above. As can been seen from the figure, the risk analysis completion date results reveal a 90 percent chance of not finishing the LPA Phase 1 Scenario later than January, 2021. The median completion date for the scenario is projected to be February, 2020, while there is a 10 percent chance that the LPA Phase 1 Scenario could be completed as early as June, 2019. The figure also reveals that there is close to a 0 percent chance that LPA Phase 1 Scenario will complete by the base modeling completion date of November, 2018, due to very few schedule opportunities and a large number of high probability schedule risks identified at the workshop.

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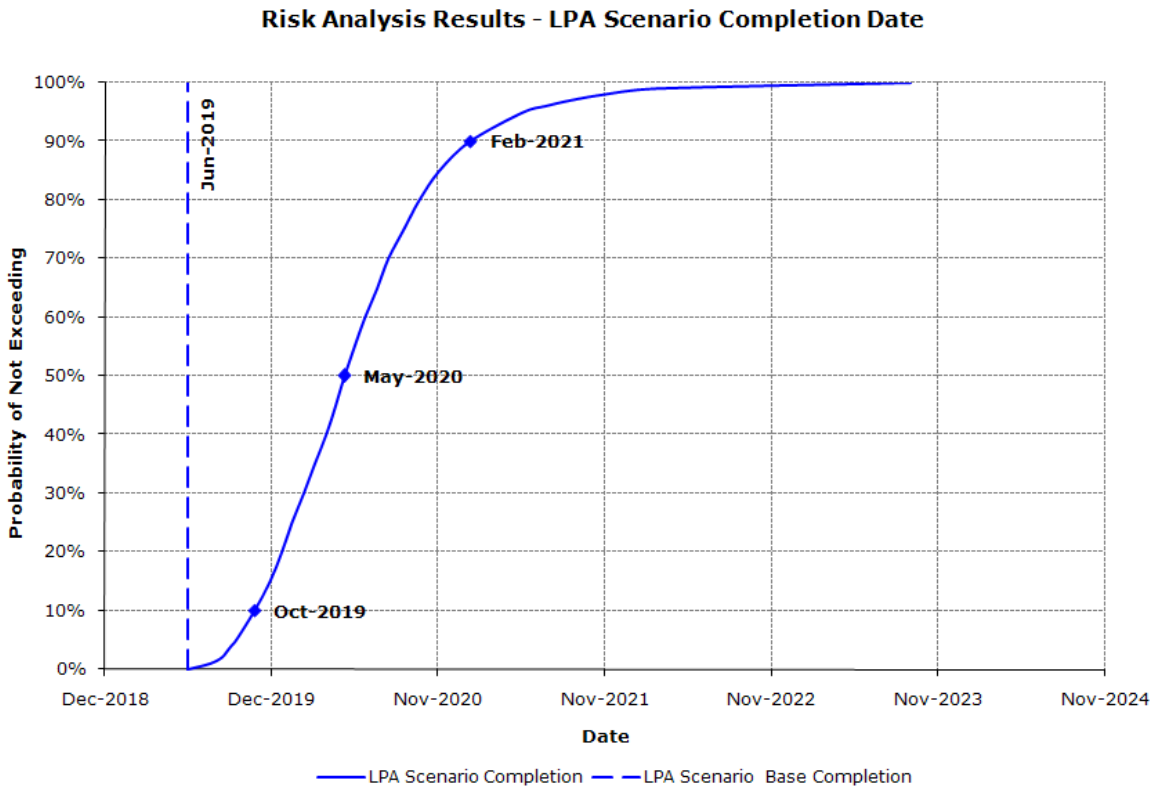
Figure 1-4. Probabilistic LPA Scenario Completion Date



Probabilistic completion date distributions for the LPA Scenario are shown in Figure 1-4, above. As can been seen from the figure, the risk analysis completion date results reveal a 90 percent chance of not finishing the LPA Scenario later than February, 2021. The median completion date for the scenario is projected to be May, 2020 while there is a 10 percent chance that the scenario could be completed as early as October, 2019. Due to very few schedule opportunities and a large number of high probability schedule risks identified at the workshop, there is close to a 0 percent chance that LPA Scenario will complete by the base modeling completion date of June, 2019.

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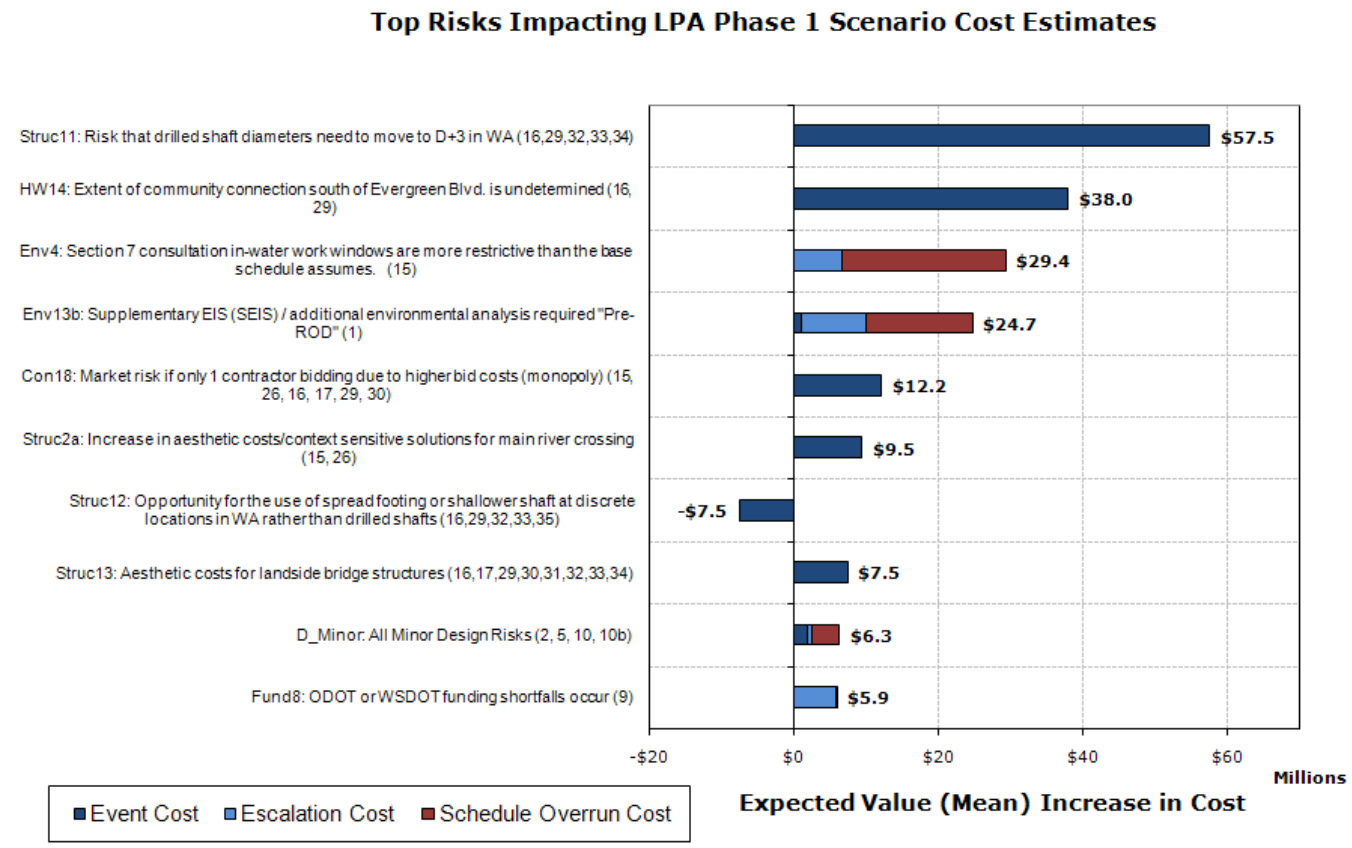
Figure 1-5. LPA Phase 1 Scenario Cost Risk Factors



The tornado chart for the top risks impacting the LPA Phase 1 Scenario cost is provided in Figure 1-5, above. This tornado chart shows the expected value increase in overall LPA Phase 1 Scenario costs for each event risk. The numbers in parentheses in each risk description indicate which flow chart activity number(s) a risk can affect. It is important to note that cost impact due to a risk may occur from three sources:

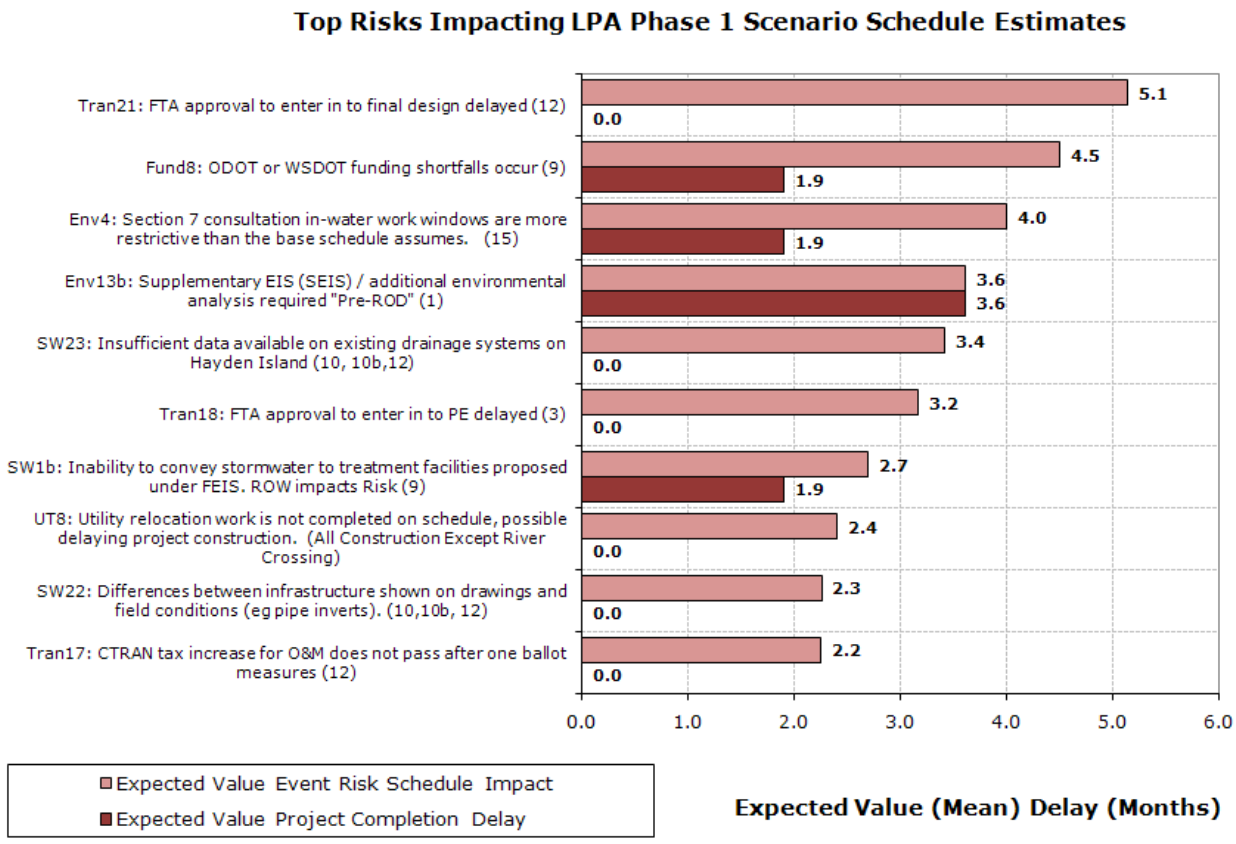
Event Risk Costs: The overall cost impact due to a risk with a pure cost effect. The tornado risk cost impact is represented by the dark blue portion of a risk's overall cost impact bar. The impact is calculated as the product of the probability of occurrence and the risk's cost estimate provided by the workshop experts.

Escalation Costs: The cost impact arising from a schedule risk's delay impact on a project activity and any subsequent dependent activities. This cost impact is due to higher escalation effects generated by activities being pushed further into the future. Escalation costs are represented by a light blue section of each schedule risk's impact bar.

Additional Support Costs: The costs incurred when the duration of an activity or group of activities stretches in duration relative to the base estimated duration. When project sections take longer than initially planned, additional dollars have to be spent by the project to pay for more

months of project management oversight, by both an agency's and a contractor's management staff. Additional support costs are represented by a dark red section of any relevant schedule risk's impact bar.

Figure 1-6. LPA Phase 1 Scenario Schedule Risk Factors



The tornado chart for top risks impacting the LPA Phase 1 Scenario schedule is shown in Figure 1-6, above. The light red bars represent the expected value schedule impact for each event risk listed. The dark red bars indicate how many months, at the expected value, a risk delays the overall LPA Phase 1 Scenario completion date. The numbers in parentheses in each risk description indicate which flow chart activity number(s) a risk can affect. As can be seen from the tornado chart, only four of the top risks impact the overall project completion date. This is due to the complex nature of the flowchart schedule of activities leading to multiple critical paths with some inherent schedule slack in the overall ordering of the scenario flowchart schedule.

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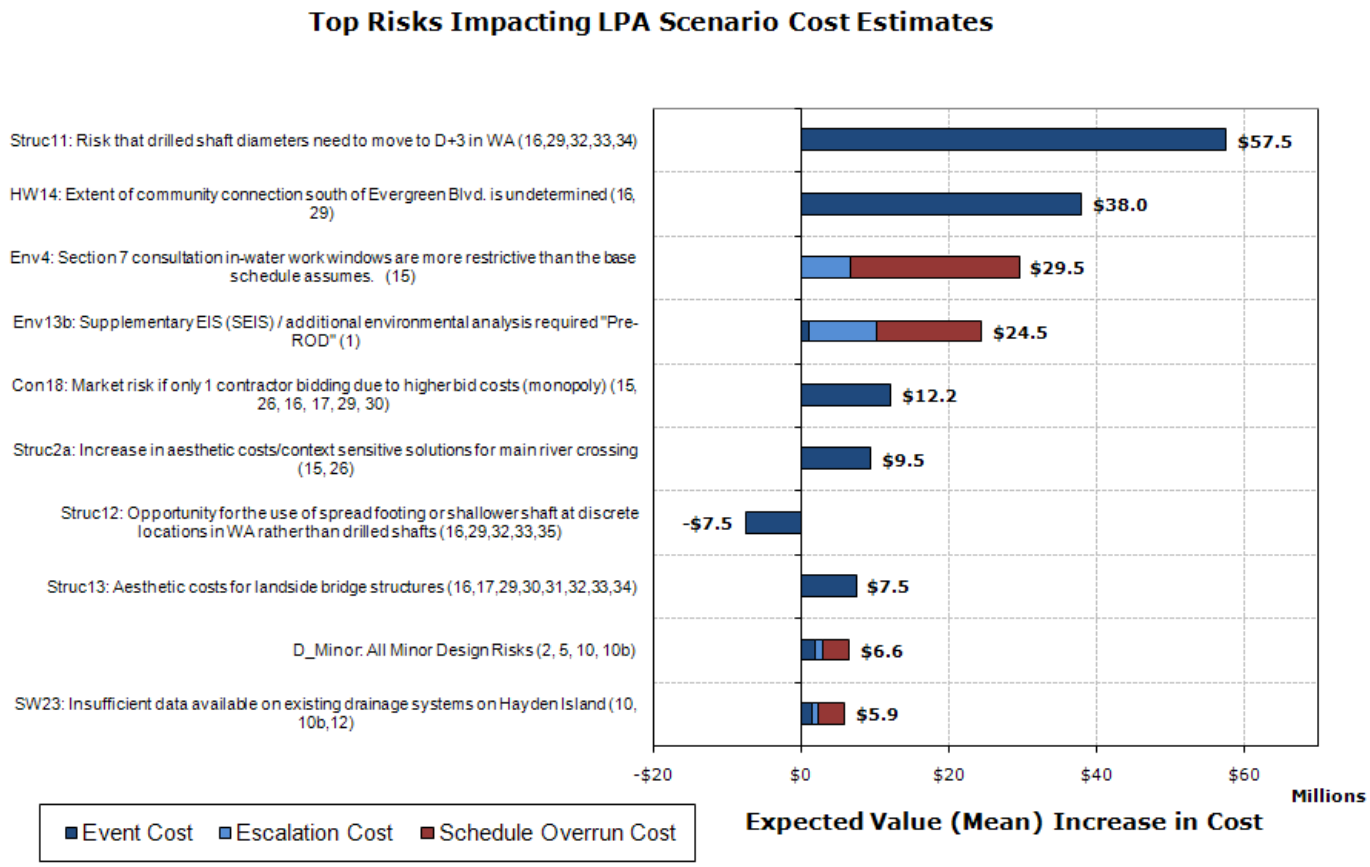
Figure 1-7. LPA Scenario Cost Risk Factors



The tornado chart for the top risks impacting the LPA Scenario cost is provided in Figure 1-7, above. This tornado chart shows the expected value increase in overall LPA Scenario costs for each event risk. The numbers in parentheses in each risk description indicate which flow chart activity number(s) a risk can affect. It is important to note that cost impact due to a risk may occur from three sources:

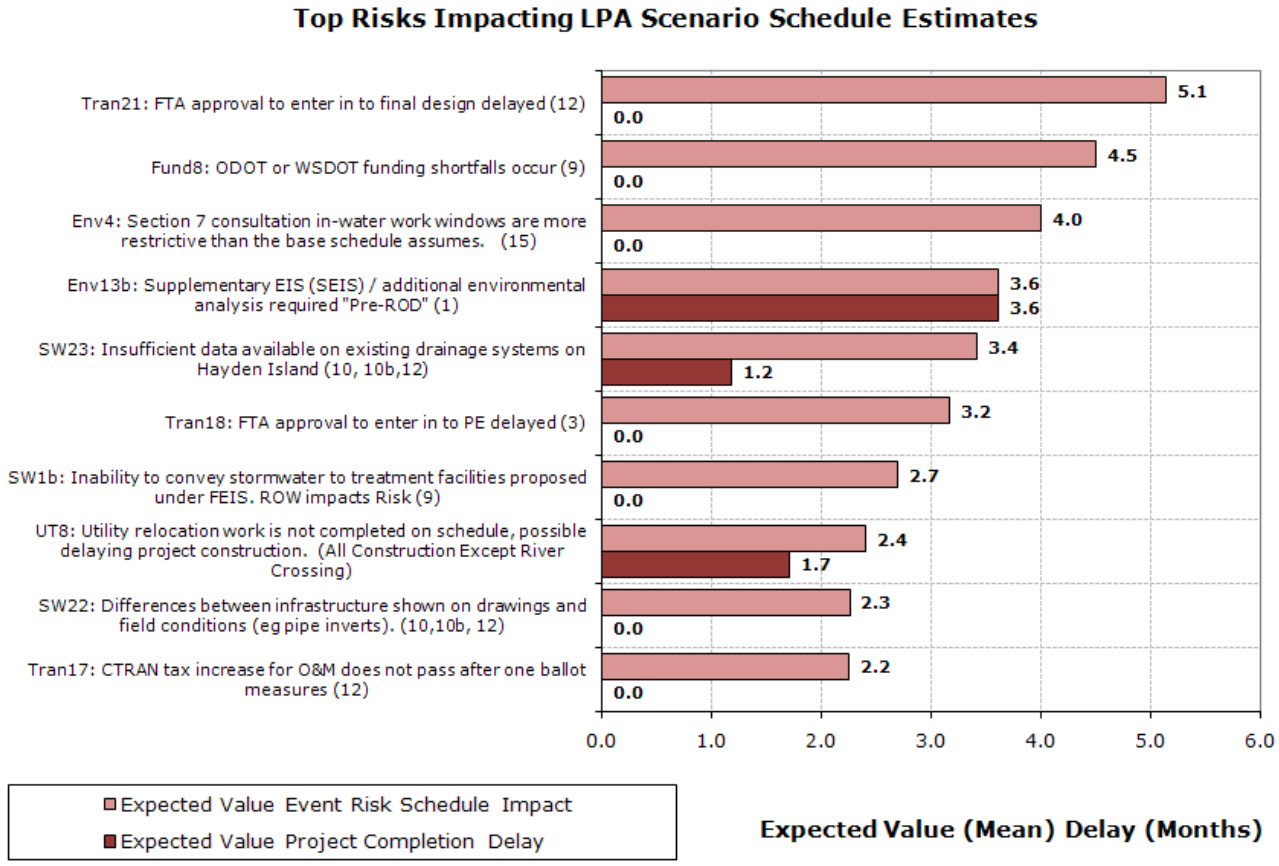
Event Risk Costs: The overall cost impact due to a risk with a pure cost effect. The tornado risk cost impact is represented by the dark blue portion of a risk's overall cost impact bar. The impact is calculated as the product of the probability of occurrence and the risk's cost estimate provided by the workshop experts.

Escalation Costs: The cost impact arising from a schedule risk's delay impact on a project activity and any subsequent dependent activities. This cost impact is due to higher escalation effects generated by activities being pushed further into the future. Escalation costs are represented by a light blue section of each schedule risk's impact bar.

Additional Support Costs: The costs incurred when the duration of an activity or group of activities stretches in duration relative to the base estimated duration. When project sections take

longer than initially planned, additional dollars have to be spent by the project to pay for more months of project management oversight, by both an agency's and a contractor's management staff. Additional support costs are represented by a dark red section of any relevant schedule risk's impact bar.

Figure 1-8. LPA Scenario Schedule Risk Factors



The tornado chart for top risks impacting the LPA Scenario schedule is shown in Figure 1-8, above. The light red bars represent the expected value schedule impact for each event risk listed. The dark red bars indicate how many months, at the expected value, a risk delays the overall LPA Scenario completion date. The numbers in parentheses in each risk description indicate which flow chart activity number(s) a risk can affect. As can be seen from the tornado chart, only three of the top risks impact the overall project completion date. This is due to the complex nature of the flowchart schedule of activities leading to multiple critical paths with some inherent schedule slack in the overall ordering of the scenario flowchart schedule.

Summary probabilistic cost and schedule results are presented for ease of reference, below, in Table 1-1.

Table 1-1 Summary of Costs & Completion Dates

Cost Category	Lower 10%	Median	Upper 10%
LPA Phase 1 Scenario Costs	$2,604	$3,088	$3,554
LPA Scenario Costs	$2,775	$3,295	$3,793
Schedule Category	**Lower 10%**	**Median**	**Upper 10%**
LPA Phase 1 Scenario Completion Date	Jun-2019	Feb-2020	Jan-2021
LPA Scenario Completion Date	Oct-2019	May-2020	Feb-2021

2. Overview

2.1 Project Summary

The Columbia River Crossing (CRC) project is a comprehensive, long-term transportation solution that addresses congestion, safety and mobility problems on I-5 between Columbia Boulevard in Portland, Oregon and SR 500 in Vancouver, Washington.

Co-sponsored by the Oregon and Washington departments of transportation, the project will:

- Replace the Columbia River Bridge:
- Extend light rail to Vancouver:
- Enhance pedestrian and bicycle routes and access to local networks; and,
- Improve five miles of highway and closely-spaced interchanges.

2.2 Project Objectives

The project will address current and future transportation problems on I-5 through a combination of bridge, public transit and highway solutions. The project is focused on addressing six problems identified in the I-5 corridor while meeting community needs and minimizing impacts.

This project will address:

- Growing travel demand and congestion
- Impaired freight movement
- Limited public transportation operation, connectivity and reliability
- Safety and vulnerability to collisions
- Substandard pedestrian and bicycle facilities
- Seismic vulnerability

2.3 Workshop Objectives

- Validate the base cost estimate
- Quantify uncertainty around the base cost estimate
- Finalize the project schedule with appropriate flowchart activities
- Identify and quantify cost and schedule risk to flowchart activities

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3. Project Scenarios

3.1 Scenarios

There are two scenarios developed within the CRC CEVP analysis; an LPA Phase 1 Scenario, and the LPA Scenario. Each scenario results in different cost and schedule CEVP results due to different base costs and schedule and to differing scenario risks.

LPA Scenario

This scenario comprises the following elements:

- A new river crossing over the Columbia River and the I-5 highway improvements, including seven interchanges, north and south of the river.
- Extension of light rail from the Expo Center in Portland to Clark College in Vancouver, and associated transit improvements, including transit stations, park and rides, bus route changes, and expansion of a light rail transit maintenance facility.
- Bicycle and pedestrian improvements throughout the project corridor.
- A new toll on motorists using the river crossing.
- Transportation demand and system management measures to be implemented with the project.

LPA Phase 1 Scenario

If funding availability does not allow the entire LPA Scenario (Full Build) to be constructed in one phase, then some elements of the project would be deferred to a future date. The Final Environmental Impact Statement (FEIS) identifies several elements that could be deferred, and refers to that possible initial investment as Phase I of the LPA. The LPA Phase I option would build most of the LPA in the first phase, but would defer construction of specific elements of the project, including:

- Defer construction of the I-5 braided on- and off-ramps at Victory Boulevard.
- Defer construction of the Marine Drive interchange flyover.
- Defer construction of the northern half of the I-5/SR 500 interchange.

The LPA Phase 1 option is also evaluated assuming that the new Columbia River bridges would be striped for 10 highway lanes rather than 12 lanes.

3.2 Flow Chart

The flowcharts for each scenario are provided in Figures 3-1 and 3-2 on the next pages:

- Each activity is represented by a square shaded box, for example, blue shading represents highway activities, while the milestones and decision points (record of decision, project completion, etc.) are represented by yellow diamonds;
- The arrows connecting the activities represent dependencies on the previous activity to either start or complete the activity in question.
- The activities are identified with a sequential number, ranging from 1 (Prepare and Publish FEIS) to 39 (Project Complete).

Figure 3-1. LPA Phase 1 Scenario Flowchart

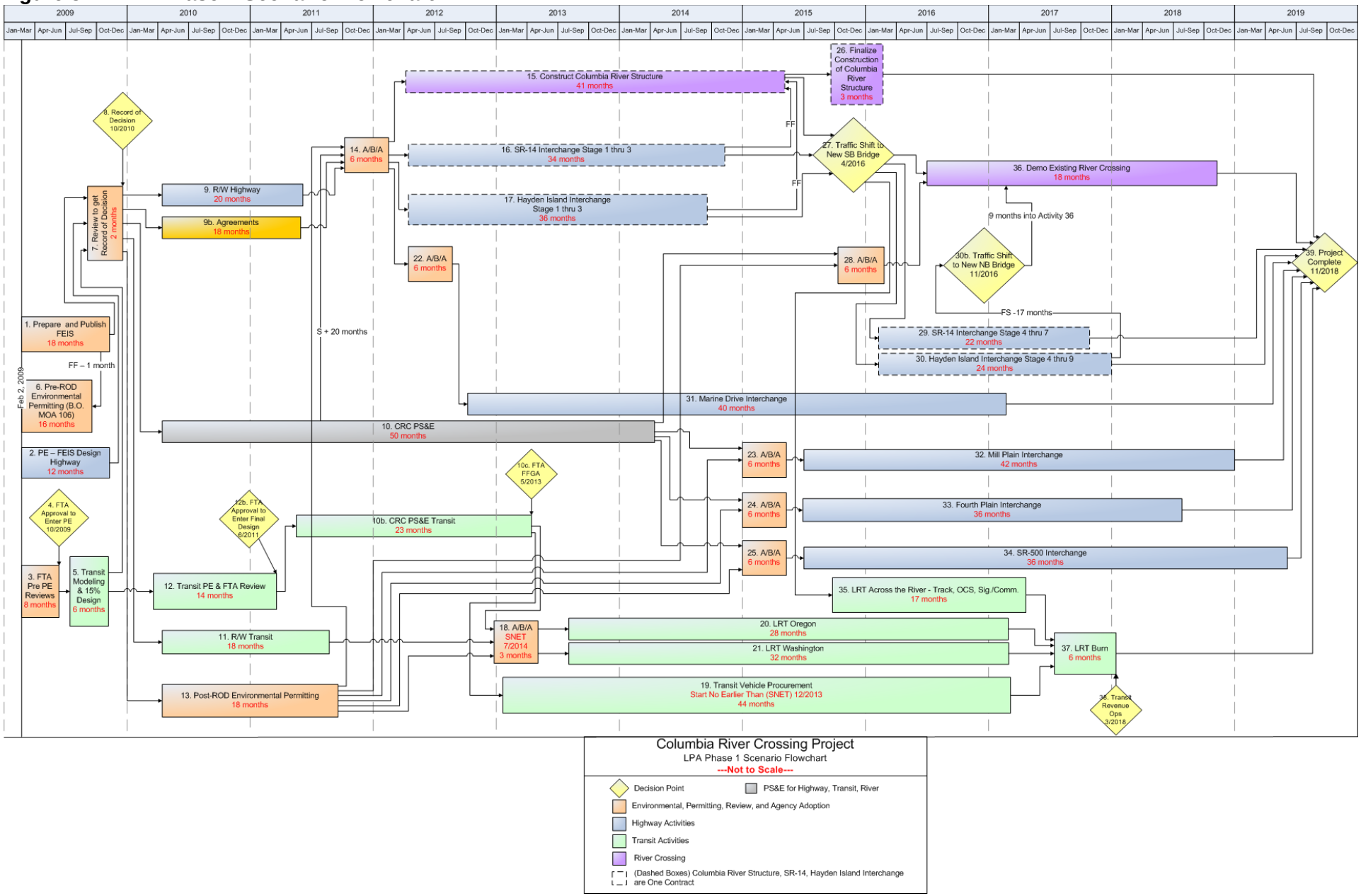

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Figure 3-2. LPA Scenario Flowchart

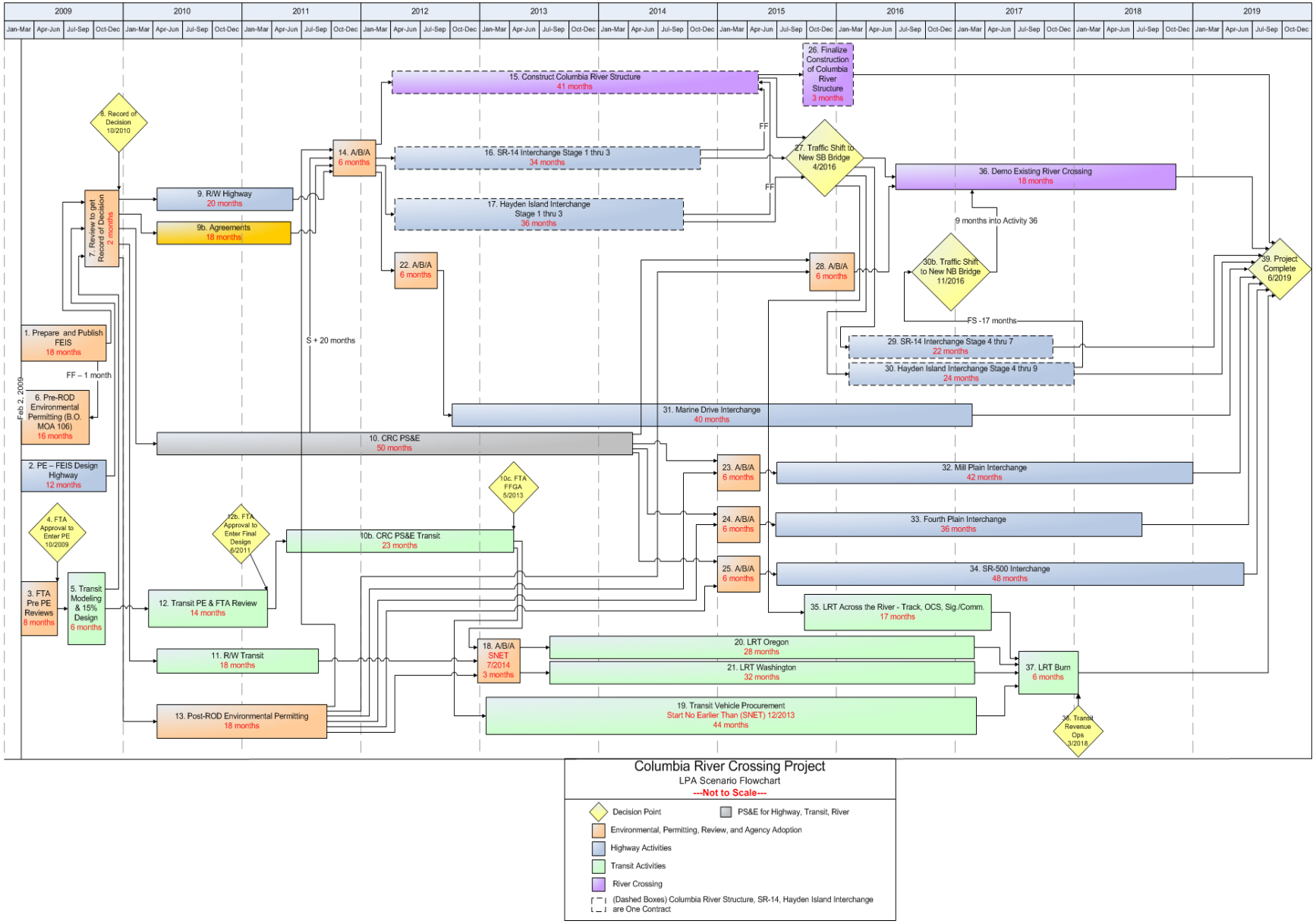

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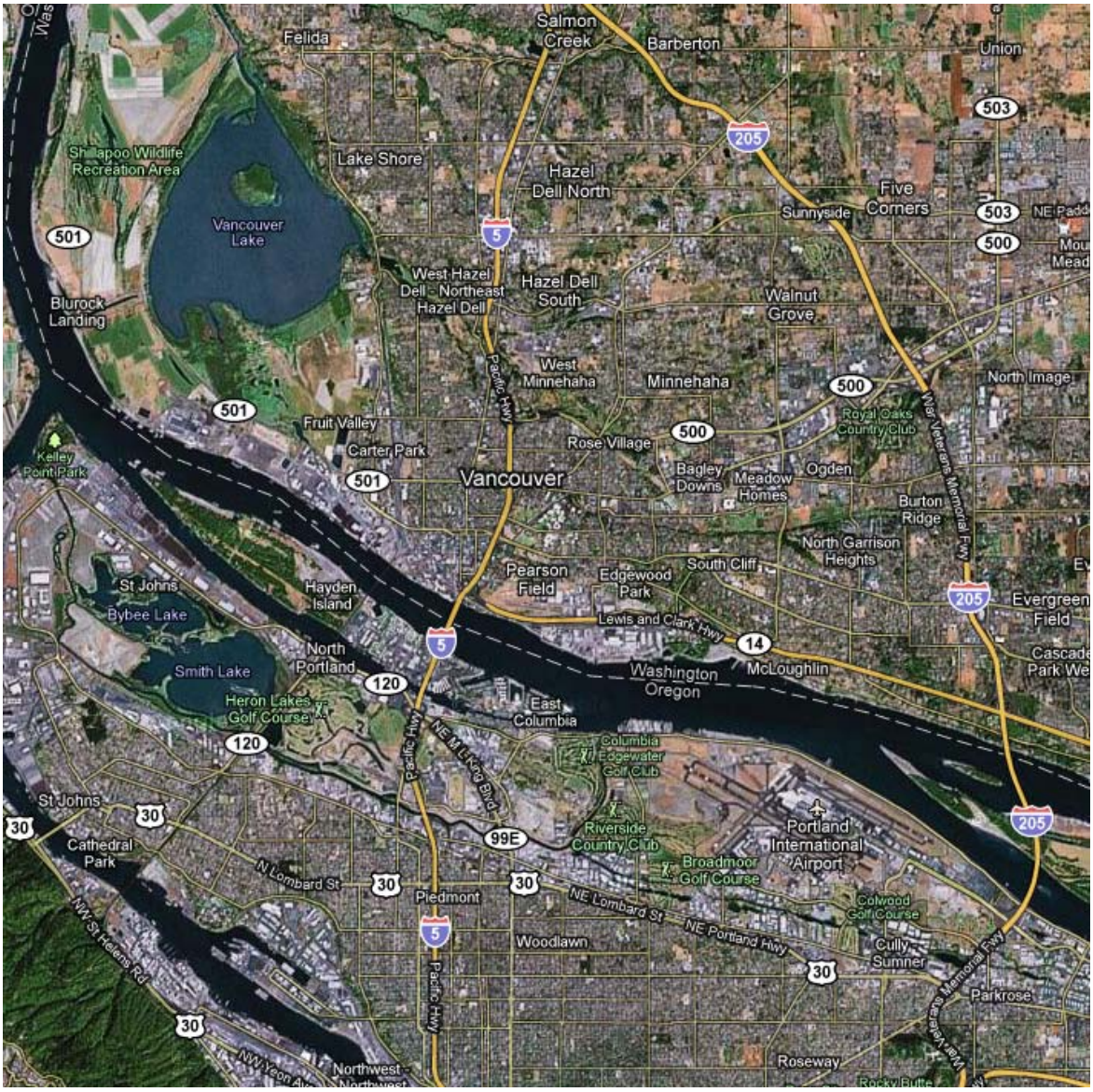
Figure 3-3. Vicinity Map of Project and CEVP Study Area



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3.3 Exclusions and Other Miscellaneous Items

None.

3.4 Common Assumptions

1. Construction Cost Inflation: Costs for all project activities, excluding ROW acquisition and Preliminary Engineering activities, will be inflated according to the Construction Cost Index (CCI) values provided by WSDOT Strategic Planning & Programming - Systems Analysis & Program Development Office. These values are available at the following WSDOT intranet web site:

   http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/cci.txt

   Note: If knowledge regarding inflation indicates values that differ significantly from those in the table this can be captured in the workshop as a risk event.

2. Right of Way (ROW) Cost Inflation: ROW acquisition will be inflated according to the R/W Cost Index tables provided by WSDOT Strategic Planning & Programming - Systems Analysis & Program Development Office. These values are available at the following WSDOT intranet web site:

   http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/RW.INFL.TXT

3. Preliminary Engineering Cost Inflation: Costs for all Preliminary Engineering project activities will be inflated according to the Construction Cost Index (CCI) values provided by WSDOT Strategic Planning & Programming - Systems Analysis & Program Development Office. These values are available at the following WSDOT intranet web site:

   http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/PE.INFL.TXT

3.5 Project Specific Assumptions

The following assumptions were made in the estimation of project costs and/or project schedule:

1. **Escalation factors** for all costs are based on the values provided by the WSDOT Strategic Planning & Programming - Systems Analysis & Program Development Office. The following escalation rates were used to define the future preliminary engineering, right of way, and construction costs.

WSDOT ESCALATION RATES			
Year	**ROW**	**PE**	**CCI**
2009	7.15%	1.56%	-7.17%
2010	7.04%	1.78%	1.40%
2011	6.82%	1.84%	3.39%
2012	6.54%	2.04%	4.09%
2013	6.60%	1.96%	3.62%
2014	6.92%	1.92%	2.89%
2015	6.97%	1.88%	2.30%
2016	7.05%	1.89%	1.60%
2017	7.14%	1.86%	2.11%
2018	7.17%	1.91%	2.30%
2019	7.09%	1.87%	2.18%
2020	7.08%	1.96%	2.17%
2021	6.99%	1.96%	2.09%
2022	7.07%	1.96%	2.08%
2023	7.07%	2.03%	2.01%
2024	7.18%	2.03%	2.00%
2025	7.14%	2.03%	1.93%
2026	7.25%	2.02%	1.92%
2027	7.34%	2.05%	1.86%
2028	7.40%	2.08%	1.85%
2029	7.43%	2.13%	1.79%
2030	7.45%	2.12%	1.79%

Sources - WSDOT intranet websites:

http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/cci.txt

http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/RW.INFL.TXT

http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/cpms/fields/PE.INFL.TXT

2. **Cost of project overruns** are assumed to vary in cost per month depending on which phase of the project incurs an overrun per the Project Team's guidance. The costs are broken down into contractor and owner overhead. The specified costs are spread out among the flowchart activities making up each phase of the project.

   For the owner:

   - Activities up to August 2009 on the project base schedule, $1.3 million per month
   - Activities from August 2009 to Record of Decision (ROD), $2.2 million per month
   - Activities from Post ROD to construction, $2.5 million per month
   - Activities that make up the initial construction contract (Hayden Island, CRC, SR14), $1.5 million per month ($1.2 billion x 0.12 /60 months) x 0.62. This assumes 12 percent contract administration with a reduction of the $1.2 billion by 10 percent +28 percent (to reflect the conservative nature of the base costs and to remove the soft costs for Preliminary Engineering (PE), design and Construction Management (CM) to not double count).
   - Activities that make up construction, other contracts, $2.1 million per month ($2.0 billion x 0.12/72 months) x 0.62. Same assumptions as above.

   For the contractor:

   - Activities making up the initial contract (Hayden Island, CRC, SR14), $3.1 million per month
   - Activities making up the other contracts, $2.1 million per month, (based on 12 percent of the contract total)

3. All project elements are assumed to be delivered through a design-bid-build procurement process.

4. In-water work is assumed to be allowed year-round with construction activity restrictions during critical periods.

See errata, cover page.

5. The main river crossing structure is assumed to be ~~segmental concrete~~ **open web box girder**.

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4. Base Cost Review

4.1 Base Cost Estimate

The CEVP results presented within this report are heavily dependent upon the previous CRC February 2009 CEVP work, especially concerning the base cost estimate. Due to this, details of both the February 2009 CEVP base cost review and the September 2009 CEVP base cost review are explained in this section.

February 2009 CEVP Base Cost Estimate

The previous Columbia River Crossing CEVP workshop occurred from February 2, 2009 through February 6, 2009 at the WSDOT regional office in Vancouver, Washington. Stated "Goals" of the workshop during the Prep-Session were to:

1. Develop a project cost range for publication in the Final Environmental Impact Statement (FEIS)

2. Utilize cash flow model output for decision making purposes.

The process included process orientation, preparatory session, advanced elicitation interviews workshop, and follow on events to develop pro-active risk response actions. A follow on CEVP workshop evaluating "Cost Saving" opportunities was also held. The schedule of major elements of the process is outlined below:

Process Orientation/Training	December 17, 2008
Prep-Session	December 18, 2008
Advance Elicitation Interviews	December 18-19, 2008
Workshop	February 2-6, 2009
Risk Response development Meetings/Calls	February 20/March 17, 2009
"Cost Saving" CEVP Workshop (Current CEVP)	September 28-30, 2009

Major assumptions utilized in the development of the Base Cost and Schedule Include:

1. All project elements will be delivered through a design-bid-build procurement process.

2. In-water work is allowed year-round with construction activity restrictions during critical periods.

See errata, cover page.

3. The main river crossing structure will be ~~segmental concrete~~ **open web box girder**.

4. Base estimate as of January 2009. This was accomplished by escalating prices from previous projects to January 2009.

5. The basis of estimate is defined in the document “Basis of Capital Cost Estimate” dated January 22, 2009, and updated in the September 15, 2009 document.

The Project Team presented the cost estimate for review in 2009 dollars during the first day of the workshop. The estimate was reviewed for much of the first day and a portion of the second day with the Cost and Risk Leads and Subject Matter Experts. Revisions to the estimate were discussed and agreed upon during the workshop.

The base cost estimate was broken down into four major geographic locations or elements of work:

- South Highway Approach
- North Highway Approach
- Columbia River Bridges
- Transit

Within the first three geographic areas the estimate was broken down generally as follows:

- Pavement (all costs within the pavement prism – surfacing, base, striping, drainage conveyance, roadway peripherals)
- Earthwork (excavation, fill)
- Bridges (construction, demolition)
- Walls
- Other (lighting, signing, ITS, construction staging)
- Non-distributed costs (mobilization, traffic control, utility relocation, environmental mitigation)
- Professional Services (engineering, construction management)
- Right of Way (Acquisition services, purchase costs)

The transit estimate is broken down generally as follows:

- Guideway
- Tracks
- Stations
- Site work
- Systems

- Non-distributed costs (mobilization, traffic control, utility relocation, environmental mitigation)
- Support facilities and vehicles
- Professional Services (engineering, construction management)
- Right of Way (Acquisition services, purchase costs)

Final activity base cost estimates are presented in Appendix B.

February 2009 CEVP Mitigated Model Run with Revised Bridge Base Costs

After the draft model run was completed additional effort by the project team to more intensely estimate bridge unit prices was undertaken. The project team evaluated current bid information from both Washington and Oregon indicating that current prices have been coming in significantly lower than the engineer's estimates. Since base costs in the initial modeling run were from previous years bid tabs and escalated, it was felt that the base costs in the initial model run were overly conservative with respect to the current bidding environment.

The project team provided a more thorough, current unit price analysis during a conference call March 17, 2009. The new information was discussed and agreed to in April, 2009. A second model run included this revised bridge unit pricing resulting in a revised overall base cost estimate and pro-active risk response actions.

"Cost Saving" CEVP Base Cost Estimate (September, 2009)

During the time period between the completion of the initial CEVP modeling in June, 2009 and September 2009, WSDOT was asked to investigate various means to defer scope and value engineer portions of the CRC project in an effort to define a more economically feasible project.

A follow on CEVP workshop was held in September of 2009, allowing for a brief review of the quantities and costs from the previous CEVP process earlier in the year. No changes to unit prices or quantities were made to the estimate during the September 2009, workshop activities.

4.2 Review and Validation Notes

February 2009 CEVP Review

Base Cost and Schedule Review

The Base Schedule was discussed as part of the flow-charting activities. Minor adjustments to the schedule were incorporated and the results are reflected in the flow chart.

The Base Cost is heavily weighted to the construction of bridge structures. Approximately seventy-five percent of the entire project cost can be attributed to the cost of bridge structures. With limited time in the workshop; a majority of the discussion centered on the bridge construction and demolition costs. Adjustments to the bridge costs, and other adjustments, including professional services and mobilization are summarized below.

No modifications to pavement, earthwork, walls, or "other" areas were made. Due to the relatively small portion of the overall construction value and the limited time; the workshop participants and project team were comfortable with the development of the cost estimate for these elements and accepted them as presented. Base uncertainty for these items was captured and is reflected in the attached "Base Cost Uncertainty" table.

Modifications to the estimate during the workshop are summarized below:

South Highway Approach

- Bridges (construction, demolition)
    - The North Portland Harbor bridge unit prices were increased by $80/square foot to reflect the difficult ground conditions expected. The increase was based on the need for similar foundations as other structures in poor ground conditions.
    - Other bridges in the South Highway Approach were evaluated based on bridge type and foundation type (deep versus shallow). Based on the large variability of structure types and the fact that bridges south of the Columbia River are in generally poor soil and north of the Columbia River are in generally adequate soil it was agreed that only two basic bridge costs per square foot would be utilized. South of the river the costs would be $330 per square foot and north of the river would be $250 per square foot. These unit prices were subsequently refined in March, 2009. The revised unit pricing reflected a variety of bridge types and foundation conditions.
    - An exception to the previous generality includes transit bridges which incorporate a 15 percent premium due to different loading.
    - Temporary bridges for staging purposes were increased from $120 per square foot to $200 per square foot
- Non-distributed costs (mobilization)

- Mobilization was increased from 8 percent of construction costs to 10 percent of construction costs to reflect what is allowed by WSDOT specification and the likely hood that contractors would bid the project per specification allowances.

- Professional Services (engineering, construction management)
  - Final design services were increased from 6 percent to 7 percent.
  - Design and Construction Management was reduced from 15 percent to 12 percent. The reduction is a result of what WSDOT actually sees as costs associated with CM, often times less than 12 percent with a small increase for the design management portion.
  - Construction administration and Management was considered a duplicate cost with Construction Management and therefore deleted.
  - Insurance is considered to be included in other bid items as a contractor's overhead and therefore a separate line item is not necessary.
  - Surveys, Testing, Investigation, and Inspections is adequately covered in the design percentages noted above and not needed as a separate line item.

- Right of Way (Acquisition services, purchase costs)
  - The cost of right of way did not include condemnation as a base cost. WSDOT has sufficient data to indicate that condemnation is a real cost on all projects at some level. Right of way subject matter experts agreed and revised the base cost to include an additional 20 percent markup of right of way to account for a base line condemnation cost to the project. Additional risk for condemnation above and beyond the 20 percent is covered in the risk model.
  - Sales tax was included in the backup information for right of way. This was removed.

North Highway Approach

- Bridges (construction, demolition)
  - Bridges in the North Highway Approach were evaluated based on bridge type and foundation type (deep versus shallow). Based on the large variability of structure types and the fact that bridges south of the Columbia River are in generally poor soil and north of the Columbia River are in generally adequate soil it was agreed that only two basic bridge costs per square foot would be utilized. South of the river the costs would be $330 per square foot and north of the river would be $250 per square foot. These unit prices were subsequently refined in March, 2009. The revised unit pricing reflected a variety of bridge types and foundation conditions.

- An exception to the previous generality includes the curved steel tub at SR500 estimated at $360 per square foot
- Temporary bridges for staging purposes were increased from $120 per square foot to $200 per square foot

- Non-distributed costs (mobilization)
  - Same as South Highway Approach
- Professional Services (engineering, construction management)
  - Same as South Highway Approach
- Right of Way (Acquisition services, purchase costs)
  - Same as South Highway Approach

Columbia River Bridges

- Bridges (construction, demolition)
  - Demolition of the existing bridges in water was discussed at length. The result of the discussion was to lower the demolition costs from $200 per square foot to $135 per square foot. Providing a large range for base uncertainty for demolition was also agreed too.
  - The methodology of construction for the main crossing and type of construction; including ~~segmental concrete~~ **open web box girder** superstructure and ten-foot diameter driven piles was discussed in depth. The estimate was reviewed in detail which included materials, labor, equipment and production rates. After a thorough evaluation the main span costs were accepted as presented.

See errata, cover page.

- Non-distributed costs (mobilization, traffic control and hazardous material)
  - Mobilization was increased from 8 percent of construction costs to 10 percent of construction costs to reflect what is allowed by WSDOT specification and the likely hood that contractors would bid the project per specification allowances.
  - Hazardous material removal was reduced from $10 million to $2 million. The risk register included a large risk element for hazardous material removal along with the large base cost. This was considered to be double counted. Hence the reduction in the base cost.
  - The traffic control language was modified to indicate “marine traffic control – Main River Crossing” as opposed to land side vehicle traffic control (i.e. from cars to boats)
- Professional Services (engineering, construction management)
  - Same as South Highway Approach

- Right of Way (Acquisition services, purchase costs)
    - Same as South Highway Approach; although there is no right of way acquisition associated with the river crossing indicated in the estimate.

Transit

- Non-distributed costs (mobilization and hazardous material)
    - Mobilization was increased from 8 percent of construction costs to 10 percent of construction costs to reflect what is allowed by WSDOT specification and the likely hood that contractors would bid the project per specification allowances.
    - Hazardous material removal was increased from $1 million to $2 million. With considerable amount of work within City streets it was felt that a higher base amount was warranted.
- Professional Services (engineering, construction management)
    - Final design services were increased from 6 percent to 7 percent.
    - Design and Construction Management was reduced from 15 percent to 12 percent. The reduction is a result of what WSDOT actually sees as costs associated with CM, often times less than 12 percent with a small increase for the design management portion.
    - Construction Administration and Management was considered a duplicate cost with Construction Management and therefore deleted.
    - Insurance is required by FTA and therefore was included in the estimate at 1.5 percent of construction costs which is an increase over the 0.5 percent that was initially included.
    - Surveys, Testing, Investigation, and Inspections are adequately covered in the design percentages noted above and not needed as a separate line item.
- Right of Way (Acquisition services, purchase costs)
    - Same as South Highway Approach

September 2009 "Cost Saving" CEVP Base Cost Review

A follow on CEVP workshop was held in September of 2009, allowing for a brief review of the quantities and costs from the previous CEVP process in February 2009. No changes to unit prices or quantities were made to the estimate during the September 2009, workshop activities. The outcome of the September 2009 CEVP workshop as it relates to cost and base uncertainty is summarized here.

- Changed base uncertainty for ROW project wide to -20 percent to +10 percent, per the February 2009 workshop. This change was only to

incorporate agreed upon changes from the February, 2009, initial workshop and the mitigation efforts undertaken in April, 2009.

- Changed base uncertainty for the SR14 Park & Ride to be -10 percent to +20 percent per input from Transit SME's during the workshop on September 30, 2009. The base uncertainty varies at this location due to specific nuances associated with the parking structure at SR14.

- Changed the base uncertainty for the main river crossing, Northbound and Southbound Columbia River Crossing to -10 percent to +20 percent. A detailed "contractor" estimate has been performed (84 page HCCS), however, the design is still early in the conceptual stage warranting an uncertainty range reflective of the level of design. The previous range was -30 percent to +10 percent based on the subject matter experts feeling during the February 2009 workshop that the estimate was quite conservative.

- Changed the base uncertainty for the light rail vehicle (LRV) to -10 percent to +10 percent and added a risk that the costs may increase due to other factors. The previous range was -10 percent to +50 percent and was generally based on a single point of data.

- Changed base uncertainty for all "non-main span CRC" bridges and Portland Harbor Bridges to -30 percent to +10 percent including bridge demolition. This makes the estimate consistent with discussions agreed upon during the February, 2009, initial workshop and the mitigation efforts undertaken in April, 2009.

The final base cost uncertainty ranges utilized within the September 2009 CEVP and reflected in the results documented within this report are detailed in the following table.

Table 4-1 Summary of Base Cost Uncertainty

Item	Notes	Unit Price Uncertainty			Quantity Uncertainty	
		Deterministic Base Unit Cost or Unit Price	Low (10th Percentile)	High (90th Percentile)	Low (10th Percentile)	High (90th Percentile)
Mobilization	No range discussed.	10%				
Drainage	Cost only includes water quality treatment; ponds, vaults, cartridges (transit). Conveyance is included in the roadway pavement unit price. No range discussed.	Various Items				
Bridge Structures	Main CRC span has been estimated in detail. Most other structures are at early design level, i.e. pre-type, size and location. Contract style estimate has removed the perceived conservatism in the original estimate and the uncertainty range reflects this change. Considerable discussion occurred on bridge uncertainty. Considering the lack of design detail for the bridges; the varied backup with respect to bridge unit prices (SF costs) from recent ODOT work to recent CEVP's performed (specifically SR520) it was felt that the overall base costs were conservative. Therefore an asymmetrical base uncertainty was established favoring the low side.	Various Items	-10% -30%	20% 10%	Included in cost range	Included in cost range
Walls (Retaining)	No range discussed.	Various Items				

Item	Notes	Unit Price Uncertainty			Quantity Uncertainty	
		Deterministic Base Unit Cost or Unit Price	Low (10th Percentile)	High (90th Percentile)	Low (10th Percentile)	High (90th Percentile)
Roadway - Pavement and Earthwork	Minor element of the overall project. No range discussed. Base includes pavement quantities and earthwork (excavation/fill). Pavement unit price includes: paving, milling, drainage, striping, existing pavement demolition, subbase, precast barrier, geotextile, and 10% miscellaneous allowance	Various Items				
TESC	No range discussed.	4% of paving, earthwork and storm drainage				
Environmental Mitigation	No range discussed. Base includes noise walls.	Plug numbers				
Permanent Traffic Items (includes signing, illumination, ITS, barrier, etc.)		Various Items				
Traffic Control	Range not discussed. Traffic control for the CRC Bridges is for Marine Traffic Control in the river itself.	5.5% (of highway construction costs not including mobilization) / 2% (of transit costs not including mobilization and artwork) / 1% (of CRC bridges not including mobilization and artwork)				

Item	Notes	Unit Price Uncertainty			Quantity Uncertainty	
		Deterministic Base Unit Cost or Unit Price	Low (10th Percentile)	High (90th Percentile)	Low (10th Percentile)	High (90th Percentile)
Construction Staging	Temporary pavement, bridges, earthwork and walls.	Various Items	-20%	20%		
Other Items	Utility relocations, aesthetic enhancements, maintenance facility, etc.	Various Items				
Preliminary Engineering	No range discussed.	3% of base construction				
Final Engineering	No range discussed.	7% of base construction				
Construction Management/Construction Engineering and Inspection		12%	12%	15%		
Allowance for Minor Items	Included at 10% of other items (i.e. 10% added to structures unit price, 10% added to paving unit price, etc…) No range discussed.	Included in other items				
ROW	Estimate includes 20% settlement factor for administrative settlement and condemnation. A large range of uncertainty due in large part to recent devaluation and the difficulty expressed in purchasing devalued property at lower estimates exists.	Various items	-20%	10%		

Item	Notes	Unit Price Uncertainty			Quantity Uncertainty	
		Deterministic Base Unit Cost or Unit Price	Low (10th Percentile)	High (90th Percentile)	Low (10th Percentile)	High (90th Percentile)
Transit	Guideway	Includes both price and quantity uncertainty	-10%	10%		
	Tracks		-10%	20%		
	Stations		-10%	20%		
	Park and Rides (base includes $2M per/P&R for retail space development) SR14 P&R		-10% -10%	10% +20%		
	Sitework		-10%	20%		
	Systems - Triangle Distribution		-10%	20%		
	Support Facilities		-10%	20%		
	Vehicles - Log Normal Distribution. A risk was added to the risk register encompassing the higher upside cost of LRV's while utilizing a symmetrical base uncertainty range.		-10%	10%		

APPENDIX A: Attendees and Workshop Notes

February 2009 Workshop Attendees

Name	Representing	Responsibility	Telephone	Email	Day 1	Day 2	Day 3	Day 4	Day 5
Aaron Myton	ODOT	Roadway	(503) 731-4996	aaron.m.myton@odot.state.or.us	x	x	x		
Ahmad Qayoumi	City of Vancouver	Street Design	(360) 487-7706	Ahmad.Qayoumi@ci.vancouver.wa.us	x	x	x	x	
Ahmer Nizam	WSDOT - HQ	Railroad	(360) 705-7271	Nizama@wsdot.wa.gov				phone	
Alan Lehto	Tri-Met	Transit	(360) 816-2206	Lehtoa@columbiarivercrossing.org					
Allan McDonald	CRC	Schedule	(360) 816-8863	Mcdonalda@columbiarivercrossing.org	x	x	x	x	
Andrew Beagle	CRC	Design	(360) 816-8880	beaglea@columbiarivercrossing.org	x	x			
Andy James	DEA	Staging	(360) 314-1600	ajames@deainc.com	x			x	
Arie Ravid	KKCS	Transit	(213) 488-0900	arie.ravid@kkcsworld.com	x	x	x	x	
Bill Hall	Parametrix	Biology/ESA	(503) 233-2400	whall@parametrix.com					
Bill Hegge	WSDOT - HQ	Geotech	(360) 709-5415	Heggewi@wsdot.wa.gov				x	
Bill Ott	Independent Consultant	Construction/Cost SME	(425) 890-3533	williamott129@yahoo.com	x	x	x	x	
Bill Perkins	Shannon and Wilson	Geotech	(503) 223-6147	wjp@shanwil.com					
Bill Womack	NCG	Construction SME	(508) 380-5049	BWOCONS@aol.com	x	x	x	x	
Bob Dethlefs	CRC	Transit	(360) 816-2190	dethlefsb@columbiarivercrossing.org					
Bob Dyer	WSDOT - HQ	Construction--Mega projects	(360) 705-7468	DyerB@wsdot.wa.gov					
Bob Hart	RTC		(360) 397-6067	bob.hart@rtc.wa.gov	x			x	
Brett Kesterson	PDOT	Transportation	(503) 823-7163	brett.kesterson@pdxtrans.org			x		
Bruce Council	ODOT Region 1	Utilities/Stormwater	(503) 731-8319	Bruce.S.Council@odot.state.or.us	x	x		x	
Cara Belcher	CRC	Highway	(360) 816-2194	belcherc@columbiarivercrossing.org	x				
Carley Francis	CRC	Communications	(360) 816-8869	francisc@columbiarivercrossing.org					
Casey Liles	CRC	Design	(360) 816-8878	lilesc@columbiarivercrossing.org	x		x		
Chivanna Pot	CRC	Design	(360) 816-4037	potc@columbiarivercrossing.org	x				
Chris Heathman	WSDOT - HQ	Geotech	(360) 709-5592	heathmc@wsdot.wa.gov				x	
Craig Moore	CH2M Hill	Cost Estimating	(425) 453-5000	cmoore1@ch2m.com	x	x			
Craig Shike	ODOT	Bridge Engineering	(503) 986-3323	craig.l.shike@odot.state.or.us				x	

Name	Representing	Responsibility	Telephone	Email	Day 1	Day 2	Day 3	Day 4	Day 5
Dan Corlett	WSDOT - SWR	Landscape Architecture	(360) 905-2086	corletd@wsdot.wa.gov	x		x		
Danielle Cogan	CRC	Communications	(360) 816-8857	cogand@columbiarivercrossing.org					
Dave Hedglin	CH2M Hill	Cost Estimating	(425) 453-5000	Dave.hedglin@ch2m.com	x	x			
Dave Parisi	CRC	Traffic	(360) 816-2165	Parisid@columbiarivercrossing.org					
Dave Warrick	HQ - ODOT	Design	(503) 986-3560	david.d.warrick@odot.state.or.us					
David Adams	Gannett Fleming	Transit	(415) 384-0822	dsadams@gfnet.com	x				
David Goodyear	T. Y. Lin	Bridge SME	(360) 754-0544	dgoodyear@tylin.com	x	x	x	x	
David Harjo	WSDOT - SWR	Right of Way	(360) 905-2140	harjod@wsdot.wa.gov					
David Sillars	OSU	Transit	(541) 737-8058	david.sillars@oregonstate.edu	x				
David Treadwell	CRC	Transit	(360) 816-2179	treadwelld@columbiarivercrossing.org	x	x	x	x	
Devin Reck	CRC	Design	(360) 816-8879	reckd@columbiarivercrossing.org	x	x	x	x	
Diane Coey	C-Tran	Funding	(360) 906-7336	Dianec@c-tran.org					
Doug Ficco	CRC	Project Director WSDOT	(360) 816-2200	ficcod@columbiarivercrossing.org	x	x	x	x	
Elizabeth Mros O'Hara	CRC	Transit	(360) 816-2166	mrosoharaE@columbiarivercrossing.org					
Frank Green	CRC	Structures	(360) 816 8855	Greenf@columbiarivercrossing.org	x	x	x		x
Fred Bullen	CRC	Schedule	(360) 816-8882	bullenf@columbiarivercrossing.org					
Fred Tharp	WSDOT - HQ	Construction	(360) 705-7816	Tharpf@wsdot.wa.gov					
Gary Peterson	Shannon and Wilson	Geotech	(503) 479-6251	glp@shnwil.com				x	
Gavin Oien	CRC	Engineering	(360) 816 2176	Oieng@columbiarivercrossing.org	x	x		x	
George Humphrey	CRC	Agreements	(360) 816-8864	humphreyg@columbiarivercrossing.org				x	
Greg Lippincott	WSDOT - HQ	Design	(360) 705-7462	LippinG@wsdot.wa.gov	x	x	x		
Heather Gundersen	CRC	Environmental	(360) 816-2199	gundersenh@columbiarivercrossing.org		x			
Jamie Jeffrey	PDOT	Transportation	(503) 823-5165	jamie.jeffrey@pdxtrans.org	x		x		
Jan Six	ODOT	Geotech	(503) 986-3377	jan.l.six@odot.state.or.us		x		x	
Jeff Heilman	CRC	Environmental	(360) 816-2164	Heilmanj@columbiarivercrossing.org					
Joel Tubbs	CRC	Bridge Engineering	(360) 816-8877	tubbsj@columbiarivercrossing.org					
John Baker	Tri-Met	ROW		BakerJ@trimet.org					
John Buchheit	Gannett Fleming	Transit	(407) 384-4412	jbuchheit@gfnet.com	x	x	x	x	

Name	Representing	Responsibility	Telephone	Email	Day 1	Day 2	Day 3	Day 4	Day 5
John Gillam	PDOT		(503) 823-7707	john.gillam@pdxtrans.org					
John Horne	PB	Geotech	(503) 274-8772	horne@pbworld.com					
John McAvoy	CRC	FHWA	(360) 816-8871	mcavoyj@columbiarivercrossing.org	x	x	x	x	
John Stout	HDR-HLB Decision Economics	Risk Lead	(240) 515-7281	John.Stout@hdrinc.com	x	x	x	x	x
John Tevis	WSDOT- HQ	Highway	(360) 705-7460	TevisJ@wsdot.wa.gov	x	x	x		
Kelly Betteridge	CRC	Transit	(360) 816-2195	betteridgek@columbiarivercrossing.org					
Ken Kirse	Tri-Met	Transit	(360) 816-2167	kirsek@columbiarivercrossing.org					
Khalid Bekka	HDR	Risk Lead	(240) 485 2605	Khalid.Bekka@hdrinc.com	x	x	x	x	
Kris Strickler	CRC		(360) 816-2201	stricklerk@columbiarivercrossing.org					
Laura Peterson	CRC	CEVP Coord./Structures	(360) 816-2197	petersonl@columbiarivercrossing.org	x	x	x	x	x
Leslie Klusmire	CRC	Transit	(360) 816-2204	klusmirel@columbiarivercrossing.org	x	x	x		
Linda Gehrke	FTA	Transit	(206) 220-4463	linda.gehrke@dot.gov					
Lou Schwab	UFS- ODOT	Right of Way	(503) 880-3609	lbschwab@comcast.net	x	x	x		
Lynn Rust	CRC	Engineering	(360) 816 2177	Rustl@columbiarivercrossing.org	x	x	x	x	
Mark Beeson	ODOT	Construction	(503) 667-8834	mark.r.beeson@odot.state.or.us	x			x	
Mark Gabel	WSDOT - HQ	CREM Team Leader	(360) 705-7457	gabelm@wsdot.wa.gov	x	x	x	x	
Mark Johnson	ODOT Region 1	Highway	(503) 731-3337	Mark.D.Johnson@odot.state.or.us			x		
Matt Bone	CRC	Highway		Bonem@columbiarivercrossing.org	x				
Matt Deml	CRC	Bridge Engineering	(360) 816-2193	demlm@columbiarivercrossing.org	x	x			
Matt Ransom	City of Vancouver	Planning	(360) 487-7707	matt.ransom@ci.vancouver.wa.us			x		
Megan Taylor	CRC	Environmental/ROW	(360) 816-2185	taylorm@columbiarivercrossing.org					
Michael Ellison	WSDOT	RES	(360) 905 2152	ellison@wsdot.wa.gov	x	x	x		
Mike Nichols	CRC	Survey	(360) 816-2162	NicholsM@columbiarivercrossing.org	x		x	x	
Natalie Freeman	CRC	Highway		freemann@columbiarivercrossing.org	x				
Nowzar Ardalan	ODOT	Bridge Engineering	(503) 731-4964	nowzar.ardalan@odot.state.or.us			x	x	
Paul Kinderman	WSDOT - HQ	Bridge Architect	(360) 705-7159	kindepa@wsdot.wa.gov			x	x	
Paul Smith	PDOT							x	
Ray Mabey	ODOT	Construction	(503) 986-3350	Raymond.Mabey@odot.state.or.us					

Name	Representing	Responsibility	Telephone	Email	Day 1	Day 2	Day 3	Day 4	Day 5
Rhonda Wiest	WSDOT HQ	Utilities	(360) 705-7318	wiestr@wsdot.wa.gov	x			x	
Rich Barrows	FHWA	Geotech	(360) 619-7704	Rich.barrows@fhwa.dot.gov				x	
Richard Brandman	CRC		(360) 816-8865	brandmanr@columbiarivercrossing.org					
Rick Chapman	Parsons	Cost Lead	(206) 494-3109	rick.chapman@parsons.com	x	x	x	x	x
Rick Henderson	WSDOT - SWR	Utilities	(360) 905-2006	henderr@wsdot.wa.gov		x			
Rob Turton	CRC	Bridge Engineering	(360) 816-2169	turtonr@columbiarivercrossing.org	x	x		x	
Roger Kitchin	CRC	Cost Estimating/Utilities/Stormwater	(360) 816-2182	Kitchinr@columbiarivercrossing.org	x	x	x	x	x
Ron Anderson	CRC		(360) 816-2171	Andersonr@columbiarivercrossing.org					
Ron Anderson	KKCS	Transit	(818) 632-2206	ron.anderson@kkcsworld.com	x	x	x	x	
Ross Roberts	Metro		(503) 797-1752	roberts@metro.dst.or.us					
Ryan LeProwse	CRC	Traffic	(360) 816-2174	Leprowser@columbiarivercrossing.org			x		
Samih Shilbayeh	WSDOT - HQ	Workshop Lead	(360) 705-7589	shlbyhs@wsdot.wa.gov	x	x	x	x	
Scott Patterson	C-Tran	ROW	(360) 906-7306	scottp@c-tran.org					
Scott Williams	WSDOT HQ	Archaeology	(360) 570-6651	Willias@wsdot.wa.gov		x			
Sharon Rainsberry	CRC	Biology/ESA	(360) 816-8884	rainsbs@wsdot.wa.gov					
Steve Saxton	FTA	Transit	(206) 220-4311	james.saxton@dot.gov	x	x	x		
Steve Siegel	Siegel Consult.	Finance	(503) 274-0013	SIEGELCONSULTING@aol.com	x			x	
Steve Witter	Tri-Met	Transit	(503) 709-2014	WitterS@trimet.org	x	x	x	x	
Terry Stones	DEA	Bridge Engineering	(503) 361-8635	tms@deainc.com	x	x		x	
Tim Moore	WSDOT Bridge	Bridge Engineering	(360) 705-7163	mooret@wsdot.wa.gov	x	x	x	x	
Tony Allen	WSDOT	Geotech	(360) 709-5450	Allent@wsdot.wa.gov	x				
Tova Peltz	ODOT	Geotech	(503) 731-4850	tova.r.peltz@odot.state.or.us	x			x	
Will Willson	Davis Langdon	Transit SME	(215) 564-3104	wwillson@davislangdon.us					

September 2009 Workshop Attendees

No	Name	Representing	Responsibility	Telephone	Email Address	Comments	Mon, Sep-28	Tue, Sep-29	Wed, Sep-30
1	Khalid Bekka	HDR	Risk Lead	(240) 485-2600	khalid.bekka@hdrinc.com		X	X	X
2	John Stout	HDR	Risk Modeling	(360) 570-7243	John.stout@hdrinc.com		X	X	X
3	Rick Chapman	Parsons	Cost Lead	(206) 494-3109	Rick.chapman@parsons.com		X	X	X
4	Frank Green	CRC	Structures Engineering Manager	(360) 816-8855	greenf@columbiarivercrossing.com		X	X	X
5	Laura Peterson	CRC	Structures Engineering	(360) 816-2197	petersonL@columbiarivercrossing.com		X	X	X
6	Roger Kitchin	CRC	Cost, Utility, and Stormwater Lead	(360) 816-2182	kitchinR@columbiarivercrossing.com		X	X	X
7	Casey Liles	CRC	Highway	(360) 816-8878	lilesc@columbiarivercrossing.org		X		X
8	Aaron Myton	CRC	Highway	(360) 816-8872	mytona@columbiarivercrossing.org		X		X
9	Andrew Beagle	CRC	Highway	(360) 816-8880	beaglea@columbiarivercrossing.org				X
10	Steve Witter	CRC	Transit	(360) 816-8889	witters@columbiarivercrossing.org		X		X
11	Vicky Smith	CRC	Transit	(360) 816-8887	smithv@columbiarivercrossing.org		X		X

No	Name	Representing	Responsibility	Telephone	Email Address	Comments	Mon, Sep-28	Tue, Sep-29	Wed, Sep-30
12	Gavin Oien	CRC	Highway	(360) 816-2176	oieng@columbiarivercrossing.org		X	X	X
13	Allan McDonald	CRC	Highway	(360) 816-8863	mcdonalda@columbiarivercrossing.org		X	X	X
14	Devin Reck	CRC	Highway	(360) 816-8879	reckd@columbiarivercrossing.org		X	X	X
15	Rob Turton	CRC	Structures	(602) 320-0123	turtonr@columbiarivercrossing.org		X	X	
16	Matt Deml	CRC	Structures	(360) 816-2193	demlm@columbiarivercrossing.org		X	X	
17	Lwin Hwee	CRC	Structures	(360) 816-8893	hweel@columbiarivercrossing.org		X	X	
18	Joel Tubbs	CRC	Structures	(360) 816-8877	tubbsj@columbiarivercrossing.org		X	X	
19	Norm Wagner	HDR	Cost Estimating	(704) 338-6826	Norman.wagner@hdrinc.com		X		
20	Lynn Rust	CRC	Engineering	(360) 816-2177	rustl@columbiarivercrossing.org			X	
21	Heather Wills	CRC	Environmental	(360) 816-2199	willsh@columbiarivercrossing.org			X	

APPENDIX B: Base Cost Uncertainty by Activity

Activity #	Activity	LPA Phase 1 Base Cost Uncertainty by Activity		
		10th Percentile	Base Estimate	90th Percentile
1	Prepare and Publish FEIS	$2,700,000	$3,000,000	$3,300,000
2	PE - FEIS Design Highway	$37,235,691	$41,372,990	$45,510,289
3	FTA Pre PE Reviews	$776,012	$862,236	$948,460
4	FTA Approval to Enter PE	$0	$0	$0
5	Transit Modeling & 15% Design	$2,328,037	$2,586,708	$2,845,379
6	Pre-ROD Environmental Permitting (B.O. MOA 106)	$8,069,303	$8,965,892	$9,862,481
7	Review to Get Record of Decision	$540,000	$600,000	$660,000
8	Record of Decision	$0	$0	$0
9	R/W Highway	$62,315,416	$77,894,270	$93,473,124
9b	Agreements	$180,000	$200,000	$220,000
10	CRC PS&E	$84,717,278	$94,130,309	$103,543,340
10b	CRC PS&E Transit	$18,352,955	$20,392,172	$22,431,389
10c	FTA FFGA	$0	$0	$0
11	R/W Transit	$25,076,208	$31,345,260	$37,614,312
12	Transit PE	$4,656,073	$5,173,415	$5,690,757
12b	FTA Approval to Enter Final Design	$0	$0	$0
13	Post-ROD Environmental Permitting	$8,069,303	$8,965,892	$9,862,481
14	A/B/A Bridge Construction	$4,050,000	$4,500,000	$4,950,000

Activity #	Activity	LPA Phase 1 Base Cost Uncertainty by Activity		
		10th Percentile	Base Estimate	90th Percentile
15	Construct Columbia River Structure	$440,483,275	$496,986,647	$590,501,428
16	SR-14 Interchange Stage 1 through 3	$142,274,785	$186,978,653	$211,093,751
17	Hayden Island Interchange Stage 1 through 3	$156,216,491	$204,343,675	$231,954,805
18	A/B/A LRT	$1,350,000	$1,500,000	$1,650,000
19	Transit Vehicle Procurement	$75,746,160	$84,162,400	$100,994,880
20	LRT Oregon	$85,071,758	$105,106,549	$120,657,049
21	LRT Washington	$205,783,649	$236,852,586	$272,758,460
22	A/B/A Marine Drive Interchange	$1,350,000	$1,500,000	$1,650,000
23	A/B/A Mill Plain Interchange	$1,350,000	$1,500,000	$1,650,000
24	A/B/A Fourth Plain Interchange	$1,350,000	$1,500,000	$1,650,000
25	A/B/A SR-500 Interchange	$0	$0	$0
26	Finalize Construction of Columbia River Structure	$48,942,587	$55,220,739	$65,611,270
27	Traffic Shift to New SB Bridge	$0	$0	$0
28	A/B/A Demo Existing River Crossing	$450,000	$500,000	$550,000
29	SR-14 Interchange Stage 4 through 7	$110,056,683	$142,829,647	$161,876,764
30	Hayden Island Interchange Stage 4 through 7	$120,527,446	$155,749,677	$177,294,539
30b	Traffic Shift to New NB Bridge	$0	$0	$0
31	Marine Drive Interchange	$176,766,712	$234,979,929	$264,744,640
32	Mill Plain Interchange	$34,159,622	$44,224,400	$49,729,608

Activity #	Activity	LPA Phase 1 Base Cost Uncertainty by Activity		
		10th Percentile	Base Estimate	90th Percentile
33	Fourth Plain Interchange	$62,903,921	$79,400,877	$90,902,304
34	SR-500 Interchange	$3,962,417	$5,367,548	$5,998,395
35	LRT Across the River - Track, OCS, Signal/Comm.	$6,617,065	$7,352,295	$8,654,658
36	Demo Existing River Crossing	$34,852,818	$49,789,739	$54,768,713
37	LRT Burn	$2,373,000	$2,636,667	$2,900,334
38	Transit Revenue Ops	$0	$0	$0
39	Project Complete	$0	$0	$0
	Totals	$1,971,654,665	$2,398,471,172	$2,758,503,610

Table B-1: Base Cost Uncertainties by Activity – LPA Phase 1 Scenario

Activity #	Activity	LPA Base Cost Uncertainty by Activity		
		10th Percentile	Base Estimate	90th Percentile
1	Prepare and Publish FEIS	$2,700,000	$3,000,000	$3,300,000
2	PE - FEIS Design Highway	$41,337,330	$45,930,366	$50,523,402
3	FTA Pre PE Reviews	$776,012	$862,236	$948,460
4	FTA Approval to Enter PE	$0	$0	$0
5	Transit Modeling & 15% Design	$2,328,037	$2,586,708	$2,845,379
6	Pre-ROD Environmental Permitting (B.O. MOA 106)	$8,752,909	$9,725,455	$10,698,001
7	Review to Get Record of Decision	$540,000	$600,000	$660,000

Activity #	Activity	LPA Base Cost Uncertainty by Activity		
		10th Percentile	Base Estimate	90th Percentile
8	Record of Decision	$0	$0	$0
9	R/W Highway	$62,315,416	$77,894,270	$93,473,124
9b	Agreements	$180,000	$200,000	$220,000
10	CRC PS&E	$92,937,768	$103,264,187	$113,590,606
10b	CRC PS&E Transit	$18,352,955	$20,392,172	$22,431,389
10c	FTA FFGA	$0	$0	$0
11	R/W Transit	$25,076,208	$31,345,260	$37,614,312
12	Transit PE	$4,656,073	$5,173,415	$5,690,757
12b	FTA Approval to Enter Final Design	$0	$0	$0
13	Post-ROD Environmental Permitting	$8,752,909	$9,725,455	$10,698,001
14	A/B/A Bridge Construction	$4,050,000	$4,500,000	$4,950,000
15	Construct Columbia River Structure	$462,565,427	$521,864,398	$620,025,233
16	SR-14 Interchange Stage 1 through 3	$142,959,342	$187,708,200	$211,868,288
17	Hayden Island Interchange Stage 1 through 3	$173,385,134	$227,359,733	$257,758,278
18	A/B/A LRT	$1,350,000	$1,500,000	$1,650,000
19	Transit Vehicle Procurement	$75,746,160	$84,162,400	$100,994,880
20	LRT Oregon	$85,008,513	$105,027,492	$120,562,181
21	LRT Washington	$205,641,128	$236,674,435	$272,544,678
22	A/B/A Marine Drive Interchange	$1,350,000	$1,500,000	$1,650,000

Activity #	Activity	LPA Base Cost Uncertainty by Activity		
		10th Percentile	Base Estimate	90th Percentile
23	A/B/A Mill Plain Interchange	$1,350,000	$1,500,000	$1,650,000
24	A/B/A Fourth Plain Interchange	$1,350,000	$1,500,000	$1,650,000
25	A/B/A SR-500 Interchange	$1,350,000	$1,500,000	$1,650,000
26	Finalize Construction of Columbia River Structure	$51,396,158	$57,984,933	$68,891,692
27	Traffic Shift to New SB Bridge	$0	$0	$0
28	A/B/A Demo Existing River Crossing	$450,000	$500,000	$550,000
29	SR-14 Interchange Stage 4 through 7	$110,741,240	$143,559,194	$162,651,301
30	Hayden Island Interchange Stage 4 through 7	$133,494,121	$172,886,815	$196,562,139
30b	Traffic Shift to New NB Bridge	$0	$0	$0
31	Marine Drive Interchange	$196,026,743	$262,116,682	$294,507,303
32	Mill Plain Interchange	$34,269,599	$44,341,605	$49,854,041
33	Fourth Plain Interchange	$63,101,375	$79,611,308	$91,125,712
34	SR-500 Interchange	$61,159,774	$79,048,170	$89,418,565
35	LRT Across the River - Track, OCS, Signal/Comm.	$6,617,065	$7,352,295	$8,654,658
36	Demo Existing River Crossing	$34,852,818	$49,789,739	$54,768,713
37	LRT Burn	$2,373,000	$2,636,667	$2,900,334
38	Transit Revenue Ops	$0	$0	$0
39	Project Complete	$0	$0	$0
	Totals	$2,119,293,214	$2,585,323,590	$2,969,531,427

Table B-2: Base Cost Uncertainties by Activity – LPA Scenario

APPENDIX C: Risk Register

The risk register developed during the risk workshop is presented in the table below.
Note that all the risk items discussed during the session, active or inactive, are provided in the table. Inactive or not applicable risk items have been grayed out.

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										Quantitative Analysis					
										Cost Impact ($)			Schedule Impact (months)		
Activity Impacted	Index	LPA	LPA Phase 1	Functional Assignment	Threat/ Opportunity Events	SMART Column	Panelists' Comments	Risk Trigger	Type of Risk	Prob.	Low	Median	High	Low	Med.	High
All Construction Activities	Env1	1	1	Environmental	New Endangered Species Act listing during construction	Species currently present in area is listed under ESA before end of construction, requires re-initiation of ESA consultation, new conservation measures	Schedule risk, work stopped while BO is revised. Cost risk, new conservation measures; During construction a new species is listed and a re-consultation is required most likely candidate species is Lamprey;		Schedule	15%				1.0	4.0	10.0
6	Env2	1	1	Environmental	New listed species shows up in the project area.	Currently listed species arrives in project area before end of construction, requires re-initiation of ESA consultation, new conservation measures	Schedule risk, work stopped while BO is revised. Cost risk, new conservation measures;		Cost & Schedule	10%	$200,000	$200,000	$200,000	1.0	2.5	4.0
6	Env3	1	1	Environmental	Obtaining a jeopardy determination, depending on the determination could cause large schedule effects	Pre-ROD Risk. Schedule / Cost risk. If a jeopardy determination is returned (jeopardizes a listed species) changes to construction may be necessary.	Changes are required in design resulting in delay to design; the negotiation time necessary is the issue; this is a preconstruction delay; jeopardy determination is returned during environmental review;		Schedule	10%				6.0	12.0	18.0
15	Env4	1	1	Environmental (Construction review)	Section 7 consultation in-water work windows are more restrictive than the base schedule assumes.	Fish passage, fish windows: work in water possible from November 1 through February 28 (4 months). (Base schedule assumes 12 month IWWW).	No extension to the window has been determined, if an extension is granted this risk should be revisited; low schedule implies a 8 month work window, high a 4 month work window; Farther along with the agencies so the effect would reduce from the last CEVP; More information was gained and now the impact lowers		Schedule	50%				4.0	8.0	12.0
All Construction activities	Env7	1	1	Environmental	Terms and conditions of the Biological Opinion and other approval cannot be met by the project during construction	Examples: pile driving operations cause more take than Biological Opinion called out, despite best efforts of contractor;	Schedule risk, work stopped while BO/other permits are revised. $5 million have to come up with different conservation measures (an extra coffer dam etc) delay is have to meet shutdown re-initiations		Cost & Schedule	25%	$5,000,000	$5,000,000	$5,000,000	1.0	2.0	3.0
17, 31	Env11	1	1	Environmental (ROW review)	Hazardous Materials - Liability associated with property acquisition	Combined with Env10; concern is Hayden Island and Marine Drive, unknown hazmat; base has some allocation for this;	Probability and costs will vary by location		Cost & Schedule	10%	$10,000,000	$10,000,000	$10,000,000	4.0	6.0	8.0
13	Env12	1	1	Environmental	Supplementary EIS (SEIS) / additional environmental analysis required "Post-ROD"	Reasons could be questions raised by public, alternatives are not evaluated completely enough; schedule is negligible, cost is due to having to pursue a supplemental EIS	Would delay getting to construction, need a supplemental ROD if discovered not enough funding need to change project significantly and would need a new SEIS. See note below as well.		Cost	40%	$5,000,000	$7,500,000	$10,000,000			
1	Env13	0	0	Environmental	Supplementary EIS (SEIS) / additional environmental analysis required "Pre-ROD"	Highly likely for this type of project. Would delay ROD. Cost impact = consultant fee to complete SEIS.	The risk of needing an SDEIS pre-ROD is lower if new options are not added. However, not evaluating these other options now would likely increase the risk of needing a SFEIS or SDEIS after the ROD.		Cost & Schedule	30%	$1,000,000	$2,000,000	$3,000,000	3.0	6.0	9.0
1	Env13b	1	1	Environmental	Supplementary EIS (SEIS) / additional environmental analysis required "Pre-ROD"	The collection of changes made in new options and designs after the DEIS, increase the risk of requiring supplemental DEIS to allow public and agency review of impacts in the NEPA context	If an SDEIS is going to be prepared, the earlier a decision is made, the less impact it would have on the ROD delivery date. Impacts are lower due to more information at this stage.		Cost & Schedule	60%	$1,000,000	$2,000,000	$3,000,000	3.0	6.0	9.0
13	Env14	1	1	Environmental	Controversy on environmental grounds expected (NEPA challenges only)	NEPA document challenges, Section 4F, Section 106, Section 10 ESA, DEQ, Purpose and Need; Have had comments on the DEIS from legal so do expect some challenges	Cost is for litigation fees, negligible schedule effect due to concurrent design		Cost	50%	$3,000,000	$5,000,000	$10,000,000			

											Quantitative Analysis					
											Cost Impact ($)			Schedule Impact (months)		
Activity Impacted	Index	LPA	LPA Phase 1	Functional Assignment	Threat/ Opportunity Events	SMART Column	Panelists' Comments	Risk Trigger	Type of Risk	Prob.	Low	Median	High	Low	Med.	High
6, 13	Env15	1	1	Environmental	Environmental regulations change	Water quality regulations, definition of jurisdictional resources (e.g., ditches). Schedule impact larger if change occurs later.	Stormwater risks covered in another category, make sure no double counting; new EPA regs; may be able to separate out specific risks from this broad category; probability of a change that affects the project is lower		Schedule	20%				1.0	2.0	3.0
6	Env16	1	1	Environmental	Interagency coordination / agreements Pre-ROD	Section 106, ESA, Marine Mammal Protection Act, Corps 404, Section 9 RHA(USCG), DEQ 401, Ecology 401, WA WPCA, OR Removal-Fill, WDFW HPA, ODFW Fish Passage, ODFW Habitat Mitigation, EPA Sole Source Aquifer Approval, COP, COV	Potential for conflicting conditions requiring renegotiation or redesign; This delay occurs for Pre-ROD;		Schedule	25%				1.0	2.0	3.0
13	Env16b	1	1	Environmental	Interagency coordination / agreements Post-ROD	Section 106, ESA, Marine Mammal Protection Act, Corps 404, Section 9 RHA(USCG), DEQ 401, Ecology 401, WA WPCA, OR Removal-Fill, WDFW HPA, ODFW Fish Passage, ODFW Habitat Mitigation, EPA Sole Source Aquifer Approval, COP, COV	Potential for conflicting conditions requiring renegotiation or redesign; conflict really comes into the Post-ROD;		Schedule	25%				1.0	2.0	3.0
6	Env18	1	1	Environmental	Tribal consultation	Ensure that there are not fatal flaws for natural resources and cultural resources with the tribes.	Schedule effect; Has been ongoing tribal consultation; Pre-ROD		Schedule	50%				3.0	3.0	3.0
6	Env19	1	1	Environmental	Section 106 process itself takes longer than expected (not due to discoveries)	Pre-ROD risk that it will take longer than scheduled; Have not received approval to advance archaeological process as of yet;	This is a risk currently as the process is taking longer than planned. The effect of this risk reduces as the schedule has adjusted to accommodate these issues.		Schedule	40%				3.0	5.0	8.0
6, 13	Env20	1	1	Environmental	Possible Section 4F archaeological during preconstruction	4F has a high threshold; things such as petro glyphs, burial ground	If a rare deposit is hit preconstruction 4F kicks in and would lead to a delay and a possible redesign; 4F prevents transportation use of historic properties; rare archaeological find that has potential for preservation in place; low prob		Schedule	10%				6.0	6.0	6.0
2, 6	Env21	1	1	Environmental	Contentious park/historic area leads to schedule impact delaying 4F approval		May need to perform a realignment to avoid contentious cultural/archaeological areas, leads to cost and schedule impact		Schedule	15%				2.0	2.0	2.0
16, 32, 29	Env23	1	1	Environmental	Inadvertent discovery of human remains	Risks associated with discovering human archaeological remains during excavation, demolition, construction			Schedule	30%				0.5	1.8	3.0
All Construction activities	Env25	1	1	Environmental	Contractor not following the terms and conditions of permits (either volitionally or negligently)	Example: IWWW needs to be extended to complete work operations. Permits include all listed in above risk.	Leads to fines, stop work order, restitution; costs fall to contractor but the contractor will price into the bid		Schedule	10%				0.3	1.6	3.0
13	Env29	1	1	Environmental	Negative community impacts expected (potential civil rights title VI lawsuit or environmental justice issues)	Potential lawsuit on EJ issues; various pressures from communities	Complaints need to be investigated; but may not lead to a delay unless a civil rights act issue arises;		Schedule	25%				2.0	2.0	2.0
13	Env_Minor	1	1	Environmental	All Minor Environmental Risks		Minor Catchall; Costs can include any design costs incurred from environmental issues.		Cost	50%	$1,000,000	$5,500,000	$10,000,000			

										Quantitative Analysis					
										Cost Impact ($)			Schedule Impact (months)		
Activity Impacted	Index	LPA	LPA Phase 1	Functional Assignment	Threat/ Opportunity Events	SMART Column	Panelists' Comments	Risk Trigger	Type of Risk	Prob.	Low	Median	High	Low	Med.	High
10, 10b	SW1	1	1	Stormwater	Inability to convey stormwater to treatment facilities proposed under FEIS. FEIS Impacts.	Currently Scope of work does not include conveyance system, pipes in roads etc. May have a concern in Washington area where the road is depressed and are discharging into the existing conveyance system. Less of a problem on elevated areas. If not able to convey with existing grades may need pump systems or more ROW. Could include park and rides,and trackway. Risk that there is not enough money in the base for this issue.	Conveyance system. Currently not scoped (Task AF). Several consequences may be effected. Treatment facilities may need to alter locations not captured under the FEIS, requiring a NEPA re-submittal. Additional right of way may be needed for a facility that conveyance systems can reach. Threat: Cost & Schedule; High Probability; High Impact	Profile or design alterations may effect conveyance. While not scoped for conveyance, the consultant team will attempt to consider as selecting prelim treatment locations. However, future design changes are difficult to anticipate.	Cost & Schedule	50%	$500,000	$2,000,000	$3,500,000	1.0	2.0	3.0
9	SW1b	1	1	Stormwater	Inability to convey stormwater to treatment facilities proposed under FEIS. ROW impacts Risk	Currently Scope of work does not include conveyance system, pipes in roads etc. May have a concern in Washington area where the road is depressed and are discharging into the existing conveyance system. Less of a problem on elevated areas. If not able to convey with existing grades may need pump systems or more ROW. Could include park and rides,and trackway. Risk that there is not enough money in the base for this issue.	Conveyance system. Currently not scoped (Task AF). Several consequences may be affected. Treatment facilities may need to alter locations not captured under the FEIS, requiring a NEPA re-submittal. Additional right of way may be needed for a facility that conveyance systems can reach. Threat: Cost & Schedule; High Probability; High Impact	Profile or design alterations may effect conveyance. While not scoped for conveyance, the consultant team will attempt to consider as selecting prelim treatment locations. However, future design changes are difficult to anticipate.	Cost & Schedule	30%	$1,500,000	$1,500,000	$1,500,000	6.0	9.0	12.0
10, 10b, 13	SW7	1	1	Stormwater	Changes in the environmental regulations and BMP selection methodology over the multi-year design process.	New technologies may decrease the cost, thus an opportunity; a threat because water quality has become more of an issue over time; Changes in the regulations and selection methodology may lead to an opportunity or risk;	This might be a risk and an opportunity and could result from more stringent requirements or monitoring that indicates that other BMPs provide adequate levels of required treatment. Threat & Opportunity: Cost; High Probability; High Impact	Changes in regulations.	Schedule	75%				1.0	2.0	3.0
10, 10b	SW11	1	1	Stormwater	Existing conveyance systems receiving outflow from Water Quality facilities have inadequate capacity or are in poor condition and need to be replaced.		This is of most concern for discharges from the constructed wetland on the west side of the Marine Drive interchange - there would be a significant increase in flows to the drainage ditch and pump station south of EXPO. Threat: Cost; High Probability; High Impact; There is a project in the works for Multnomah county to upgrade their pump station; May have a cost impact due to having to upgrade the pump station on the project cost; May impact cost to the Marine drive interchange by having to provide dollars. MINOR	Preliminary design indicates inadequate capacity or condition survey shows pipes in poor condition.	Cost	75%	$2,000,000	$2,000,000	$2,000,000			
13	SW18	1	1	Stormwater	New outfall required for proposed biofiltration swale on Hayden Island.	Potential need for a new outfall from Hayden Island to North Portland Harbor; Only on the Oregon side;	This will require additional permitting. Threat: Schedule; High Probability; Low Impact MINOR	Preliminary design or ownership issues indicate that existing outfall cannot be used.	Schedule	25%				1.0	2.0	3.0
10,10b, 12	SW22	1	1	Stormwater	Differences between infrastructure shown on drawings and field conditions (eg pipe inverts).	Would survey ahead of time to get a good idea of the issue;	Preliminary design based on as-built drawings. This is mainly an issue in Vancouver. Threat and Opportunity: Schedule; High Probability; High Impact; MINOR Cost	Survey data that indicates a difference. Higher invert elevations would present a threat while lower elevations could increase opportunities to treat runoff.	Cost & Schedule	90%	$500,000	$2,000,000	$3,500,000	1.0	2.5	4.0

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10, 10b,12	SW23	1	1	Stormwater	Insufficient data available on existing drainage systems on Hayden Island	Hayden Island almost entirely privately owned; have a lack of data on the existing drainage systems; Unknown if the systems are in place or maintained; May be issues with septic systems and row issues there; Correlated with other ROW risks	Could provide alternative opportunity for discharging runoff or additional cost should facilities be located under proposed footprint. Threat and Opportunity: Cost; Low Probability; High Impact	Data becomes available from owners or through survey.	Cost & Schedule	95%	$500,000	$1,500,000	$2,500,000	1.0	3.5	6.0
13	SW2	1	1	Stormwater	Issues with the Oregon BMP Selection Tool	Flagged as a MINOR risk; Oregon BMP tool has just been finalized, project decided to go with this tool; inherent problem is concern over WA ecology wont accept this tool; may require more provisions over and above what the Oregon BMP tool is providing; Idea was that this could save time in the long run since Oregon has already bought into this tool; May interfere with 401 certification;	Oregon BMP Selection Tool has been generally agreed to project wide (WA Ecology still needs to buy into this use). While we have agreed to this tool, the services may not understand the Oregon BMP tool does not imply Oregon Design standards. Proceeding with design using jurisdictional standards, but selecting BMPs using the Oregon BMP tool. Fear that services may require Oregon Design Criteria, which WA State Agencies may not permit given their extensive work and research of BMP issues. Additionally BMP design may differ. This may require special provisions written to replace Standard Specifications -> resulting in additional time for approval, and potential complications with NPDES permit through Ecology (BMP construction specs are incorporated in WA NPDES permit. Threat: Schedule; Low Probability; High Impact	Discussions with the Services may raise this implication. Suggest preparation to mitigate this potential risk that early communication on this issue occurs.	Schedule	30%				1.0	2.0	3.0
10,10b,12	SW3	1	1	Stormwater	DEIS identified several areas of existing stormwater near the project area (but not part of the project) that drain into the existing system. Risk is these areas will need to be treated.	This occurred on Salmon Creek Interchange project; Most drastic in Washington because of the area that is draining into the project area includes about 250 acres of downtown Vancouver; this is not being touched or affected by the project but may still end up with this area requiring treatment by the local government; Oregon NMFS has taken the lead so may not have the coordination with Washington; All stormwater schedule delay risks so far can occur in parallel, not additive;	The DEIS states these areas will remain untreated. Opportunity: Cost; Low Probability; High Impact	If difficulties occur with the Services these areas might be possible to incorporate in design. However, funding may be an issue as State Funding is not allowed for localized improvements.	Cost & Schedule	25%	$1,500,000	$3,000,000	$5,000,000	3.0	6.5	10.0
9,10,11,12	SW6	1	1	Stormwater	Infiltration rates may be different from those assumed for preliminary design.	Been having difficulty obtaining right of entry to obtain geotechnical borings; Stormwater needs multiple seasons of data to desingt drainage systems properly; If the assumed infiltration rate is inadequate may need more facilities potentially affecting ROW acquiring or requiring supplemental EIS	This would affect facilities located north of the Columbia River only. The SR 14 interchange area has the highest potential negative impact should measured infiltration be lower - it has the largest PGIS and available land is limited. Threat & Opportunity: Schedule & Cost; High Probability; Low Impact	Site specific infiltration rates indicate values different from those assumed to size the ponds.	Cost & Schedule	20%	$200,000	$500,000	$750,000	1.0	3.5	6.0
6	SW12a	1	1	Stormwater	Agencies disagree with premise that exclusive LRT guideway is considered non-polluting.	Are proceding under Washington NMFS; typically Oregon NMFS is less restrictive than WA NMFS in concerns to Stormwater; more of a design issue with a potential for larger treatment necessary; May need ROW in downtown Vancouver	The would increase the cost of proposed cartridge filters with the greatest impact occurring with a 3-bridge river crossing. Threat: Cost; Low Probability; High Impact	Agenices formally indicate disagreement.	Cost & Schedule	10%	$200,000	$2,500,000	$4,500,000	3.0	4.5	6.0

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6	SW12b	1	1	Stormwater	Agencies disagree with premise that exclusive LRT guideway is considered non-polluting.	Are proceding under Washington NMFS; typically Oregon NMFS is less restrictive than WA NMFS in concerns to Stormwater; more of a design issue with a potential for larger treatment necessary; May need ROW in downtown Vancouver; less impact on 2 bridge	This would increase the cost of proposed cartridge filters with the greatest impact occurring with a 3-bridge river crossing. Threat: Cost; Low Probability; High Impact	Agencies formally indicate disagreement.	Cost & Schedule	10%	$200,000	$3,500,000	$6,500,000	3.0	4.5	6.0
21	SW14	1	1	Stormwater	Agencies insist that runoff from all replaced pollutant generating impervious surface would require treatment.		There are currently areas where this would be problematic. Threat: Cost; Low Probability; Low Impact	Agencies formally indicate this is required. Currently less than 5% PGIS would not be treated.	Cost	75%	$3,000,000	$4,000,000	$5,000,000			
21	SW15	1	1	Stormwater	Vancouver city streets adjacent to single guideways would need to be replaced rather than resurfaced.	If have to rebuild the street, then need the highest level of water quality treatment, needs oil control, ponds, etc. The risk is crossing the threshold from basic treatment to enhanced treatment which occurs when you expose the subgrade; would be on Mcloughlin or Washington; Schedule impact is negligible	This would necessitate treatment. Threat: Cost; Low Probability; Low Impact	LRT guideway profile is significantly different from existing street grades. Extensive utility relocation may also require replacing pavement. Street reconstruction is a trigger for this	Cost	75%	$5,000,000	$7,500,000	$10,000,000			
All Construction except 15, 26, 36, 35, 19, 37	SW21	1	1	Stormwater	Incorporating Low Impact Development opportunities as design work progresses.	Minor Opportunity	They would reduce the size of the proposed "regional" WQ facilities. Opportunity: Cost; Low Probability; Low Impact	No specific trigger. Identifying opportunities would be ongoing.	Cost	50%	-$1,000,000	-$1,000,000	-$1,000,000			
21	SW25	1	1	Stormwater	Ability to mitigate stormwater impacts at the basin-level, rather than within or adjacent to project ROW.	Minor Opportunity (Basin-level areas are larger watershed areas such as Burnt Bridge Creek Watershed)	Opportunity: Cost; Low Probability; High Impact	Agency willingness to accept basin-level stormwater mitigation. Potential to substantially reduce sotrmwater costs.	Cost	5%	-$1,000,000	-$1,000,000	-$1,000,000			
All Construction Except River Crossing	UT3	1	1	Utilities	Utility information provided by owners is not accurate and infrastructure is not where shown on the drawings.	This has occurred in the past due to private companies buying other company's lines and not getting this information updated; if they are there by franchise the utility will pay if by easement the project…	This is particularly likely for underground Qwest and PGE infrastructure as data provided was schematic. Threat: Schedule; High Probability; High Impact	Utility unearthed or severed by contractor.	Schedule	20%				2.0	3.5	5.0
9b	UT5b	1	1	Utilities	Agreements between utility and land owners is not known for downtown Vancouver area;		Agreements could be a matter of public record but these records may not be found/known; Rights are generally not recorded except in times when easements had been required; Base has $5M in public utility relocation costs, risk is that private utilities have rights that were previously unknown and require relocation costs.		Cost	35%	$2,000,000	$3,500,000	$5,000,000			
All Construction Except River Crossing	UT8	1	1	Utilities	Utility relocation work is not completed on schedule, possible delaying project construction.	This applies to all KNOWN utilities but the relocation does not happen according to schedule;	This is a project-wide threat. Threat: Schedule & Cost; High Probability; High Impact	Utility relocation work behind schedule.	Schedule	60%				2.0	4.0	6.0

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17	UT9	0	0	Utilities	Inability to maintain fire flow and pressure on Hayden Island.	Cost is to put a standby well on the island;	The 16" main on the North Portland Harbor bridge can only be out of service for a maximum of 4 hours. Threat: Schedule & Cost; Low Probability; High Impact	The construction schedule will demonstrate whether alternative opportunities exist to maintain water supplies when the bridge is demolished.	Cost	20%	$1,000,000	$1,000,000	$1,000,000			
16, 34	UT10	1	1	Utilities	Inability to find suitable alternative routes for affected gravity sanitary sewer pipes.	Cutting into sewer North on 39th street and on 5th street in Vancouver; MINOR Cost	Threat: Cost; Low Probability; High Impact	Preliminary design of relocation options indicates that this is the case.	Cost	20%	$1,000,000	$2,000,000	$3,000,000			
All Construction except 15, 26, 36, 35, 19, 37	UT13	1	1	Utilities	Utility owners argue a project impact where none has been identified	On other projects utility owners have come back and argued a project impact where none has occurred; MINOR Cost	For example, the 16" water main and 20"/30" forcemain under I-5 south of Marine Drive interchange and MLK east of the interchange. Threat: Cost; High Probability; High Impact	MOUs or owner feedback that identify such.	Cost	50%	$2,000,000	$2,000,000	$2,000,000			
21	UT14	1	1	Utilities	Not all utilities adjacent to the LRT guideway in downtown Vancouver need to be relocated.	Will be digging down 6 to 10 feet so will need to relocate anything in this range; only if utilities are deeper would you not;	The current cost estimate assumed they do need to be moved. Opportunity: Cost; High Probability; Low Impact	The extent of this opportunity will be evident after a block-by-block assessment of relocation needs supplemented by more detailed utility mapping.	Cost	10%	-$2,000,000	-$1,500,000	-$1,000,000			
15	HW1a	1	1	Highway (Bridge Review)	Multi-use bike/ped path design is required to be wider or narrower than planned	Current standards for path is 14'	Threat: wider than a 16 foot multi-use ped/bike path. (Other than River Crossing); Opp: less than 16'; Tacoma Narrows is 10 feet, this project standards are higher than normal;	Pedestrian bike advisory committee is examining the project and they decide for larger and the project goes forward with their recommendations	Cost	10%	-$2,000,000	$0	$10,000,000			
31, 32, 33, 34	HW6	1	1	Highway (Construction Review)	Planned pavement overlaying needs to be rebuilt instead only overlaying	Vertical profile of the highway in these areas is not changing; the age of the current pavement is about 35 years old by the time construction begins; Cost per 2 miles is about 15 million above resurfacing costs; This risk is due to the condition of the pavement leading to more rebuilding than planned	May need to completely rebuild and not overlay on sections south of Marine Drive and a section north of Mill Plain both on I-5. The base estimate assumes a significant amount of overlay paving, …would lead cost and schedule impact		Cost	60%	$1,000,000	$3,000,000	$5,000,000			
16, 29	HW10	1	1	Highway (Construction, Organizational/Agreements Review)	Staging (general) issues due to local partners not agreeing on access restrictions	Temporary exits to city center closures create delays; will need to build in costs for improvements to onramps/off ramps, city has to agree to the detours; No money in the base costs currently	Risk that local partners do not agree on the access restrictions of the staging plan.		Cost	90%	$5,000,000	$5,000,000	$5,000,000			
16, 29	HW14	1	1	Highway (Bridge Review)	Extent of community connection south of Evergreen Blvd. is undetermined	Could be a 4F impact at the Reserve, so this could be a mitigation of that impact; why its not in the base costs; costs are above the mitigation costs in the base estimate; If this is larger than 200 feet it could qualify as a tunnel would need fire review;	risk that construction of a community connection in downtown Vancouver south of Evergreen should be included in base estimate	After IGA approval will know whether to go with this or not. Size will be determined by lane width, length along the highway will be determined by clearances.	Cost	95%	$30,000,000	$40,000,000	$50,000,000			

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9	HW24	0	0	Highway (ROW review)	Risk that the IAMP (Interchange Access Management Plan) does not allow a deviation for site access on Hayden Island.	Upper range is for full access, lower is for modified access	Hayden Island access spacing issues may lead to more ROW purchases (assumption is less than standard on the east side of interchange)		Cost	30%	$5,000,000	$7,500,000	$25,000,000			
9	HW24b	1	1	Highway (ROW review)	Risk that the IAMP (Interchange Access Management Plan) does not allow a deviation for site access on Hayden Island.	Upper range is for full access, lower is for modified access	Hayden Island access spacing issues may lead to more ROW purchases (assumption is less than standard on the east side of interchange)		Cost	30%	$5,000,000	$7,500,000	$15,000,000			
16, 17, 29, 30	HW2	1	1	Highway (Bridge Review)	Multi-use bike/ped path design requires more access points than planned		Additional access points are required to the multi-use ped/bike path (stairs or ramps); The base estimate includes elevators at HI and Vancouver and all the amenities discussed with PBAC are included in the estimate.		Cost	10%	$2,000,000	$3,500,000	$5,000,000			
31	HW21	1	1	Highway	Local Road construction (Marine Drive)	Connection between Marine Drive and Vancouver Way is required; ROW costs would be needed	Risk of scope increase on the local road connections		Cost	75%	$1,000,000	$1,000,000	$1,000,000			
All Highway Activities	HW_ Minor	1	1	Highway	All Minor Highway Risks		Minor Catchall		Cost	50%	$1,000,000	$5,500,000	$10,000,000			
1,2	Traf2	1	1	Traffic	Changes to current travel demand modeling parameters, 2035 time period or changes to model standard practices lead to a new model runs required; Pre-ROD leads to delays	Took time to get the 2 MPOs to agree to the 2035 year, may need to go to 2045; Risk is cannot get agreement and the parameters change requiring new model runs; new model runs are required that cause a delay potentially; may have effect on environmental air quality, noise etc...may delay FEIS; if parameters change the purpose and need of the project might only be met with 12 lanes option; If time elapses on the opening of the project too long, new model runs for future years at least 20 years past opening year may be required;	Low probability due to 2035 model runs will most likely be projected on a straight line to other years (2045 etc) instead of rerunning the model; The only difference in design is between 10 and 12 lanes but both are being considered; delay would be to just model reruns not redesign		Schedule	10%				3.0	4.5	6.0
1	Traf2b	0	1	Traffic	Number of lanes changes from 12 to 10 and not all prior 10 lane traffic analysis can re-used	Minor	The risk is that 10 lanes is being pursued; not switching to 12 lanes threatens FHWA participation for the project		Schedule	10%				1.0	3.0	6.0
10	D4	1	1	Design	Final 10 vs. 12 decision is delayed	Delaying the decision will hold up the design documentation approval, deviation development and approval; Longer it takes the longer it will take to focus design on just one option; delay would occur if after a decision is made the decision gets reversed; If the decision is not made by Jan 2010 will cause a delay;	Risk for schedule, cost of rework is minor and captured elsewhere		Schedule	10%				1.0	2.0	3.0

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7	D12	1	1	Design	Design approval is delayed	Project summary, corridor analysis, anticipated deviations, conceptual approval of roundabouts. Design approval is needed for right of way plans, appraisals, acquisition, etc (not before the NEPA is finished though).	Schedule risk that delays the start of final design (PS&E); early design approval can lock in footprints and such; speeds ROW; efficient project delivery could be jeopardized due to a delay; ROW plans approval would be the tightest issue;		Schedule	10%				1.0	2.0	3.0
7	D14	1	1	Design	New projects may delay approval process	Additional projects may cause more projects to get through the approval process (stimulus package).	Volume of projects due to stimulus package creates some delays (Concurrent Delays with d12)		Schedule	10%				1.0	2.0	3.0
2, 5, 10, 10b	D_Minor	1	1	Design	All Minor Design Risks		Minor Catchall		Cost & Schedule	50%	$2,000,000	$4,000,000	$6,000,000	-2.0	0.0	4.0
21	Tran12	1	1	Transit	Project chooses side-running alignment, causing access closures	Low probability that will have significant access closures; most businesses have right and left turn access if we take away one; increased cost for ROW impacts (underground parking for condos, bank drive up windows etc) which would be quite expensive and reconfiguring the access; Looking at many options for staging and trying to look at them for design;	Different magnitude for couplet vs. 2-way options		Cost	30%	$4,000,000	$7,000,000	$10,000,000			
12	Tran17	1	1	Transit	CTRAN tax increase for O&M does not pass after one ballot measures	If the tax does not pass it may jeopardize the FTA approval to enter final design; There is not enough time prior to the FTA approval needed for final design to hold 2 ballot measures;			Schedule	25%				6.0	9.0	12.0
3	Tran18	1	1	Transit	FTA approval to enter in to PE delayed	Delay could be due to decisions that haven't been made yet, stimulus package going through HQ, could be asked to revisit cost effectiveness numbers; Legislative delays are occurring now;			Schedule	95%				1.0	2.0	6.0
12	Tran21	1	1	Transit	FTA approval to enter in to final design delayed	Hinges on NEPA approval and finance plan			Schedule	75%				3.0	6.0	12.0
10b	Tran22	1	1	Transit	Full Funding Grant Agreement delayed	Other than the C-Tran tax increase vote risk (Tran17)			Schedule	30%				1.0	3.0	6.0
21	Tran42	1	1	Transit (Construction review)	Construction days/hours are less limited than assumed in the base schedule	Base assumes some delay and limited construction time downtown Vancouver; may be opportunities if businesses want the work done faster and relax the work windows; Don't believe this is feasible as of the most recent update	Risk is the work windows are more restrictive than planned, opportunity is that can work in the night or outside the windows in the base		Schedule	25%				-6.0	-3.0	-1.0
20, 21, 35	Tran54	1	1	Transit	Changes in technologies (esp. communications and signaling)	Issues with compatibility of systems between Oregon and Washington; testing delay would be minor			Cost & Schedule	50%	$2,000,000	$5,000,000	$10,000,000	1.0	2.0	3.0
17, 30	Tran100	1	1	Transit	Risk that ground improvements are necessary for transit across Hayden Island				Cost	30%	$2,000,000	$5,000,000	$8,000,000			
All Transit Activities	Tran_ Minor	1	1	Transit	All Minor Transit Risks				Cost	50%	$1,000,000	$3,000,000	$5,000,000			

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9, 11	RW2	1	1	Right of Way	To meet short acquisition time frame, many preliminary r/w functions need to occur before the ROD. The 18 month schedule for transit and the 20 month schedule for hw may be unattainable due to some issue.	Impact is delay of acquisition missed construction windows; The risk is to the core project;	Need ROW necessary to construct the river crossing early, but other ROW not acquired early may not cause a delay; worst case scenario is 6 months		Schedule	25%				3.0	4.5	6.0
9, 11	RW4	1	1	Right of Way	Floating home owners file legal appeal over relocation plan, court might delay relocation.	Impact is delay of acquisition missed construction windows; Costs are covered in the base cost uncertainty; This delay is concurrent with RW2;	Legal action to get relocation may cause a delay on Hayden Island		Schedule	25%				6.0	9.0	12.0
15, 26	Struc2a	1	1	Technical / Structure	Increase in aesthetic costs/context sensitive solutions for main river crossing		Non standard light fixtures, other nonstandard items to improve users' experience. This risk accounts for both the Columbia River portion. New items coming out of the design group are flares, sustainable energy elements, aesthetic lighting, overlook, stair tower, these nonstandard items are decoupled from the signature bridge risk. May revise the base cost to narrow the range on this risk as the unknowns.		Cost	95%	$5,000,000	$10,000,000	$15,000,000			
	Struc10	0	0	Technical / Structure	Pedestrian crossing at 7th street in Vancouver is required	Costs will be monetized here; probability will be covered under Organizational; push is strong enough that it may happen;	About 200 feet long pedestrian bridge and 24 feet wide		N/A							
16,29,32,33,34	Struc11	1	1	Technical / Structure	Risk that drilled shaft diameters need to move to D+3 in WA		Do not double count with Struc12		Cost	50%	$110,000,000	$115,000,000	$120,000,000			
16,29,32,33,35	Struc12	1	1	Technical / Structure	Opportunity for the use of spread footing or shallower shaft at discrete locations in WA rather than drilled shafts	SR-14 and WA approaches may be able to go to spread footings	Do not double count with Struc11		Cost	50%	-$20,000,000	-$15,000,000	-$10,000,000			
16,17,29,30,31,32,33,34	Struc13	1	1	Technical / Structure	Aesthetic costs for landside bridge structures	These could include unique column shapes, lighting, bridge rail, wall formliner, etc.			Cost	75%	$5,000,000	$10,000,000	$15,000,000			
15,26	Struc14b	1	1	Technical / Structure	Further development of river crossing structure reveals additional design complexities with added cost. Web member details change.	Web member details change from circular sections to built up sections. Each section is a custom piece so cost is high.			Cost	10%	$10,000,000	$20,000,000	$30,000,000			
15,26	Struc14c	1	1	Technical / Structure	Further development of river crossing structure reveals additional design complexities with added cost. Improvements to reduce impacts from terrorist attack.	Base assumes unfilled web members. Risk that web members would be concreted resulting in extra mass and increases in foundation. This might be pursued to reduce impacts from terrorist attacks.			Cost	10%	$30,000,000	$40,000,000	$50,000,000			
31	Struct16a	1	1	Technical / Structure	Foundations need to be deeper than 125' in the vicinity of Marine Drive due to differing geotechnical conditions	Upper end is having to go to 240' deep on the Oregon bridges; median is going to 160', low end is it remains at 125'			Cost	50%	$1,000,000	$5,000,000	$15,000,000			

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17,30	Struct16d	0	0	Technical / Structure	Opportunity that foundations end up shallower than 210' in the vicinity of Hayden Island due to differing geotechnical recommendations.				Cost	30%	-$45,000,000	-$20,000,000	-$5,000,000			
17,30	Struc17	0	0	Technical / Structure	Risk that tall MSE walls are not feasible at north end of HI for option 4, and structures are required.				Cost	10%	$25,000,000	$30,000,000	$35,000,000			
15	Con1	1	1	Construction / Geotech	Saving money from the pile shaft test program.	Pile/shaft test program possible. $5M investment could save significantly in bid and claim costs. Pile test program that includes constructability, environmental mitigation and load test ability may lead to savings over base; This confirms the process to be used; leads to a better bid and lower chance of a catastrophic shutdown from environmental issues; Environmental schedule savings may be under Env risks	Current base assumption is to use large diameter shafts rather than driven piles for foundation. Driven piles will be used. Acoustic monitoring for piles could be incorporated into test pile/shaft program. High end savings are save a shaft per pier and maybe improve production rates (may take 7 days per shaft); high end may have slower production rates for shafts (taking 10-12 days per shaft) or changes to how shafts are built adding cost; Can add more crews to not have a schedule impact		Cost	50%	-$20,000,000	$0	$30,000,000			
15, 26, 16, 17, 29, 30	Con18	1	1	Construction	Market risk if only 1 contractor bidding due to higher bid costs (monopoly)	Base assumes SR 14, River crossing, and Hayden Island are one contract.	Can award the contract to one bidder if within 5% of engineers estimate; if only one bidder may have 30% higher bid than anticipated;		Cost	10%	$50,000,000	$100,000,000	$200,000,000			
15, 16, 29, 32, 33, 34	Geo4	1	1	Geotech	Sole source aquifer that underlies this region may be impacted by pile driving and shafts, possible cross contamination of aquifers to drinking water aquifers	if occurs during construction could have an impact; low probability due to not coming near or drilling deep enough to hit the aquifer	Do not believe this a problem but need more study to prove scientifically; base assumes no problem; if occurs may limit the use of drilling slurries in construction; A report has been submitted since the last CEVP and it does not foresee a problem. EPA has not ruled on this yet however, it may require more work to get the EPA to approve the findings. This issue is only in the WA side.		Cost	5%	$5,000,000	$10,000,000	$15,000,000			
17,30	Geo10	1	1	Geotech	Ground improvements	Additional Hayden Island ground improvements are needed for LPA option beyond what is assumed in the base.	Base assumes band of improvements from OHW to 110' from shore at both the north and south ends of Hayden Island. Improvements assumed to extend 50' beyond structure drip lines.		Cost	10%	$1,000,000	$3,000,000	$5,000,000			
31	Geo11	1	1	Geotech	Ground improvements	Additional Marine Drive ground improvements are needed beyond what is assumed in the base for LPA option and alignment which retains existing NPH structure.	Base assumes band of improvements from OHW to 110' from shore at the south shore of the North Portland Harbor. Improvements assumed to extend 50' beyond structure drip lines.		Cost	10%	$30,000,000	$40,000,000	$60,000,000			
31	Geo13	0	0	Geotech	Ground improvements	Additional Marine Drive ground improvements are needed for LPA option beyond what is assumed in the base.	Base assumes band of improvements from OHW to 110' from shore at the south shore of the North Portland Harbor. Improvements assumed to extend 50' beyond structure drip lines.		Cost	10%	$15,000,000	$20,000,000	$30,000,000			
17,30	Geo14	1	1	Geotech	Ground improvements	Additional Hayden Island ground improvements are needed beyond what is assumed in the base for the option that retains the existing NPH structure.	Base assumes band of improvements from OHW to 110' from shore at both the north and south ends of Hayden Island. Base also assumes stone columns adjacent to the full length of TI Drive. Improvements assumed to extend 50' beyond structure drip lines.		Cost	10%	$5,000,000	$30,000,000	$35,000,000			

										Quantitative Analysis					
										Cost Impact ($)			Schedule Impact (months)		
Activity Impacted	Index	LPA	LPA Phase 1	Functional Assignment	Threat/ Opportunity Events	SMART Column	Panelists' Comments	Risk Trigger	Type of Risk	Prob.	Low	Median	High	Low	Med.	High
17,30	Geo15	0	0	Geotech	Ground improvements	Additional Hayden Island ground improvements are needed beyond what is assumed in the base for LPA lowered option.	Base assumes band of improvements from OHW to 110' from shore at both the north and south ends of Hayden Island. Base also assumes stone columns adjacent to the full length of TI Drive. Improvements assumed to extend 50' beyond structure drip lines.		Cost	10%	$5,000,000	$30,000,000	$35,000,000			
9b	Agree7	1	1	Agreements	ODOT/WSDOT agreement may be delayed	Agreements - Funding, administration and oversight for construction, maintenance; Delay is due to funding issues; Agree8 and Agree9 are included in this risk;			Schedule	10%				3.0	4.5	6.0
16	Agree15	1	1	Agreements	Railroad agreements may take longer than assumed and can delay construction	Railroad may require their own flaggers during construction and will need to approve encroachment onto their right of way for construction;			Schedule	50%				1.0	4.0	8.0
9	Fund8	1	1	Funding	ODOT or WSDOT funding shortfalls occur	This includes Fund7			Schedule	50%				6.0	9.0	12.0
14	Toll1b	1	1	Tolling	Tolling authority for I-5 is delayed	A delay to the authority to toll along I-5 could lead to a delay to construction; Washington legislature needs to pass a statute allowing I-5 tolling; but ODOT has tolling authority already;	MINOR due to 3 years of legislative sessions		Schedule	5%				12.0	18.0	24.0

APPENDIX D: Additional Model Output

Model output not detailed within the body of this report is contained within this appendix.

LPA Phase 1 Scenario Costs by Build-Up Category and Probability of NOT Exceeding (Millions $'s)

Cost Curve Build-Up Category	Effect	10%	20%	30%	40%	50%	60%	70%	80%	90%
Base Cost Estimate	Project Base Cost without Risk or Escalation	$2,398	$2,398	$2,398	$2,398	$2,398	$2,398	$2,398	$2,398	$2,398
Base Costs + Budget Uncertainty	Base Costs Budget Uncertainty Effect	$1,971	$2,106	$2,210	$2,297	$2,376	$2,452	$2,534	$2,631	$2,758
Base Costs + Budget Uncertainty + Escalation (Base Schedule)	Escalation Effect to Base Schedule	$2,281	$2,438	$2,558	$2,660	$2,751	$2,840	$2,935	$3,048	$3,195
Base Costs + Budget Uncertainty + Escalation (Risk Adjusted Schedule)	Escalation Effect due to Schedule Event Risks	$2,309	$2,471	$2,595	$2,699	$2,789	$2,877	$2,977	$3,087	$3,240
Base Costs + Budget Uncertainty + Escalation (Risk Adjusted Schedule) + Event Risks	Cost Impact due to Cost Event Risks	$2,532	$2,690	$2,811	$2,918	$3,016	$3,109	$3,205	$3,322	$3,479
Base Costs + Budget Uncertainty + Escalation (Risk Adjusted Schedule) + Event Risks + Additional Support Costs	Cost Impact due to Additional Support Costs due to Extended Overhead Costs	$2,604	$2,763	$2,883	$2,992	$3,088	$3,184	$3,283	$3,400	$3,554

LPA Scenario Costs by Build-Up Category and Probability of NOT Exceeding (Millions $'s)

Cost Curve Build-Up Category	Effect	10%	20%	30%	40%	50%	60%	70%	80%	90%
Base Cost Estimate	Project Base Cost without Risk or Escalation	$2,585	$2,585	$2,585	$2,585	$2,585	$2,585	$2,585	$2,585	$2,585
Base Costs + Budget Uncertainty	Base Costs Budget Uncertainty Effect	$2,119	$2,265	$2,378	$2,472	$2,557	$2,640	$2,728	$2,833	$2,969
Base Costs + Budget Uncertainty + Escalation (Base Schedule)	Escalation Effect to Base Schedule	$2,453	$2,623	$2,754	$2,864	$2,963	$3,059	$3,162	$3,283	$3,442
Base Costs + Budget Uncertainty + Escalation (Risk Adjusted Schedule)	Escalation Effect due to Schedule Event Risks	$2,483	$2,657	$2,792	$2,905	$3,003	$3,099	$3,206	$3,324	$3,489
Base Costs + Budget Uncertainty + Escalation (Risk Adjusted Schedule) + Event Risks	Cost Impact due to Cost Event Risks	$2,708	$2,877	$3,008	$3,128	$3,228	$3,330	$3,434	$3,558	$3,723
Base Costs + Budget Uncertainty + Escalation (Risk Adjusted Schedule) + Event Risks + Additional Support Costs	Cost Impact due to Additional Support Costs due to Extended Overhead Costs	$2,775	$2,943	$3,072	$3,190	$3,295	$3,400	$3,503	$3,626	$3,793

APPENDIX E: Glossary

A comprehensive glossary of terms can be found at:

http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/

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