

Washington State Department of Transportation

A Policy for Cost Risk Assessment

GENERAL INFORMATION

Cost Risk Assessment is an integral element of project risk management at WSDOT. Cost Risk Assessment quantifies, within a reasonable range, the cost and schedule necessary to complete a project. This information is used by program level decision-makers to program projects and by project managers to monitor projects as they are being developed. Predicting the completion cost and schedule for a project is a challenge in the delivery of any project. A degree of risk and uncertainty in cost estimating and scheduling is present in all projects. Early in a project's life, when little is known about the details of design and construction, the amount of uncertainty is relatively great. As a project advances toward construction, further engineering analysis and design takes place, increasing project knowledge and decreasing the amount of uncertainty inherent in many projects. WSDOT has developed the Cost Estimate Validation Process (CEVP[®]) and Cost Risk Assessment (CRA) to identify, assess and evaluate risk that could impact cost and/or schedule during project delivery.

POLICY STATEMENT

A Cost Risk Assessment (CRA) is required for all projects with an estimated cost of \$25 million or more. A Cost Estimate Validation Process (CEVP[®]) is required for any project with an estimated cost of \$100 million or more. Other projects that can benefit from Cost Risk Assessment will be identified for CRA or CEVP[®]. Other types of projects may benefit from formal risk assessments; typically they have a preliminary estimate exceeding \$5 million or more and include one or more of the following factors:

- Projects that are unique or unusual
- Projects with a high degree of political interest
- Projects that have been through an abbreviated scoping process
- Projects with alternative solutions that vary the scope and cost
- New alignment or bypass sections
- Capacity improvements that widen an existing highway
- Major structures
- Interchanges on multilane facilities
- Projects with extensive or expensive environmental or geotechnical requirements
- Materials that are difficult to acquire or require special efforts
- Major reconstruction or difficult construction
- Projects requiring major traffic control
- Projects with multiple stages
- Major right-of-way and/or utility issues

These factors are important because the levels of risk, variability and opportunity associated with each are generally higher than with routine or typical projects.

PURPOSE

To meet our agency's goal of increasing the accuracy, consistency, confidence, success, and decreasing the uncertainty in delivering our projects within their estimated cost and schedule. CRA is used to identify, quantify and confirm the known and uncertain elements of a project, and to develop and communicate likely project costs and schedule ranges. An important element of CRA involves removing general conservatism and contingencies, and replacing those with identified and quantified risk events. The uncertainties from these risk events are incorporated in a deliberate and scientifically valid manner to account for uncertainty in project costs and schedules. As a result, CRA expresses cost and schedule estimates as a range of values instead of the traditional single point value. CRA also provides:

- Validation/evaluation of probable cost and schedule early in the development and decision process of a project, in order to identify a reasonable target cost and schedule;
- Identified and prioritized cost and schedule risk events associated with the project;

Better communication is a result of the CRA. This process provides an open and honest evaluation of risks associated with projects and the potential consequences to cost and schedule. Identifying sources of change or potential change, CRA provides critical information to feed risk management efforts.

REFERENCES

Joint Legislative Audit and Review Committee (JLARC) preliminary report, conclusions and recommendations of 17-Dec-2004.

A Guide to the Project Management Body of Knowledge (PMBOK), Third Edition, 2004.
Project Risk Management Handbook, June 26, 2003, CalTrans.

Cost Estimating Validation Process (CEVP) Evaluation Report, WSDOT, July 2002.

Reilly, McBride, Sangrey, MacDonald and Brown, 2004. "The Development of a New Cost-Risk Estimating Process for Transportation Infrastructure Projects." Civil Engineering Practice; Vol. 19, Number 1. Spring/Summer.

Term	Definition (Glossary of terms for cost estimating and risk assessment)
Allowance	Additional resources included in an estimate to cover the cost of known but undefined requirements for an activity or work item. Allowances are included in the Base Cost.
Base Cost	The Base Cost represents the cost, which can most reasonably be expected if no significant problems occur, with typically small uncertainty or variance. The Base Cost Estimate = sum of Base Costs excluding contingencies and risk events.
Contingency	A markup applied to account for substantial uncertainties in quantities, unit costs and the possibility of currently unforeseen risk events related to quantities, work elements or other project requirements.
CEVP[®]	Cost Estimate <u>Validation</u> Process, an intense workshop in which a team of top engineers and risk managers from local and/or national private firms and public agencies examine a transportation project and review project details with WSDOT engineers. Many of the participants have first-hand experience in large project programming and delivery. CEVP performs a project cost and schedule validation, and develops updated cost and schedule ranges using probabilistic risk assessment.
CRA	Cost Risk Assessment (CRA) is a term used to describe a broad program of risk-based assessment being conducted within Washington State Department of Transportation. CRA is also a term that describes a workshop process similar but less intense than a CEVP[®] .
CRA/CEVP Team	The Project Team, working together as an integrated unit with the Cost and Risk Teams during the CRA/CEVP workshop
Cost Team	CRA/CEVP Team members plus Project Team members who focus on Base Costs.
Cost Validation	A detailed examination of the Project Team Estimate for the project under consideration to assess validity, reasonableness, consistency and accuracy of these costs. Development of a project Base Cost is a product of the validation process. Cost Validation is a key component to a CEVP workshop, - full validation does not take place in a typical CRA.
Estimate	Quantitative assessment of the likely amount or outcome. Usually applied to project costs, resources, effort, and durations and is usually preceded by a modifier (i.e. preliminary, conceptual, order-of-magnitude, scoping, design, or PS&E). An estimate should include some indication of accuracy (e.g., ± percent). PMBOK
Project Team	The Team representing the particular project under consideration.
Project Team Estimate	The cost estimate for the project presented by the project team, consisting of Base Costs, Allowances and Contingencies. Allowances and Contingencies should be documented
Risk	An uncertain event or condition that, if it occurs, has a positive or negative impact on a project. PMBOK
Risk Assessment	A systematic evaluation of possible Risk Events in order to quantify project uncertainty.
Risk Management	The process of identifying, analyzing, developing responses to risk and monitoring and controlling the project.
Risk Team	CRA/CEVP Team members plus Project Team members who focus on Risk for the particular project under consideration.
Subject Matter Experts (SME)	People who are qualified in their fields to make reasonable subjective assessments on project costs and schedules without bias; subject matter experts provide relevant technical, management, and political insight to the project and critically examine the project estimate to validate cost and quantity components. Subject matter experts use their real-world construction, risk analysis and cost estimating knowledge to identify and quantify uncertainties. Subject matter experts must not have personal agendas and must be willing to work as part of a team. Subject matter experts can be internal or external and can be local or national.

PROCEDURE

CRA uses a probabilistic-based assessment of the estimated cost and schedule to complete a project. The CRA approach uses a peer-level review or “due diligence” analysis of the scope, schedule and cost estimate for a project to estimate uncertainty. The process is conducted in a workshop where the input from project team participants and independent internal and external Subject Matter Experts (SMEs) is obtained. The process focuses on the project team for both input of primary information and applying workshop results to more effectively manage their projects.

CRA Elements

CRA is based on the definition and analysis of two fundamental components: the Base component and a complementary Risk component. For estimates of cost, the following definitions illustrate the differences between these two fundamental parts:

1. *Base Cost* – The most probable cost for a unit or element of the planned project that can be expected if no significant problems occur. The base cost does not include conservatism or contingency.
2. *Risk Events* – Potentially favorable (opportunities) or unfavorable (threats) events that affect the project resulting in impacts to cost and/or schedule, but do not include the uncertainties inherent in the Base. Significant correlation among risk events and their consequences should also be included.

CEVP[®] and CRA Methodology

Either method generally follows the seven-step process outlined below:

1. Project and Method Selection

Once a project has been selected for a CRA, the project team determines the magnitude and scale of the effort. The selection of CEVP[®] or CRA will depend on several factors including level of knowledge and complexity about the project as well as the intended use of workshop results.

2. Structuring the Project Team Effort

CRA primarily focuses on cost and schedule. The process requires that the project team prepare plans, exhibits, and project documents to describe the scope, character and timeframe of the project. Conventional project cost estimates include the base costs plus allowances and contingencies. The initial step is for the team members to evaluate the project team estimates with the following objectives:

- a. Understand the project scope and major strategy assumptions for the CRA evaluation. If multiple project scenarios or alternatives are to be evaluated, the scope and assumptions for each scenario must be clearly defined.
- b. The project team provides a detailed description of the current project plan and

schedule, as well as any major issues and concerns. From this information, the CRA team develops a “project flow chart” that represents the sequence of major activities to be performed in the project. Major decision points (e.g. funding decisions) and project milestones, as described by the project team, are explicitly represented in the flow chart. Base costs and durations for each activity will be entered on the flow chart. Values are confirmed or defined by the CRA cost team, in cooperation with the project team.

3. Define and Evaluate the Base

The initial project team estimates usually include allowances and/or contingencies, without regard to specific risk events. The CRA process requires separating the project team estimate into a base component and other components that represent risk and other uncertainties. The base estimate is defined as the project estimate if the project were ‘to go as planned’, without contingencies or allowances.

A team’s conservatism, related to cost and schedule, is typically incorporated in estimates one of two ways. It can be included explicitly or it can be embedded. Typically explicit contingency is represented in cost estimates through the use of a line item multiplier that inflates the overall total estimate by some determined percentage. In schedule estimates the overall schedule float is an example of explicit contingency. In a cost estimate, embedded contingencies and conservatism result when project unit quantities or costs are inflated above the expected value. The same is true for schedule estimates when working days are increased above the expected value.

Through the involvement of the project team and the use of Subject Matter Experts (SMEs), the accuracy of the base cost estimate is confirmed; contingency removed, and significant uncertainties (in place of the removed contingency) are individually identified for assessment.

The level of this evaluation can range from a comprehensive examination of the cost estimate, (i.e. validation provided by CEVP[®]), to a simple review of the base cost component, (i.e. assessment through a typical CRA). Various types of cost estimates such as parametrically or unit-cost-based can be accommodated by quantifying uncertainty and bias with appropriate uncertainty factors.

When the base schedule and cost have been defined, these values are distributed among the project activities as described in the project flow chart.

4. Assess Uncertainty and Risk

Assess uncertainty in the “base” cost and schedule. Risk is assessed by identifying and characterizing a comprehensive group of non-overlapping significant risk issues. A risk event is described in terms of its likelihood of occurrence and potential consequences if it does occur. A risk event, if realized, may cause positive or negative impacts to cost, schedule, or other project performance measures. A Positive risk event presents an opportunity and a negative risk event poses a threat, often a risk event has the potential to be positive or negative. Relationships among events can also be

addressed through correlation, if appropriate.

Risk events can be classified as technical (i.e. geotechnical, structural, or environmental design considerations), non-technical (i.e. right of way costs, regulatory concerns, or market conditions), or political (i.e. funding, legal challenges, or scope changes). Example risk events include the potential for additional requirements to meet environmental regulations, adverse geotechnical conditions in constructing high retaining walls, or the discovery of unexpected utilities.

Experts from the project team and other independent experts, including the SMEs, who have a valued perspective on the risk/opportunity issues, develop the list of risks (the risk register) in a workshop setting. Uncertainty and correlations in the base costs and durations can also be assessed when they are significant, and these are defined consistently with the risk and opportunity events.

The likelihood and consequences of occurrence for each risk/opportunity event are assessed during the workshop. These assessments are made with the workshop leader and the risk elicitor facilitating the development of a collective opinion from among the project team and independent SMEs.

5. *Quantifying Uncertainty in the Project Cost and Schedule*

The next step in the CRA process is to develop and implement a probabilistic model for quantifying uncertainty in project performance measures. Current and year of expenditure cost forecasts are provided as outcomes in the model.

6. *Documentation and Applications*

After the probabilistic analysis is complete, the results are then interpreted, documented and reported to the project team. Standard results include total project cost and schedule distributions both in terms of current dollars and year of expenditure dollars. The resultant distributions or ranges have specific probability characteristics and are reported as percentage values.

These results can be produced for individual project phases or specific milestones. Cash flow curves are often helpful results for projects that extend over numerous biennium or that have time variable cash flow requirements.

Typical applications of CRA results:	
<ul style="list-style-type: none">• Cost Estimate Ranges• Project Assessment and Management• Risk Management• Value Engineering	<ul style="list-style-type: none">• Integrated Project/Program Mgmt.• Design/Build and Other Applications• Communications• Financial Management

- Cost Estimate Ranges – An Estimate is not a number: The ultimate cost and time to complete a project is subject to many variables that cannot all be known beforehand. A cost estimate represents only one possible outcome of multiple variables. These variables are not all directly controllable or absolutely quantifiable. Therefore cost estimating and the cost validation process must consider probabilities in assessing cost, using a recognized, logical and tested process.

- Project Assessment and Management – When experts carefully scrutinize a project the result is an assessment of the project that serves as useful information during project delivery.
- Risk Management – The results of a cost risk assessment fold right into the project risk management plan.
- Value Engineering - Risks identified in a CRA can also serve as input for a value engineering study. For many of these applications it is appropriate to conduct a reassessment of the project risks from time to time to update project understanding and estimates.
- Integrated Project/Program Management – With the results of project cost risk assessments comes opportunities for management to review the overall program of projects with an idea of the risks associated with the projects in the program and decide whether or not program level adjustments are desired.
- Design/Build and Other Applications - The identification of potential risks associated with the project used to assign responsibility for each risk area to either WSDOT or the design-builder. Preparation of the Risk Allocation Matrix can draw useful information from the Cost Risk Assessment results.
- Communications – Communicating project cost estimates and schedules along with the uncertainty involved with these estimates provides a more accurate picture. Those to whom we communicate will better understand the risks involved and uncertainty associated with project cost and schedule.
- Financial Management – A clearer understanding of a project's risks and the associated uncertainty with the estimated cost and schedule can provide useful information to decision-makers who have to decide how and when to fund a project.

7. Implementation and Performance Measurement

Identified risks are prioritized and responses are developed. A Risk Management Plan identifies how assessed cost and schedule risk is going to be managed. Prioritizing risks, determining the owner(s) of each risk, identifying potential mitigation measures, and establishing a monitoring plan accomplish this management. Cost of the risk response should be lower than the cost associated with the risk effect.

Comparing project costs from the risk assessment with realized costs is part of the overall project delivery and management effort. These tracking activities portray levels of success in reducing cost or schedule through risk management, and ultimately tracking accuracy of the CRA by comparing CRA results with final costs of WSDOT projects.

Timing Cost Risk Assessments and Cost Estimate Validation Process (CEVP[®]) Workshops

CRA/ CEVP[®] can be beneficial almost anytime during project development and can be used as an iterative project and program management tool. CRA at a planning level will produce data different from one conducted just before PS&E. An early CRA will typically produce information about risks that could impact the project as it develops, and will have a large cost range representing the high degree of uncertainty typical for an early cost estimate. It will also result in developing a risk management philosophy and plan or response strategy for delivery of the project. If a CRA approach is determined appropriate for a project in the planning level, the process shall be conducted before releasing any official departmental cost or schedule estimates.

A CRA just prior to PS&E serves to validate costs as project elements are better defined. Since many of the risks have been managed at this point the resulting cost range distribution is tighter. A Mega-project CEVP[®] is typically updated annually and CRAs are typically updated when design changes or other significant project changes warrant updated cost risk assessment for the project.

CRA Scalability

The level of cost risk evaluation can range from a comprehensive examination of the cost estimate, validation provided by the CEVP[®] level of evaluation, to a simple review of the base cost component, provided by a scaled back level of evaluation. The level of detail used in the cost evaluation will influence the ultimate outcome of a specific CRA.

The process is scalable. However, a comprehensive definition of the project scope, as well as an established project schedule and budget, are required elements for a risk assessment.

WORKSHOP SCHEDULING

The procedure for scheduling a CRA workshop:

- STEP 1:** The region CRA coordinator will work with region leadership to identify candidate projects and studies for CRA
- STEP 2:** The region CRA coordinator will present the projects identified in Step 1 to regional management to prioritize the projects and studies into a regional CRA work plan.
- STEP 3:** The Headquarters Cost Risk and Estimating Management (CREM) Office will review the regional CRA work plans. The content and schedule of the regional plans will then be aggregated into a statewide plan. Revisions will be coordinated with the Regions as necessary, in order to finalize the plan for incorporation into a Statewide CRA work plan.

This process will be completed on an annual cycle. For emergent needs, this same process can be used on a project-by-project basis.

Headquarters Cost Risk and Estimating Management (CREM) Office

The Cost Risk Estimating and Management office can provide assistance with all risk management activities: risk management planning, qualitative or quantitative risk assessments, developing a Risk Response Plan, and risk monitoring and control strategy development. In addition CREM is responsible for the following:

- Provides expertise to project offices in the application of risk-based estimating;
- Maintains state-of-the-art knowledge in cost risk assessment;
- Helps project managers develop information that allows better control of project schedules and budgets when change occurs;
- Teams with project offices, consultants, and internal & external subject matter experts toward the goal of higher reliability in project budget and schedule estimates.
- Provides cost estimating and risk management planning support;
- Ensure statewide consistency in application of CRA processes;
- Statewide reporting of CRA activities including number of projects, typical risks identified and avoided, etc.;
- Communication with Executives, Regional CRA Coordinators, Legislature, and national colleagues, and
- Workshop leadership and administrative support.

Regional CRA Coordinator

Each region shall have a designated CRA coordinator who will:

- identify projects for CRA/ CEVP[®] workshops and when they are needed based on their prioritized regional CRA needs;
- review workshop requests and submit to the HQ CREM office;
- communicate with region support offices, Project Development, Construction, and HQ CREM office;

-
- coordinate and follow-up with project team to insure participants are prepared when they arrive at the prep sessions and workshops;
- report risk management strategies and progress to Headquarters CREM Office;
- provide input on future direction of cost risk assessment and project risk management;
-

A general Comparison of a few characteristics for CRA and CEVP®

WORKSHOP TYPE ☞ CHARACTERISTIC ¶	Cost Risk Assessment (CRA)	Cost Estimate Validation Process (CEVP®)
Workshop length (typical)	1 – 2 days	4 – 5 days (or longer)
Subject Matter Experts	Typically internal and local	Can include internal/local and must include external/national experts for independent “validation” of cost estimates.
Timing (when to hold workshop)	Anytime. Typically updated when design changes or other changes to the project warrant an updated CRA.	Best to start early in the process, mega-projects are typically updated annually.
General	An assessment of risks with an evaluation and update of costs.	An intense workshop that provides an external validation of costs and assesses risks. Typically utilizing external subject matter experts.
		<i>CEVP® - is a registered trademark of WSDOT.</i>

COMMUNICATING WORKSHOP RESULTS

Results from the Cost Risk Assessment (CRA) or Cost Estimate Validation Process (CEVP[®]) workshop are provided in a draft report which is reviewed by the project team. The CRA/CEVP[®] team, will generate the final report based on feedback from the draft review. In addition a “1-pager” summary will accompany the report. The report is considered a “working document” and as such is not subject to public disclosure. The “1-pager” is provided as a convenient communication tool and can be used as a communication tool and it may serve a role in the public information activities of your project. Project teams should make use of their region communication offices when discussing projects and when using the “1-pager” CRA/CEVP[®] results.

CRA/CEVP[®] is not a magic bullet that removes uncertainty from projects. As stated at the beginning of this policy document, Cost Risk Assessment is an integral element of project risk management at WSDOT. Cost Risk Assessment quantifies, *within a reasonable range*, the cost and schedule necessary to complete a project. This information is used by program level decision-makers to program projects and by project managers to monitor projects as they are being developed. Predicting the completion cost and schedule for a project is a challenge in the delivery of any project. WSDOT has developed the Cost Estimate Validation Process (CEVP[®]) and Cost Risk Assessment (CRA) to identify, assess and evaluate risk that could impact cost and/or schedule during project delivery.

