

# **Guide for Project Risk Management and Risk-Based Estimating**

May 2026

This guide serves to enhance the safety, reliability, and cost-effectiveness of transportation projects. It reflects contributions from internal experts, industry partners, and academic professionals, all dedicated to advancing risk management practices in the transportation sector.

Development Division  
Engineering Analysis

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## The Need for Risk Management

The future is uncertain, yet project teams must confront fundamental questions: *How much is it going to cost, how long is it going to take? And Why?* The answers to these questions influence project expectations and affect reputations depending on outcomes. Quite often, early planning leans toward a single number that conveys a false sense of precision, and problems arise if people fixate on the early number. WSDOT's solution is to assess the uncertainty and express costs and schedules as **ranges**.

Many disciplines use some kind of risk assessment, some of which are shown in this table:

| Type of Risk Management                                                                                              | Sample Objectives                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <i>Project Risk Management:</i> Any uncertainty that, if it occurs, would affect one or more project objectives.     | Time, cost, performance, quality, scope, client satisfaction.                                                      |
| <i>Business Risk Management:</i> Any uncertainty that, if it occurs, would affect one or more business objectives.   | Profitability, market share, competitiveness, Internal Rate of Return (IRR), reputation, repeat work, share price. |
| <i>Safety Risk Management:</i> Any uncertainty that, if it occurs, would affect one or more safety objectives.       | Low accident rate, minimal lost days, reduced insurance premiums, regulatory compliance.                           |
| <i>Technical Risk Management:</i> Any uncertainty that, if it occurs, would affect one or more technical objectives. | Performance, functionality, reliability, maintainability.                                                          |
| <i>Security Risk Management:</i> Any uncertainty that, if it occurs, would affect one or more security objectives.   | Information security, physical security, asset security, personnel security.                                       |

*Credit: David Hillson, Effective Opportunity Management for Projects*

The complexity of a project determines the depth of risk management, and although simple projects may rely on qualitative analysis, increasingly complex projects benefit from quantitative methods—such as Monte Carlo simulation—that generate probabilistic ranges.

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*What gets us in trouble is not what we don't know. It's what we know for sure that just ain't so.*

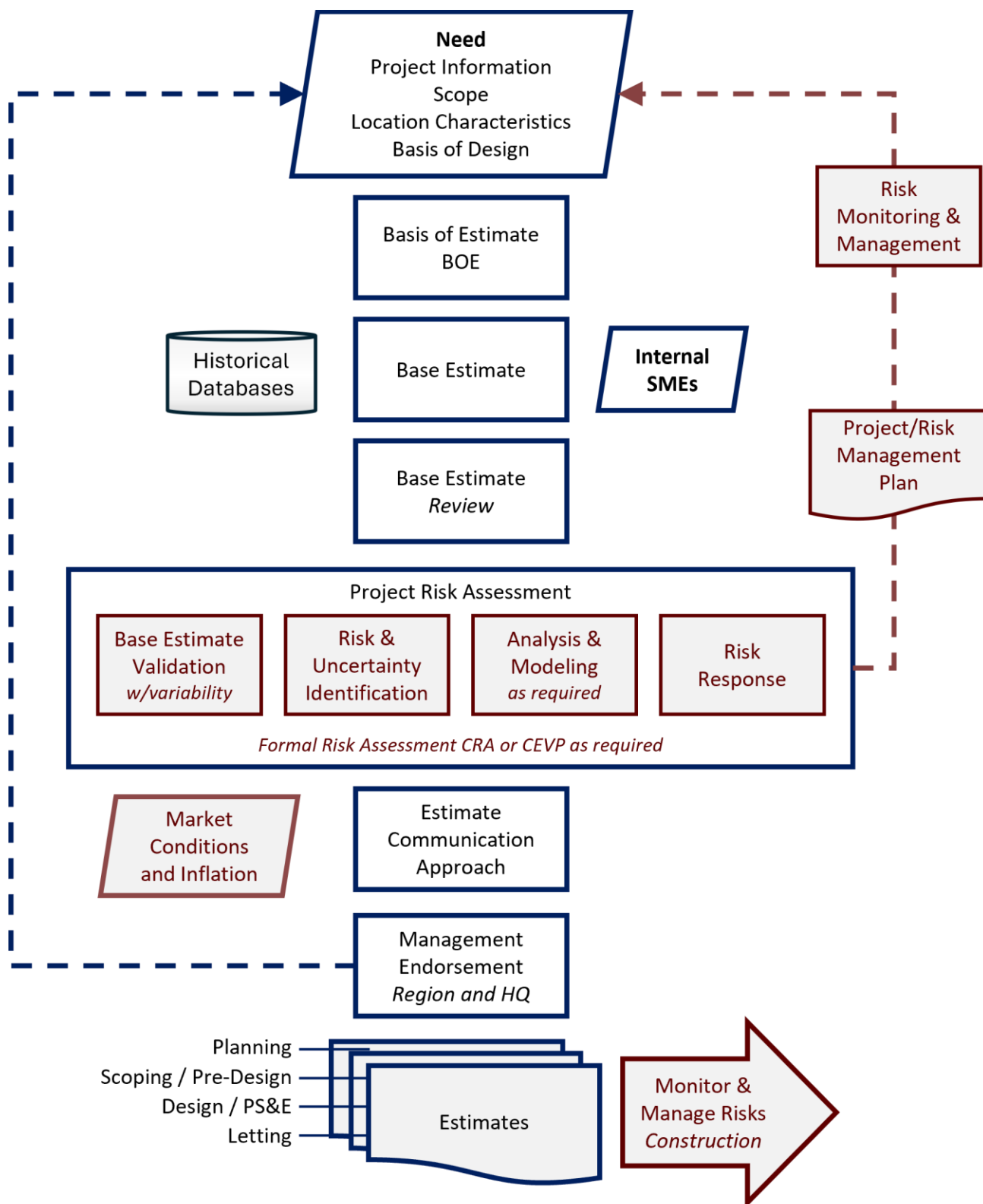
*– Mark Twain*

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## Guidance in this Document

This document promotes a proactive approach to risk and offers guidance for Project Managers, teams, and staff involved in **Project Risk Management** (PRM) and **Risk-Based Estimating** (RBE). PRM and RBE are part of the broader activities of Project Management, Quality Management, and Cost and Scheduling Management (see the [Cost Estimating Manual](#)).

The process map below illustrates WSDOT's cost estimating process, which is applied throughout all phases of project development—from initial planning through scoping, pre-design, design, and finally Plans, Specifications, and Estimates (PS&E).



Source: NCHRP 574

## Project Risk Management

PRM rests on two core pillars: **risk identification** and **risk response**. The first pillar, identification, is the disciplined process of uncovering uncertainties that could affect project outcomes. The second pillar, response, defines how the team plans to address those uncertainties through practical, agreed actions. Together, these pillars create a clear line of sight from recognizing risk to doing something about it.

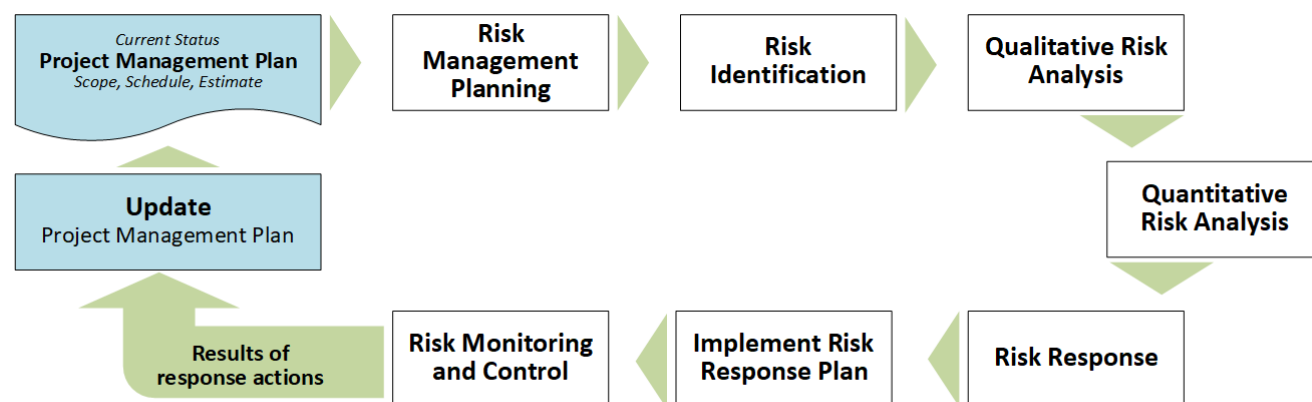
PRM is planned deliberately, with its activities integrated into the project schedule and resource plan from the outset. The process then moves through identifying, analyzing, responding to, and monitoring risks. It strengthens decision-making across scope, quality, schedule, and cost, and it scales to project size and complexity by adjusting participation, facilitation methods, and the depth of analysis.



WSDOT now mandates PRM and has been a pioneer in advancing quantitative risk analysis across our industry.

Since WSDOT has demonstrated the importance of PRM, many agencies have since followed suit by adopting policies that treat PRM as standard practice. In addition, FHWA requires its use for projects that meet certain funding thresholds.

The PRM process looks like this:



### Project Risk Management Process

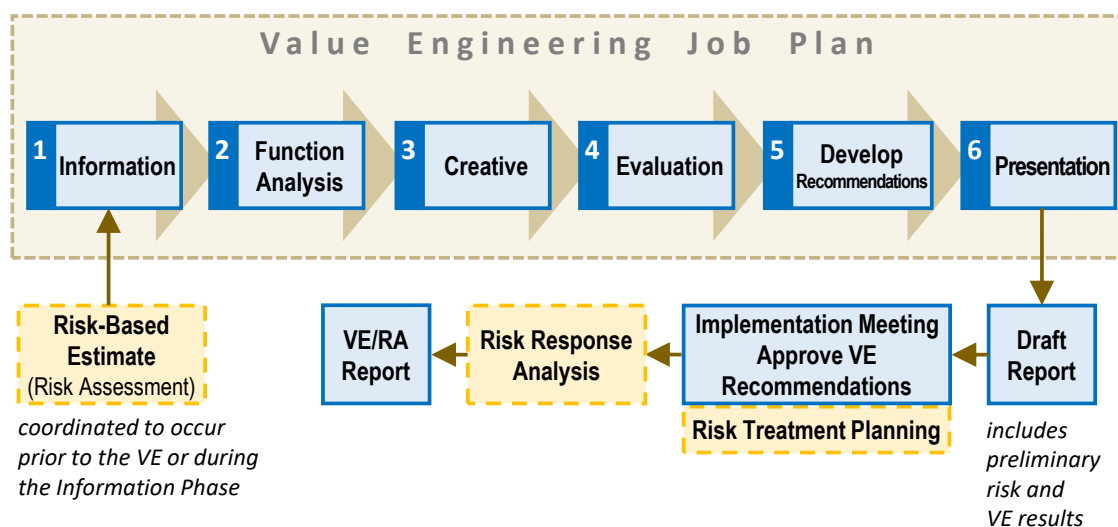
PRM exists in many disciplines. The following table presents various project management knowledge areas and their connections to risk management. Understanding these relationships enhances decision-making and problem-solving.

| Project Management Knowledge Area | As affected by Risk Management                                                                                                                      |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Integration Management         | Threats and opportunities can affect all areas of project management; promoting risk awareness at project outset is crucial.                        |
| 2. Scope Management               | Recognizing risks in scope definition is essential. Proactively assessing risks, helps ensure realistic expectations, and enhances decision-making. |
| 3. Schedule Management            | Proactive risk management can help establish more realistic timelines, adaptability, and improve stakeholder confidence.                            |
| 4. Cost Management                | Major cost risks can drain resources and stall progress. Proactive management improves the odds of project success.                                 |
| 5. Quality Management             | The consequences of a significant, foreseeable risk without having identified and planned for it is antithetical to Quality Management.             |
| 6. Resource Management            | Proactive risk planning helps produce resource optimization, and contingency planning to enhance stability, efficiency, and resilience.             |
| 7. Communications Management      | Integrating robust communication into risk management, organizations enhance decision-making, build trust, and improve project performance.         |
| 8. Risk Management                | Effective Project Risk Management is a proactive approach to navigating uncertainty, ensuring resilience, and maintaining project integrity.        |
| 9. Procurement Management         | Proper procurement planning sources essential tools, materials, and services, minimizing disruptions for efficient project execution.               |
| 10. Stakeholder Management        | Stakeholders expect proactive risk management. Effective risk planning strengthens resilience, protecting operations and credibility.               |

*Credit: Knowledge Area List: Project Management Institute*

As a natural complement to PRM, industry and public agencies also integrate Value Engineering (VE) (See Chapter 310 in the [Design Manual](#)).

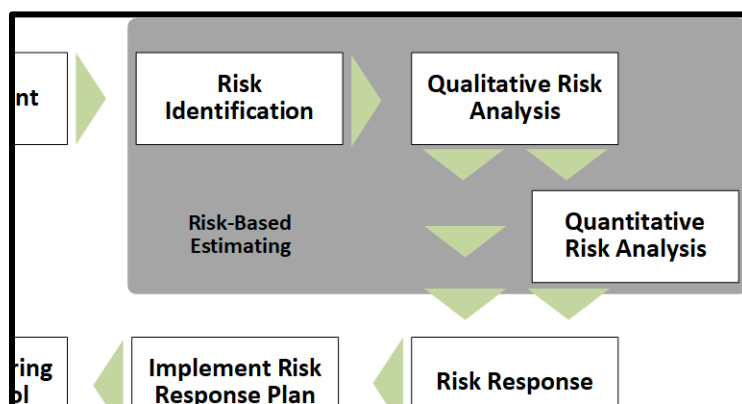
VE enhances projects by balancing function, performance, and value. By coordinating VE with RBE, teams generate actionable information to mitigate threats and seize opportunities. The process map below highlights the conventional VE job plan, which is strengthened by RBE insights.



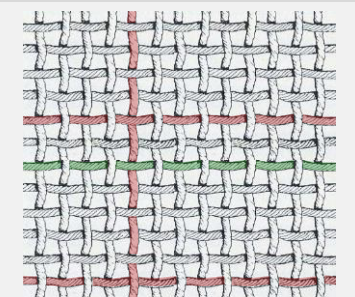
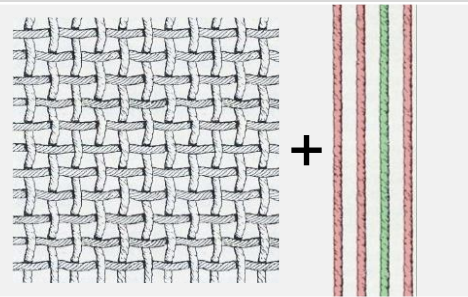
## Risk-Based Estimating

RBE is not just an estimating technique—it is a core mechanism of PRM. It is a structured approach to cost and schedule estimation that explicitly incorporates uncertainties and risks into the estimating process. Rather than relying solely on deterministic values, PRBE uses probabilistic methods to forecast project outcomes, ensuring that contingencies are based on identified risks rather than arbitrary percentages.

RBE is applied during three steps in the PRM Process.



Generally, estimates are comprised of two components: the base cost, representing the expected expense if things proceed as planned, and risk and uncertainty, which accounts for potential disruptions. Uncertainties are often casually accounted for in an estimate by subjective adjustments in the quantity and/or cost of items. You could imagine it as fabric woven from two kinds of threads. The **base estimate** forms the strong, reliable weave that represents known scope and expected costs. The **colored threads** symbolize risks and uncertainties, but the real value comes when these threads are set aside into a **risk register**. By separating the base from the risks, PRBE provides clarity: the foundation remains visible, while each risk is explicitly defined and managed. This transparency allows project teams to focus their efforts where they matter most, on actively managing project risk.

| Traditional Estimate                                                                | RBE — Base Estimate + Risk                                                           |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  |  |
| Risk and uncertainty are woven into the fabric of the total cost.                   | Risk and uncertainty are accounted for separately and individually.                  |

## **Benefits of PRM and RBE**

So, to wrap it up, PRM and RBE improve collaboration, transparency, and efficiency by providing:

- **Stronger Communication** – Enhances teamwork, stakeholder conversations, networking, and mutual understanding of project issues.
- **Objective Expert Reviews** – Imparts transparency on risks and uncertainties and minimizes bias.
- **Knowledge Sharing** – Supports professional development, mentoring, and lessons learned, during cost risk assessments.
- **Improved Project Execution** – Enhances constructability, quality, and value engineering through risk meetings.
- **Early Issue Identification** – Discusses coordination, utilities, access, and other potential conflicts early, preventing costly late-stage corrections.
- **Safety Enhancement** – Reduces work zone exposure and mitigates hazards from unexpected delays.
- **Confidence in Decision Making** – Strengthens credibility, reduces uncertainty, and positively enhances an organization's reputation.
- **Sustainable Resource Use** – Optimizes resources, minimizes waste and environmental impact, and ensures efficient project delivery.
- **Accountability** – Assigns responsibility, or ownership, for individual risks which avoids confusion and encourages effective risk management.
- **Opportunities** – Encourages identification and optimal benefit from opportunities. This positive challenge also stirs innovative thinking—the creating of opportunity/value.



Risk Management Planning sets the foundation for identifying, assessing, and mitigating risks throughout a project's lifecycle. It defines a structured approach to Risk Management and Risk-Based Estimating (RBE), ensuring teams proactively address uncertainties before they escalate into major challenges. To help ensure effective risk management, project engineers and their teams should establish project risk management activities early, and while the following bulleted items are common, tasks and activities should be customized for a project's specific needs:

- Develop, refine, and regularly update project estimates and schedules.
- Conduct project risk assessments and updates.
- Coordinate VE with risk management.

The PRM process begins at the project kickoff meeting. The kickoff agenda should set risk management expectations, outline key risk considerations, and establish milestones for regular updates on project cost, schedule estimates, and risk management progress. After project kickoff, risk management planning continues as a collaborative effort, thriving on teamwork and shared accountability. Each meeting should include participants like:

- Project Manager/Engineer
- Selected project team members
- Key stakeholders
- Risk management leads
- Subject matter experts
- Skilled facilitators

The creation of the RMP requires participants to understand risk tolerance and exercise expert judgment. Consult professionals with expertise in risk policies, project-specific management, and industry factors to tailor risk strategies effectively.

## 1-1 Risk Management Plan

The Risk Management Plan (RMP) is an essential document that explains how risks will be identified, analyzed, prioritized, and addressed. It details the strategy, methods, reporting, and tracking needed to manage risks effectively throughout the project. The RMP is created as the team examines the Project File, Design Documentation Package, [Master Deliverables List](#), and [Deliverables Expectations Matrix](#). See Design Manual Section 300.03(3).

### Risk Management Plan Outputs

- Risk Strategy – Defines the overall approach to managing risks.
- Methodology – Details the tools, processes, and data sources used.
- Roles and Responsibilities – Assigns team members to specific risk management tasks.
- Funding – Estimates financial resources required for risk activities, including contingency planning.
- Timing – Establishes schedules for risk-related activities, aligned to project milestones.
- Risk Categories – Groups risks systematically, often structured into a Risk Breakdown Structure (RBS) (See [Exhibit 2-2](#)).
- Stakeholder Risk Appetite – Identifies the level of risk stakeholders are willing to accept, guiding response priorities.
- Risk Probability and Impact Definitions – Tailored to project-specific risk levels, impact may be expressed as direct effects or percentages of total project cost and duration. Opportunities are evaluated similarly, as time and cost savings.
- Reporting Format – Defines the structure and content of risk management outputs, including the risk register, risk report, and other relevant documentation. Standardizing reports ensures consistency and clarity for stakeholders.
- Tracking – Outlines how risk management activities are documented, monitored, and audited throughout the project lifecycle. A systematic tracking approach maintains accountability and allows for continuous improvement in risk mitigation strategies.

## 1-2 Common Terminology

The terminology of PRM has evolved over time and continues to advance. [Exhibit 1-1](#) describes relationships among commonly encountered terms.

**Exhibit 1-1 Common Risk Related Terms**

| Likelihood            | Impact              | Severity                  | Characteristic        | Assessment               | Response             |
|-----------------------|---------------------|---------------------------|-----------------------|--------------------------|----------------------|
| Remote possibility    | Negligible impact   | Minimal concern           | Known risk            | Risk register            | Avoidance            |
| Rare                  | Minor impact        | Manageable threat         | Unknown risk          | Risk matrix              | Mitigation           |
| Unlikely              | Moderate impact     | Moderate challenge        | Emerging risk         | Risk evaluation          | Acceptance           |
| Low probability       | Significant impact  | High-risk exposure        | Escalating risk       | Threat analysis          | Transfer             |
| Occasional occurrence | Disruptive effects  | Critical hazard           | Residual risk         | Vulnerability assessment | Contingency planning |
| Possible              | Financial strain    | Extreme vulnerability     | Controllable risk     | Impact assessment        | Proactive management |
| Likely                | Operational delays  | Immediate action required | Project-specific risk | Risk scoring             | Reactive management  |
| Frequent occurrence   | Safety concerns     | Long-term implications    | Uncontrollable risk   | Risk thresholds          | Risk prioritization  |
| High probability      | Reputational damage |                           | Organizational risk   | Threat assessment        | Risk monitoring      |
| Highly likely         | Severe impact       |                           | Systemic risk         |                          | Early intervention   |
|                       | Catastrophic        |                           |                       |                          |                      |

### 1-2.1 Qualitative and Quantitative Terms

Project risk assessment and analysis fall into two categories: qualitative and quantitative. Qualitative risk assessment relies on subjective evaluations rather than concrete data, allowing project teams to identify and prioritize critical threats or opportunities to promote effective resource allocation.

Quantitative values can be assigned to qualitative descriptions, though definitions may vary by industry and context. [Exhibit 1-2](#) presents example percentages commonly associated with qualitative terms, offering a structured way to assess and communicate risk likelihood. Similarly, [Exhibit 1-3](#) illustrates an approximate value association between qualitative terms and quantitative impact levels for a \$100M project.

**Exhibit 1-2 EXAMPLE percentages for qualitative terms of Likelihood**

| Likelihood term       | Associated likelihood % |
|-----------------------|-------------------------|
| Remote possibility    | less than 1%            |
| Rare                  | 1% to 5%                |
| Unlikely              | 5% to 15%               |
| Low probability       | 15% to 30%              |
| Occasional occurrence | 30% to 50%              |
| Possible              | 50% to 65%              |
| Likely                | 65% to 80%              |
| Frequent occurrence   | 80% to 90%              |
| High probability      | 90% to 95%              |
| Highly likely         | 95% to 99%              |

**Exhibit 1-3 EXAMPLE Cost Impacts for \$100M project**

| Impact term         | Approximate Cost Impact Range \$ |                  |
|---------------------|----------------------------------|------------------|
| Negligible impact   | <\$100K                          | (less than 0.1%) |
| Minor impact        | \$500K                           | (0.1% to 0.5%)   |
| Moderate impact     | \$2M                             | (0.5% to 2%)     |
| Significant impact  | \$5M                             | (2% to 5%)       |
| Disruptive effects  | \$10M                            | (5% to 10%)      |
| Financial strain    | \$15M                            | (10% to 15%)     |
| Operational delays  | \$20M                            | (15% to 20%)     |
| Safety concerns     | \$30M                            | (20% to 30%)     |
| Reputational damage | \$40M                            | (30% to 40%)     |
| Severe impact       | \$60M                            | (40% to 60%)     |
| Catastrophic        | >\$60M                           | (more than 60%)  |

Exhibit 1-4 offers an expanded description on the Risk Nature terms.

Exhibit 1-4 Descriptions for Risk Phrases

| Risk Nature Descriptions |                                                     |
|--------------------------|-----------------------------------------------------|
| 1. Known risk            | Identified and understood from the outset           |
| 2. Unknown risk          | Not yet discovered or anticipated                   |
| 3. Emerging risk         | Developing over time as new challenges arise        |
| 4. Escalating risk       | Growing in severity or complexity                   |
| 5. Residual risk         | Remaining after mitigation efforts                  |
| 6. Controllable risk     | Can be managed or influenced                        |
| 7. Uncontrollable risk   | Outside direct control, requiring adaptation        |
| 8. Project-specific risk | Unique to an individual project                     |
| 9. Organizational risk   | Affecting broader business operations               |
| 10. Systemic risk        | Large-scale risks impacting industries or economies |

Note: This arrangement moves from awareness (known vs. unknown risks) to development (emerging/escalating), then to persistence (residual risks), followed by control (manageable vs. uncontrollable risks), and finally, by scale (specific project-level risks up to systemic industry-wide risks).

1-3 A Balanced Approach to Project Risk Management

Exhibit 1-5 illustrates a balanced approach to PRM. It considers risk tolerance and the investment of resources required for effective risk management. A properly structured risk management approach is comprehensive and scalable, ensuring adaptability to the size, complexity, and specific needs of each project.

Exhibit 1-5 Balanced Risk Management

- Processes match organization’s risk tolerance
- Proactive management of project risks
- optimize allocation of resources

Risk-seeking

- Paying little attention to risk
- Not allocating resources for risk
- Surprise at bad news

Risk-averse

- Over-allocation of resources on risk
- Money spent on low-priority risks
- Tedious processes



To further support scalability, [Exhibit 1-6](#) outlines the appropriate risk management process based on project size, categorizing approaches according to financial thresholds. This framework promotes proportional, efficient strategies tailored to project demands.

### Exhibit 1-6 Risk Management Process

| Estimated Construction Cost             | Risk Management Process                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         | Project Managers may adopt a higher-level process when appropriate. Projects may benefit from coordinating value engineering study and risk-based estimating.                                                                                                                                                                                                                                                           |
| <b>Qualitative, QL Risk Assessment</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>\$10M or less</b>                    | <b>Qualitative Risk Assessment</b><br>Project teams may use the <a href="#">Qualitative Spreadsheet</a> or their own format as preferred. No matter the format, the following information must be included: risk name, risk description, risk trigger, classification (threat or opportunity), impact, and probability.                                                                                                 |
| <b>Quantitative, QT Risk Assessment</b> |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>\$10 M to \$25 M</b>                 | <b>Risk-Based Estimating Meeting</b><br>The project team convenes to identify and assess project risks, potentially including other participants. The analysis can be performed using WSDOT's Project Risk Analysis Model (PRAM). Support is available from the HQ Design Office.                                                                                                                                       |
| <b>\$25 M to \$100M</b>                 | <b>Cost Risk Assessment (CRA)</b><br>The project team and subject matter experts collaboratively assess cost and schedule estimates, identifying risks in a structured review. These inputs feed into a Monte Carlo Analysis model that integrates cost and schedule risk. For high-risk items, independent cost estimation and input from industry experts is <b>recommended</b> .                                     |
| <b>\$100M or more</b>                   | <b>Cost Estimate Validation Process (CEVP®)</b><br>The project team and independent subject matter experts collaboratively review and validate cost and schedule estimates, identifying risks in a structured review. These inputs feed into a Monte Carlo Analysis model that integrates cost and schedule risk. For high-risk items, independent cost estimation and input from industry experts is <b>required</b> . |

## 1-4 How to plan for Project Risk Management

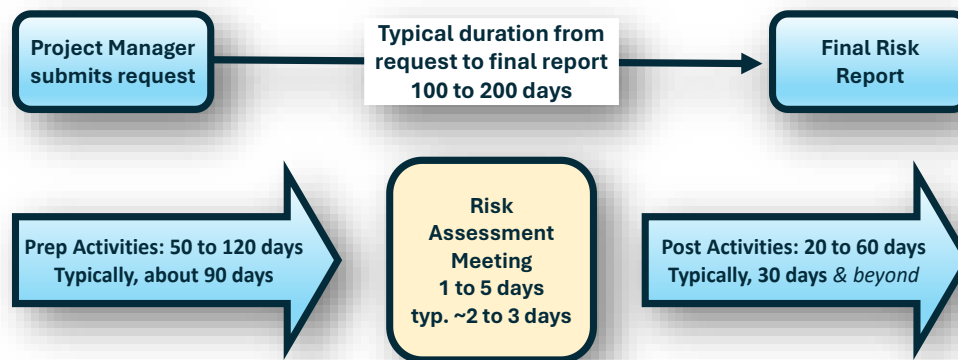
Do you plan to manage risk for your project? Yes, you do. The Project Risk Management Plan must be part of your Project Management Plan, PMP.

1. Determine the risk management process for your project.
2. Incorporate risk management activities into the project schedule.
3. Make risk management an agenda item for regularly scheduled project meetings.
4. Regularly communicate risk management and its importance to the project team.
5. Establish an expectation that risk is to be managed, documented, and reported.

## 1-5 Tips for Risk Management Planning

- Define major project elements; scope, schedule, estimate for meaningful risk assessment.
- Start early, as the design is developed, gather risk information to ensure readiness for risk assessments.
- Allocate prep time for cost and schedule reviews and Quality Assurance ([Exhibit 1-7](#) and [Exhibit 1-8](#)).
- Budget for risk activities. Include time and resources for risk assessment, throughout the project lifecycle.
- Update risk assessments at key milestones (30, 60, 90) and after major changes.
- Understand organizational risk tolerance and determine acceptable risk levels to guide decision-making.
- Leverage Value Engineering by coordinating risk assessment and value engineering.

**Exhibit 1-7 Typical Durations**



**Exhibit 1-8 Typical Durations**

| Typical Prep Activities may include                                                                                                                                                                                                                                                                                                                                            | Typical Post Activities may include                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Discuss required risk process and approach</li> <li>• Schedule activities</li> <li>• Process task orders &amp; contracts</li> <li>• Prepare Project Materials for Presentation</li> <li>• Prep Meeting/confirm &amp; invite attendees</li> <li>• Determine duration of risk assessment</li> <li>• Advance risk elicitation</li> </ul> | <ul style="list-style-type: none"> <li>• Perform action items</li> <li>• Prepare Monte Carlo models</li> <li>• Prepare reports</li> <li>• Act to implement response actions</li> <li>• Discuss and Present results</li> <li>• Review and process consultant invoices</li> <li>• Schedule the next risk assessment</li> </ul>  |
| Frequent causes of delaying the start                                                                                                                                                                                                                                                                                                                                          | Frequent causes of delaying the finish                                                                                                                                                                                                                                                                                        |
| <ul style="list-style-type: none"> <li>• Poorly defined project scope</li> <li>• Poorly prepared cost estimates</li> <li>• Poorly prepared schedule estimates</li> <li>• No current project management plan</li> </ul>                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Delays in decision-making</li> <li>• Unresolved issues at end of risk meeting</li> <li>• Requested information is not provided</li> <li>• Changes after the risk meeting is over</li> </ul>                                                                                          |
| Note: If the project team cannot provide a clear problem statement, schedule, and cost estimate aligned to the project's development stage, the risk assessment should be deferred until these details are available.                                                                                                                                                          | Note: Once the risk assessment meeting concludes, allow the process to finalize, the model to be developed, and the report delivered. The project team should then assess results, respond accordingly, and update the Project Management Plan. Avoid unnecessary hypothetical scenarios that do not support decision-making. |

## 1-6 Build Risk Management into the Project Schedule

Successful projects build risk management into their plans right from the start. Risk management activities should be included in the overall project management plan and schedule—not as an afterthought, but as a core part of how the project is organized.

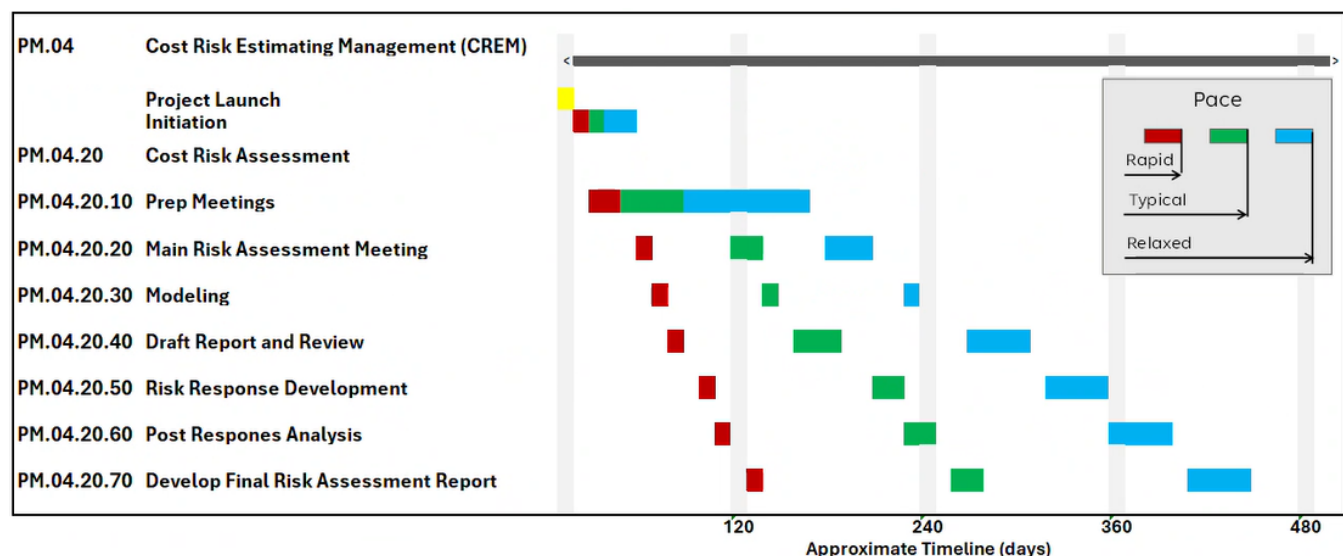
To be most effective, these activities must be coordinated with other essential processes such as cost estimating, scheduling, value engineering, and quality management. This coordination is critical because risk identification and assessment depend on a solid foundation: a well-developed, vetted cost estimate and schedule estimate. Without reliable baseline estimates, risk assessments may be incomplete or misleading, and mitigation strategies may not be properly aligned with project realities.

Equally important is the ongoing integration of risk management with project schedule updates. As estimates evolve and schedules are refined, risk management activities must be revisited to ensure that identified risks remain valid, new risks are captured, and mitigation plans are adjusted accordingly. Depending on the size and complexity of the project, as well as the duration of design and development phases, these considerations may need to be repeated multiple times. Regularly updating the risk assessment ensures that the project team stays aligned with changing conditions and maintains a realistic view of potential challenges.

**Exhibit 1-9** provides general guidance on typical duration ranges for risk management tasks. Project teams are encouraged to use this guidance as a baseline, then adjust the schedule and task durations to reflect the specific needs, size, and complexity of their project.

By embedding risk management into the project schedule early on—and ensuring it is properly resourced and coordinated with cost and schedule estimates—teams create a proactive framework that anticipates challenges, strengthens decision-making, and improves overall project outcomes.

### Exhibit 1-9 Considerations for Planning your Project Risk Management Effort



## 1-7 Growth of Knowledge in Project Development

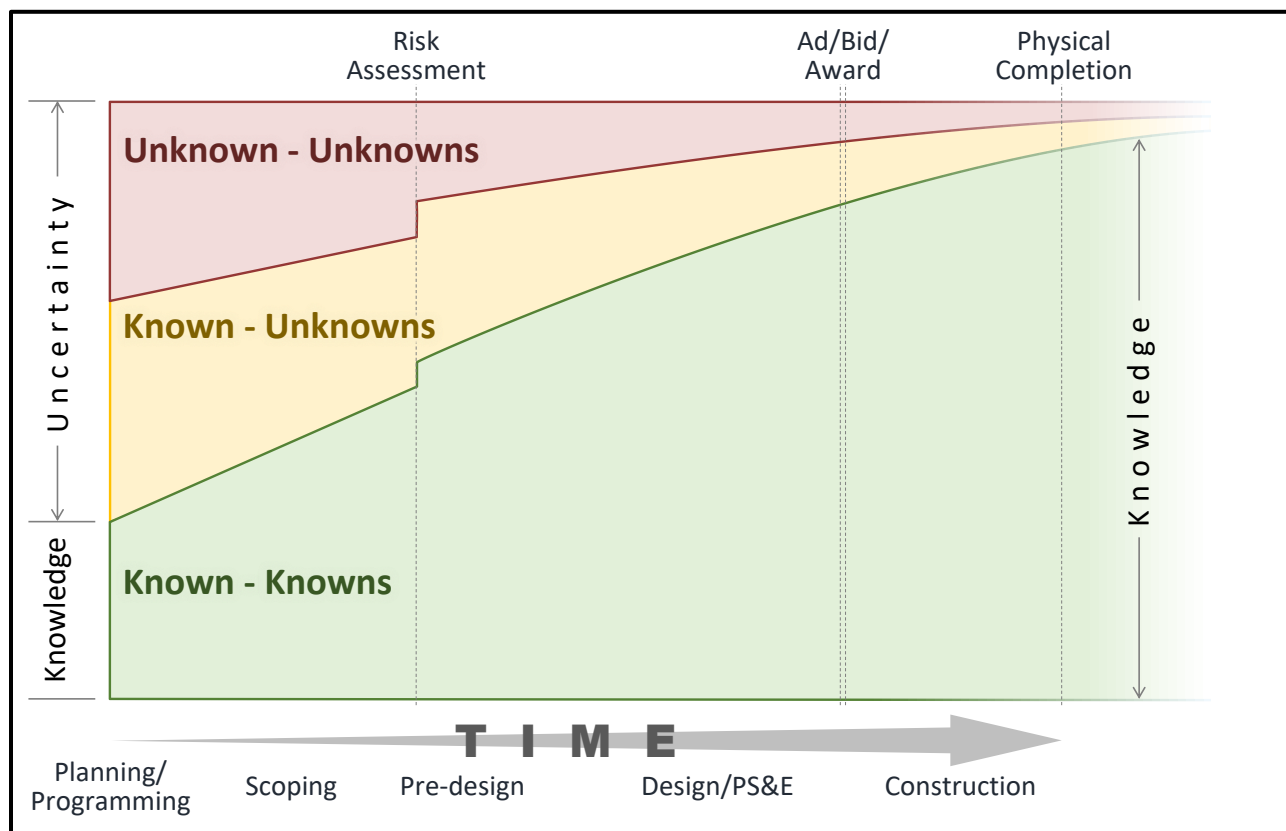
Every project begins with uncertainty. Early design stages are marked by limited knowledge and many unknowns. As the project advances through planning, scoping, pre-design, and design and PS&E, clarity grows. By the time a project is advertised, most uncertainty has been resolved, though some unpredictability always remains.

The path from concept to construction demands deliberate effort. Teams develop reliable cost estimates, complete environmental reviews, and secure permits. They perform value analyses, refine pavement designs, and coordinate utilities and railroad requirements. Access management and right-of-way needs are defined, and community engagement ensures the project reflects shared priorities. Each design decision is documented, creating a clear foundation for the work ahead.

Multiple disciplines converge to shape the project. Roadway geometrics, pavement markings, hydraulics, stormwater systems, and erosion control are refined. Surveyors chart the terrain, uncovering details and potential risks for design engineers. Engineers then shape structures and adapt systems for illumination, signaling, and transportation. Geotechnical studies guide foundations and pavement, while safety and traffic analyses shape operations. Plans ensure traffic flow during construction, establish signing requirements, and integrate maintenance for lasting functionality. Even aesthetics are considered, with roadside restoration and landscaping woven into the final vision.

All of this culminates in the Plans, Specifications, and Estimate package—the PS&E. It represents the transformation of uncertainty into readiness, design into construction, and vision into reality.

**Exhibit 1-10 Knowledge Growth vs Time**





### 2-1 Risk Identification During Project Development

Risk identification begins with recognizing uncertain events that could affect scope, schedule, or cost, then documenting them in the risk register with estimates of probability and impact. As projects progress, risk exposure shifts, new risks emerge, and existing ones evolve, requiring teams to update the register to reflect these changes and explain why they occurred. The register guides decisions by capturing, analyzing, and tracking risks over time. Structured reviews at major milestones, and during significant project changes, ensure that teams proactively update the register to refine response strategies and maintain a complete picture of both major and minor risks. At what point does a risk become a major risk? If you're familiar with Pareto's law, or the 80/20 rule, the idea is that a small share of causes produce the largest share of results. In other words, there are a small number of dominant factors that have the greatest impacts on a project. The project team will decide the threshold value for what constitutes a major risk, which could be a dollar amount or a percentage. For example, impacts below \$200,000 or under two weeks may be classified as minor and placed on a lookout list. This ensures the project team's focus remains on major risks that could significantly impact project outcomes.

### 2-2 Risk Identification: Inputs, Tools and Techniques, Outputs

#### 2-2.1 Inputs

The project team, incorporating input from cost risk and subject matter experts, identifies potential risks that affect project objectives. There are several major inputs for risk identification, including:

- Project scope and design documents
- Stakeholder inputs and public feedback
- Historical data and organizational knowledge

#### 2-2.2 Tools and Techniques

1. **Expert Judgment** – Bias affects judgments, including expert assessment, and must be considered and addressed to maximize objectivity.

2. **Documentation Reviews** – Peer reviews, checklists, and quality reviews can help identify risks. They are most effective as a preliminary step before brainstorming.
3. **Information Gathering for Risk Identification**
  - **Risk Elicitation** – The process of systematically identifying and documenting potential risks with input from teams, stakeholders, and experts. It may range from informal discussions to formal risk meetings on specific concerns (e.g., geotechnical issues). Skilled facilitation and pre-assessment interviews help surface risks early. In some cases, advance sessions with subject matter experts before the risk assessment meeting can provide deeper insight into project risks.
  - **Examination of Other Projects** – Lessons from similar projects can highlight potential issues and prevent repeated mistakes, though risks must be judged in context.
  - **Risk Breakdown Structure (RBS)** – A framework that categorizes risks by phase or specialty group. Adapted to each project, it provides standardized organization, consistent categories, trend identification, a foundation for elicitation, and support for surveys when workshops are not feasible. Note that decision-makers may have other, enterprise level considerations that are difficult to quantify, such as: trust, credibility, safety, and reputation of the organization.
4. **Other Techniques** – Surveys and interviews provide insights, site visits assess environmental and logistical challenges, and work breakdown structure reviews expose hidden vulnerabilities. *What-if* scenarios foster proactive thinking to anticipate and mitigate risks.
  - **Pre-Mortem** – Participants envision project failure and identify causes.
  - **Combined Approach** – Most projects require multiple methods.
  - **Project Data Review** – Techniques such as root cause analysis, function analysis, SWOT, and document analysis refine risk identification.
  - **Prompt Lists** – Like the RBS mentioned previously, structured lists help categorize and define risks using expert, stakeholder, or reference input.

### 2-2.3 Outputs

Risk identification data is typically recorded in a risk register. WSDOT uses a SMART form that collects the following information (see [Exhibit 2-1](#)):

- **Unique ID** – Assign a unique identifier for tracking, preferably using an established Risk Breakdown Structure (RBS) (see [Exhibit 2-2](#)).
- **Specialty Group** – Note the relevant specialty (Environmental, Utilities, etc.) to facilitate expert involvement. Risk ID prefixes can indicate this.
- **Date Identified** – Record when the risk was identified and the project phase (planning, scoping, design/PS&E, construction).
- **Risk Name** – Provide a concise, meaningful name (e.g., "NEPA Delay," "Reduction in Condemnation"). Refer to RBS naming conventions.
- **Risk Nature** – Specify whether the risk is a threat (negative impact) or opportunity (positive impact).
- **Description** – Clearly define the risk so stakeholders understand its implications. List relevant parties involved (agencies, businesses, interest groups).
- **Risk Trigger** – Document circumstances or warning signs preceding the risk (e.g., "NEPA Approval Date" for legal challenges, excavation for burial discoveries).

- **Impact Type** – Indicate whether the risk affects schedule, cost, or both.
- **Impact Phase** – Identify the phase impacted (Design, Right-of-Way, Construction for Design-Bid-Build; Owner Conceptual Design, Design/Build for Design-Build).
- **WBS Reference** – Link to affected activities for tracking.
- **Potential Responses** – Outline possible mitigation strategies (avoid, transfer, mitigate, accept for threats; exploit, share, enhance for opportunities).
- **Risk Owner** – Assign responsibility to a person or entity. For Design-Build, clarify whether risks fall to the owner, contractor, or both.
- **Risk Title** – a pithy label that captures the essence of the risk in just a few words.
- **Lookout List** – Maintain a separate collection for minor risks.
- **Other Notes** – Include thoughts on next steps, contacts, countermeasures, related risks, key dates, and observations. Consult relevant stakeholders, including local utility service providers, businesses, and agencies, to reveal risks that may not be readily apparent. Include risk discussions into community outreach.

**Comments**—risk management is essential to project management. Risk assessments are iterative, and the risk register evolves. It serves as a vital input to Risk Analysis. Further details and resources: [Project Management Guide](#).

## 2-3 Identifying Risk Events

1. **Define** – determine criteria for a “significant” project risk.
2. **Establish thresholds** – set a minimum cost value and time duration that qualify as significant to the project.
3. **Focus** – prioritize major risks that could impact project objectives.
4. **Document** – record and describe risks systematically in a risk register (see [Exhibit 2-3](#) and [Exhibit 2-4](#)).
5. **Assess** – characterize risks in terms of impact and probability.

Note: Low probability, High-impact risks should still be considered significant, despite having low probability<sup>1</sup>.

### 2-3.1 Risk Statements

A risk statement is a communication tool designed to convey identified risks clearly. A risk statement should be precise, complete, and free of jargon, ensuring accessibility to all stakeholders, regardless of their technical expertise. It should provide a straightforward description of the risk, potential triggers, likelihood, and impact, enabling informed decision-making and effective risk response.

**Differentiate Challenges from Risks** – not every issue qualifies as a risk event—some are merely challenges. Risks involve uncertain events or conditions that could impact project objectives. Challenges are known obstacles encountered in the project development and delivery that require proactive management.

**Prioritize** - Focusing on critical risks ensures resources target issues that could significantly impact outcomes. Overloading assessments with minor concerns can dilute attention and reduce effectiveness.

*"Due to definite cause(s), uncertain event or condition may occur, potentially leading to effects on objective(s)."*  
 ≈ **Risk Name**

<sup>1</sup> If an identified low-probability/high-impact risk was to occur, in retrospect, some might call it a “Black Swan” event, after Taleb (2007), but that more strictly applies to major-consequence, unpredictable, “unknown-unknown” category of events, like the Fukushima nuclear disaster. In our case, this would more properly, and more embarrassingly be called a “Grey Swan”; a “known-unknown” event, foreseen, but with underappreciated probability and/or impact. See Glossary.

### Example

“Due to the project's location in a high-value habitat area, additional time may be required to address Endangered Species Act (ESA) compliance and Incidental Harassment Authorizations (IHA), exceeding initial schedule assumptions. This could delay the advertisement date by up to six months.” ≈ **High Priority Habitat**

### Exhibit 2-1 Risk Identification Example (SMART)

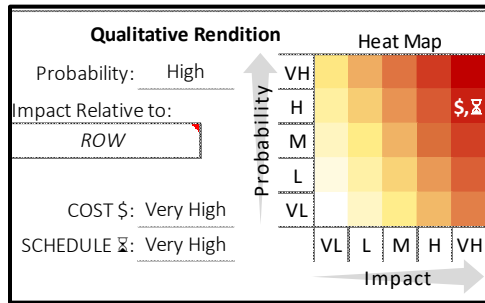
|                                                                                                                                                                                                                                                                   |                                   |                                                                                           |                              |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------------|------------------------------|-------|
| <b>Risk Form</b>                                                                                                                                                                                                                                                  |                                   | <b>SR 050/Marker Road RR-Xing; Construct Bridge - OVER</b>                                |                              | Date: |
| Risk ID: <b>ROW050.10</b> Category: <b>Right-of-Way</b> RBS Code: <b>ROW050.10</b> MDL Code:                                                                                                                                                                      |                                   |                                                                                           |                              |       |
| Risk Title: <b>R/W Impacts (condemnation)</b>                                                                                                                                                                                                                     |                                   |                                                                                           |                              |       |
| Status: <b>Active</b>                                                                                                                                                                                                                                             | Phase that it Impacts: <b>ROW</b> |                                                                                           | Critical Path? <b>Yes</b>    |       |
| Detailed Description of Risk Event: (SMART—Specific, Measurable, Attributable, Relevant, Timebound)<br><i>Significant impacts to properties on the west side of Railroad (UPRR). Northwest quadrant; property would be split in half by the Road realignment.</i> |                                   |                                                                                           |                              |       |
| Trigger: <b>condemn</b>                                                                                                                                                                                                                                           |                                   |                                                                                           |                              |       |
| <b>Pre-Response Quantitative Assessment</b>                                                                                                                                                                                                                       |                                   |                                                                                           | <b>Qualitative Rendition</b> |       |
| Nature: <b>Threat</b>                                                                                                                                                                                                                                             | Probability: <b>75%</b>           |                                                                                           |                              |       |
| COST \$ Millions (\$M)                                                                                                                                                                                                                                            | SCHEDULE months (mo)              |                                                                                           |                              |       |
| Minimum: <b>0.01 \$M</b>                                                                                                                                                                                                                                          | Minimum: <b>6.0 mo</b>            |                                                                                           |                              |       |
| Most Likely: <b>0.28 \$M</b>                                                                                                                                                                                                                                      | Most Likely: <b>12.0 mo</b>       |                                                                                           |                              |       |
| Maximum: <b>0.40 \$M</b>                                                                                                                                                                                                                                          | Maximum: <b>18.0 mo</b>           |                                                                                           |                              |       |
| Expected Value ↓<br><b>0.19 \$M</b>                                                                                                                                                                                                                               | Expected Value ↓<br><b>9.0 mo</b> | Impact Relative to: <b>ROW</b><br>COST \$: <b>Very High</b><br>SCHEDULE: <b>Very High</b> |                              |       |
| This Risk may occur independent of Prior Risks.                                                                                                                                                                                                                   |                                   | This Risk has <b>Correlation with the Prior?</b><br>Schedule Risk Link: <b>0</b>          |                              |       |

| Supplemental notes about this risk event                 |              |                                                                                          |  |                                                                                                             |               |                 |
|----------------------------------------------------------|--------------|------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------|---------------|-----------------|
| Risk trigger details<br>(include estimated life of risk) |              | Risk exposure during R/W phase.<br>(March 15, 2929 to March 15, 2930)                    |  | Trigger – negotiations to acquire property are unsuccessful and it is necessary to go through condemnation. |               |                 |
| Risk owner                                               |              | Mr. R. Ofway                                                                             |  |                                                                                                             |               |                 |
| Critical path (yes or no?)                               |              | Yes                                                                                      |  |                                                                                                             |               |                 |
| Possible response actions                                |              | Evaluate all possible alternatives to either avoid property or reduce the amount needed. |  |                                                                                                             |               |                 |
| Action by date                                           | May 15, 2929 | Status review dates                                                                      |  | June 15, 2929                                                                                               | July 15, 2929 | August 15, 2929 |

**Specific** - A detailed description of the Risk Event. What is the specific issue of concern?

|                                                                                                                                                                                                                                                                   |                                   |                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------|
| Risk Title: <b>R/W Impacts (condemnation)</b>                                                                                                                                                                                                                     |                                   |                           |
| Status: <b>Active</b>                                                                                                                                                                                                                                             | Phase that it Impacts: <b>ROW</b> | Critical Path? <b>Yes</b> |
| Detailed Description of Risk Event: (SMART—Specific, Measurable, Attributable, Relevant, Timebound)<br><i>Significant impacts to properties on the west side of Railroad (UPRR). Northwest quadrant; property would be split in half by the Road realignment.</i> |                                   |                           |

**Measurable** - Probability *and* consequence of Risk Event Occuring? (cost or schedule impact)



**Attributable** - What will trigger (cause) this risk? How do we know? Who owns this risk?

Trigger:

**Relevant** - Why is this risk important to our project? Will it impact project objectives? Is it critical?

Detailed Description of Risk Event: (SMART—Specific, Measurable, Attributable, Relevant, Timebound)

*Significant impacts to properties on the west side of Railroad (UPRR). Northwest quadrant ; property would be split in half by the Road realignment.*

**Timebound** - Risks have a "shelf life" – the project is not indefinitely exposed - when are we at risk?

| Supplemental notes about this risk event                 |              |                                                                                          |  |                                                                                                             |               |                 |
|----------------------------------------------------------|--------------|------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------|---------------|-----------------|
| Risk trigger details<br>(include estimated life of risk) |              | Risk exposure during R/W phase.<br>(March 15, 2929 to March 15, 2930)                    |  | Trigger – negotiations to acquire property are unsuccessful and it is necessary to go through condemnation. |               |                 |
| Risk owner                                               |              | Mr. R. Ofway                                                                             |  |                                                                                                             |               |                 |
| Critical path (yes or no?)                               |              | Yes                                                                                      |  |                                                                                                             |               |                 |
| Possible response actions                                |              | Evaluate all possible alternatives to either avoid property or reduce the amount needed. |  |                                                                                                             |               |                 |
| Action by date                                           | May 15, 2929 | Status review dates                                                                      |  | June 15, 2929                                                                                               | July 15, 2929 | August 15, 2929 |

Exhibit 2-2 Risk Breakdown Structure (RBS)

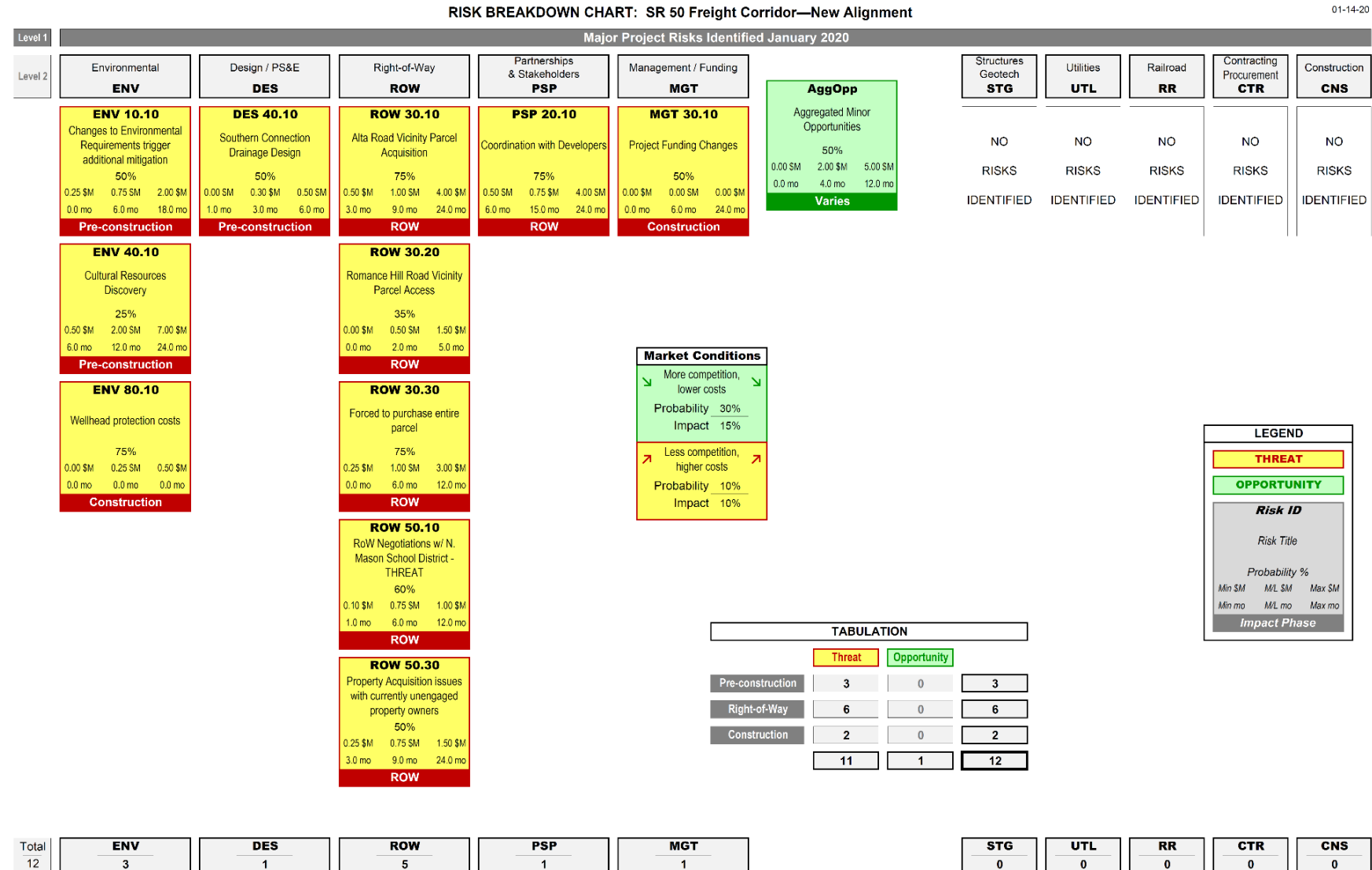
| RISK BREAKDOWN STRUCTURE |                                                                                                                        |                                                                                                        |                                                                                                                                 |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                                                                                          |                                                                                       |                                                                                                                                             |                                                                                       |                                                                                                                     |
|--------------------------|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Major Project Risks      |                                                                                                                        |                                                                                                        |                                                                                                                                 |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                                                                                          |                                                                                       |                                                                                                                                             |                                                                                       |                                                                                                                     |
| Level 1                  | Environmental<br><b>ENV</b>                                                                                            | Structures<br>& Geotechnical<br><b>STG</b>                                                             | Design / PS&E<br><b>DES</b>                                                                                                     | Right-of-Way<br>Acquisition & Access<br><b>ROW</b>                                                                          | Utilities<br><b>UTL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Railroad<br><b>RR</b>                                                                                                      | Partnerships<br>& Stakeholders<br><b>PSP</b>                                                                             | Management /<br>Funding<br><b>MGT</b>                                                 | Contracting<br>& Procurement<br><b>CTR</b>                                                                                                  | Construction<br><b>CNS</b>                                                            | Premiums<br><b>PRE</b>                                                                                              |
| Level 2                  | ENV 10<br>NEPA/SEPA<br>– documentation completion,<br>Section 446f, challenges                                         | STG 10<br>Structure Design Change<br>– bridge superstructure,<br>retaining walls                       | DES 10<br>Roadway Design Change<br>– vertical / horizontal<br>alignment, earthwork,<br>pavement                                 | ROW 10<br>Plan Development Issues<br>– easements: temporary<br>construction/subterranean,<br>FHWA approval                  | UTL 10<br>Plan Development Issues<br>– design coordination,<br>agreements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | RR 10<br>Plan Development Issues<br>– design coordination,<br>agreements, right-of-entry                                   | PSP 10<br>Tribal Issues                                                                                                  | MGT 10<br>Project Management Issues<br>– change in managers / other<br>key leadership | CTR 10<br>Project Delivery Method<br>– changes or issues                                                                                    | CNS 10<br>Traffic Control & Staging<br>– MOT / WZTC, multimodal<br>traffic management | PRE 10<br>Unidentified Risks<br>– unknown-unknowns,<br>aligned to level of<br>development                           |
|                          | ENV 20<br>ESA Issues<br>– consultation, Biologic<br>Assessments / Biological<br>Opinions, Fish Passage                 | STG 20<br>Geotechnical Design Change<br>– foundations, ground<br>improvements, unsuitable<br>materials | DES 20<br>Roadway Design Criteria<br>Change<br>– Design Manual, design<br>analysis approval, practical<br>design considerations | ROW 20<br>Project ROW Cost Change<br>– change in land use/zoning,<br>urbanization, market<br>conditions                     | UTL 20<br>Practical Issues<br>(in the field)<br>– relocation, conflicts,<br>discoveries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | RR 20<br>Construction Coordination<br>Issues<br>– flagging, work restrictions /<br>windows, right-of-entry<br>requirements | PSP 20<br>Public Involvement Issues                                                                                      | MGT 20<br>Delay<br>– indecision, submittal review                                     | CTR 20<br>Contract Language Issues<br>– contract packaging,<br>warranties, liquidated<br>damages, DBE,<br>insurance/bonding                 | CNS 20<br>Construction Permitting<br>– work restrictions                              | PRE 20<br>Location Premium<br>– urban & access under<br>traffic, remote rural location,<br>other                    |
|                          | ENV 30<br>Environmental Permitting<br>– delays, appeals,<br>unanticipated conditions                                   | STG 30<br>Structural Design Criteria<br>Change<br>– seismic, hydraulic,<br>geometric, building codes   | DES 30<br>Aesthetic Design Changes<br>– Architectural, CSS,<br>Landscaping                                                      | ROW 30<br>Limited Access Issues<br>– Access Revision Report<br>(ARR), access hearing,<br>permanent construction<br>easement |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | RR 30<br>Property Rights Issues<br>– challenges in acquiring from<br>RR, considerations for<br>delivery method (DB vs DBB) | PSP 30<br>Scope / Design Changes<br>– artwork, shared-use<br>pathways, arterial/intersection<br>improvements             | MGT 30<br>Funding<br>– availability, cash flow<br>restrictions                        | CTR 30<br>Contract Procurement<br>Process Issues<br>– addenda / extensions,<br>protests                                                     | CNS 30<br>Work Window Coordination<br>– weather, in/over-water                        | PRE 30<br>Labor<br>– labor disruption (i.e., strike)<br>by key trade during<br>construction                         |
|                          | ENV 40<br>Discoveries<br>– cultural resources (Section<br>106), historic property<br>impacts & mitigation              | STG 40<br>Geotechnical Design Criteria<br>Change<br>– soil stabilization, hydraulic,<br>codes          | DES 40<br>Hydraulic Design Changes<br>– flow control, water quality,<br>criteria changes                                        | ROW 40<br>Managed Access Issues<br>– appeal hearing                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            | PSP 40<br>Interagency Issues<br>(Sound Transit, USFS, cities,<br>counties, etc.)<br>– design coordination,<br>agreements | MGT 40<br>Political / Policy Changes                                                  | CTR 40<br>Market Conditions<br>– non-competitive bidding<br>environment, lack of qualified<br>bidders, bids exceed upset<br>price or budget | CNS 40<br>Schedule Uncertainty<br>(general)                                           | PRE 40<br>Supply Chain<br>– delays and cost increases<br>due to supply chain disruption                             |
|                          | ENV 50<br>Hazardous Materials<br>– soil/groundwater contami-<br>nation, building/structure<br>abatement, lead paint    |                                                                                                        | DES 50<br>Traffic Design Changes<br>– ITS, illumination, signals,<br>intersections                                              | ROW 50<br>Acquisition Issues<br>– appraisals, condemnation,<br>relocations, demolitions                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            | PSP 50<br>Multimodal Considerations<br>– design coordination,<br>agreements, bicycle,<br>pedestrians, transit            | MGT 50<br>State Workforce Limitations                                                 | CTR 50<br>Procurement Delays /<br>Premiums<br>– specialty materials /<br>equipment, “Buy America”                                           | CNS 50<br>Marine / Over-Water                                                         | PRE 50<br>Subcontractor<br>– cost due to added outreach,<br>training, lack of qualified<br>firms, busy local market |
|                          | ENV 60<br>Habitat Mitigation Issues<br>– wetlands / stream /<br>floodplain                                             |                                                                                                        | DES 60<br>WSDOT Initiated Changes<br>– maintenance request,<br>change to purpose and need                                       |                                                                                                                             | <p>Using the Risk Breakdown Structure (RBS)</p> <p>Each project is unique and has a specific project risk profile. Examples provided are an aid to identify risk types and are not to be considered complete or exclusive. Develop project risk registers by identifying and assessing risks for the project under review.</p> <p>The RBS provides several functions and benefits, including:</p> <ol style="list-style-type: none"> <li>1) Consistent risk organization, approach and taxonomy (wording).</li> <li>2) Common standard categories.</li> <li>3) Allows for identification of trends (risk event categories, types and characteristics).</li> <li>4) Offers a basis for initiating risk identification and elicitation.</li> <li>5) Eases the ability to conduct risk surveys for those unable to attend workshops</li> </ol> <p>For more information regarding the RBS, see the <a href="#">Project Risk Management Guide</a>.</p> <p>Note: decision-makers may have other enterprise level considerations that are difficult to quantify, such as: trust, credibility, safety, and reputation of the organization.</p> |                                                                                                                            |                                                                                                                          |                                                                                       |                                                                                                                                             |                                                                                       |                                                                                                                     |
|                          | ENV 70<br>Environmental Justice<br>(disadvantaged communities)<br>– traffic mgmt, access, temp<br>construction impacts |                                                                                                        | DES 70<br>Tolling Design Changes<br>– infrastructure requirements,<br>toll collection, back-office                              |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                                                                                          |                                                                                       |                                                                                                                                             |                                                                                       |                                                                                                                     |
|                          | ENV 80<br>Construction Impacts<br>– water quality, TESC                                                                |                                                                                                        | DES 80<br>External Initiated Changes<br>(contractor or other party)<br>– innovation, ATC                                        |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                                                                                          |                                                                                       |                                                                                                                                             |                                                                                       |                                                                                                                     |
|                          | ENV 90<br>Noise<br>(permanent mitigation)                                                                              |                                                                                                        | DES 90<br>ADA<br>– curb ramp modifications<br>require ROW, MEF approval                                                         |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                                                                                          |                                                                                       |                                                                                                                                             |                                                                                       |                                                                                                                     |
|                          | ENV 900<br>Other ENV Issues                                                                                            | STG 900<br>Other STG Issues                                                                            | DES 900<br>Other DES Issues                                                                                                     | ROW 900<br>Other ROW Issues                                                                                                 | UTL 900<br>Other UTL Issues                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | RR 900<br>Other RR Issues                                                                                                  | PSP 900<br>Other PSP Issues                                                                                              | MGT 900<br>Other MGT Issues                                                           | CTR 900<br>Other CTR Issues                                                                                                                 | CNS 900<br>Other CNS Issues<br>– change orders, disputes,<br>claims                   | PRE 900<br>Other PREM Issues                                                                                        |

Exhibit 2-3 Example Risk ID Sheet, Qualitative

| Project Name    |                  | Project Identification Number (PIN)                                                                                                                                                                                                                             |                                 | Date:                                                                                                                |                                                                                      |
|-----------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Project Manager |                  | Name of Risk Owner:                                                                                                                                                                                                                                             |                                 |                                                                                                                      |                                                                                      |
| Status          | Active Risk      | RISK EVENT NAME: <b>unknown utilities</b>                                                                                                                                                                                                                       | <b>QUALITATIVE ANALYSIS</b><br> |                                                                                                                      | RISK RESPONSE                                                                        |
| RBS Category    | UTL              | RISK TRIGGER: <b>discovery</b>                                                                                                                                                                                                                                  |                                 |                                                                                                                      | STRATEGY<br><b>avoid</b>                                                             |
| Risk Number     | 20               | THREAT                                                                                                                                                                                                                                                          |                                 |                                                                                                                      | ACTION<br><b>TO BE TAKEN</b>                                                         |
| Project Phase   | Design           | Areas outside of R/W have not been investigated for conflicts. Additional work is required for sewer/storm, water, gas, power, communications.                                                                                                                  |                                 |                                                                                                                      | subsurface utility investigations immediately; assign team member to this full time. |
| Date            | May 32, 2929     | Triggers include: utilities found late in design or during construction.                                                                                                                                                                                        |                                 |                                                                                                                      |                                                                                      |
| Risk Owner      | M. Example       |                                                                                                                                                                                                                                                                 |                                 |                                                                                                                      |                                                                                      |
|                 |                  | Very Lo to Lo    some    Hi to Very Hi<br>Impact →                                                                                                                                                                                                              |                                 | MONITOR and CONTROL<br>Date, Status and review comments<br>update at the next Quarterly Project Report (QPR) meeting |                                                                                      |
| Status          | Active Risk      | RISK EVENT NAME: <b>noise wall</b>                                                                                                                                                                                                                              | <b>QUALITATIVE ANALYSIS</b><br> |                                                                                                                      | RISK RESPONSE                                                                        |
| RBS Category    | ENV              | RISK TRIGGER: <b>analysis results</b>                                                                                                                                                                                                                           |                                 |                                                                                                                      | STRATEGY<br><b>avoid</b>                                                             |
| Risk Number     | 90               | THREAT                                                                                                                                                                                                                                                          |                                 |                                                                                                                      | ACTION<br><b>TO BE TAKEN</b>                                                         |
| Project Phase   | Design           | possibility that a noise wall will have to be added to the project - pending results of the type 1 analysis; this is a high impact high probability threat                                                                                                      |                                 |                                                                                                                      | press for noise analysis ASAP                                                        |
| Date            | May 32, 2929     |                                                                                                                                                                                                                                                                 |                                 |                                                                                                                      |                                                                                      |
| Risk Owner      | Green Jeans      |                                                                                                                                                                                                                                                                 |                                 |                                                                                                                      |                                                                                      |
|                 |                  | Very Lo to Lo    some    Hi to Very Hi<br>Impact →                                                                                                                                                                                                              |                                 | MONITOR and CONTROL<br>Date, Status and review comments<br>analysis due August 39th.                                 |                                                                                      |
| Status          | Item of Interest | RISK EVENT NAME: <b>cultural resources</b>                                                                                                                                                                                                                      | <b>QUALITATIVE ANALYSIS</b><br> |                                                                                                                      | RISK RESPONSE                                                                        |
| RBS Category    | ENV              | RISK TRIGGER: <b>discovery</b>                                                                                                                                                                                                                                  |                                 |                                                                                                                      | STRATEGY<br><b>accept</b>                                                            |
| Risk Number     | 40               | THREAT                                                                                                                                                                                                                                                          |                                 |                                                                                                                      | ACTION<br><b>TO BE TAKEN</b>                                                         |
| Project Phase   | Design           | discovery of artifact; triggered during design if field investigation results in discovery; also trigger if discovered during construction   deemed low probability - this area has been investigated previously and very little new ground is being disturbed. |                                 |                                                                                                                      | monitor                                                                              |
| Date            | May 33, 2929     |                                                                                                                                                                                                                                                                 |                                 |                                                                                                                      |                                                                                      |
| Risk Owner      | Green Jeans      |                                                                                                                                                                                                                                                                 |                                 |                                                                                                                      |                                                                                      |
|                 |                  | Very Lo to Lo    some    Hi to Very Hi<br>Impact →                                                                                                                                                                                                              |                                 | MONITOR and CONTROL<br>Date, Status and review comments<br>supplemental field investigation report due November 31.  |                                                                                      |

## Exhibit 2-4 Example Project Risk Chart (project risk exposure)

01-14-20

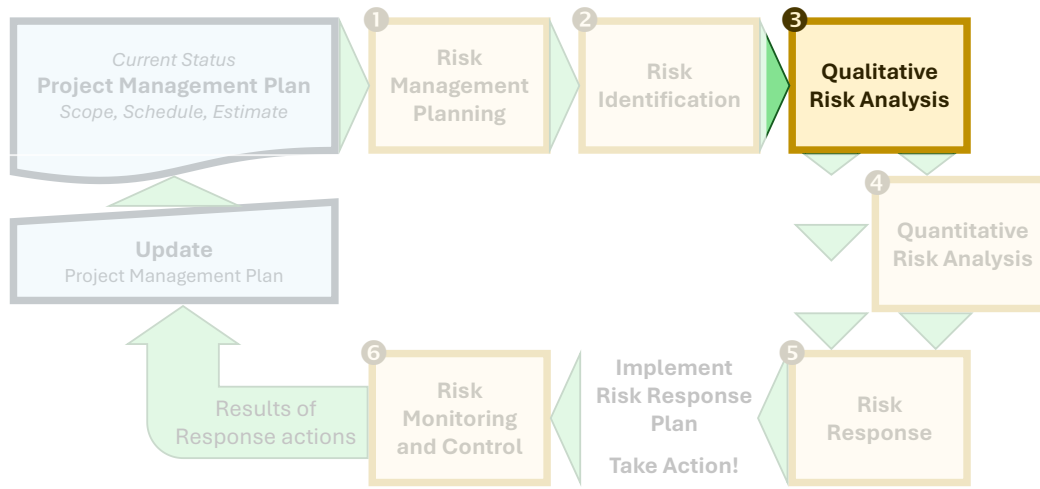


## 2-4 After Risk Identification

Following risk identification, update any affected documents to reflect newly recognized risks and insights. These may include:

- Basis of Estimate (BOE) – Review and adjust estimates and schedules as needed, ensuring changes are properly documented for reconciliation.
- Base Cost Estimate – Incorporate any necessary revisions based on identified risks.
- Risk register – Add, remove, or change the information recorded for each risk.
- Other Design Documents – Modify relevant plans to align with updated risk considerations.

Risk identification sets the stage for risk assessment/analysis. The next two chapters explore the two primary approaches: qualitative and quantitative risk assessment/analysis.



### 3-1 Qualitative Risk Assessment

A qualitative risk assessment focuses on identifying risks (see [Chapter 2](#)) and describing their relative significance by estimating likelihood and impact in broad terms—such as low, medium, or high—and documenting these judgments in the risk register. This provides an early, structured view of the project’s risk landscape without relying on data, models, or numerical inputs. A qualitative risk analysis then examines each risk’s characteristics, drivers, triggers, and interactions to clarify why it matters and how it could affect project objectives. The qualitative process creates a narrative, judgment-based foundation that supports informed decision-making and prepares the team for later quantitative analysis, or, for smaller projects, may be sufficient on their own.

Qualitative risk analysis is often used for:

- Initial screening of project risks.
- Quick assessments, if time or resources are limited.
- Small or simple projects that do not need detailed quantitative analysis.
- Identifying and assigning risk ownership.
- Establishing a foundation for Quantitative Risk Analysis, if needed.

Because uncertainty is inherently subjective, teams are encouraged to engage subject matter experts or functional units for specialized risk evaluations; however, it is important to remember that risk assessments are shaped by individual perceptions, attitudes, and biases. Diverse participants beyond the core team may offer valuable insights that enhance accuracy and effectiveness, reducing misjudgments that could distort priorities.

These key terms describe the ways risk evaluators interpret information and form judgments during the assessment process.

- **Decision**  
A conclusion or choice reached after considering options and evidence.  
Example: “We made a decision to use a higher unit price based on recent market volatility.”  
Synonyms: conclusion, determination, judgment

- **Discernment**  
The ability to recognize subtle factors, interpret incomplete information, and form sound evaluations.  
Example: “Her discernment helped identify a permitting risk that wasn’t obvious from the documents.”  
Synonyms: insight, perception, acumen, sagacity
- **Guess**  
A conclusion formed with little or no evidence; a conjecture.  
Example: “Without geotechnical data, estimating settlement impacts would be nothing more than a guess.”  
Synonyms: assume, speculate, suppose
- **Judgment**  
A reasoned evaluation formed by comparing evidence, experience, and expert insight.  
Example: “Based on professional judgment, we set the risk range wider to reflect uncertainty in the design.”  
Synonyms: assessment, evaluation, opinion

### 3-1.1 Qualitative Risk Analysis Process Inputs

- Project Management Plan (PMP)
- Project Documents
- Risk Management Plan (RMP)
- Risk Register
- Enterprise Environmental Factors
- Organizational Process Assets
- Industry or Organizational Risk Information

### 3-1.2 Qualitative Risk Analysis Tools and Techniques

#### Gather Project Information and Subject Matter Expert (SME) Input

Gathering project information begins with engaging the project team members and SMEs directly involved in project design and development. Complementing their perspectives with input from impartial subject matter experts who are not part of the project brings in viewpoints that can strengthen the accuracy of the risk evaluation and help reduce or counteract potential biases.

How to do it:

- Identify the right experts  
Look for individuals with deep knowledge of the project domain (see glossary), technology, regulatory environment, or similar past projects.
- Conduct structured interviews or workshops  
Ask SMEs to identify potential risks, estimate likelihood and impact, and highlight blind spots.
- Document expert judgment  
Capture assumptions, rationale, and confidence levels to support later analysis.

#### Perform Systematic Data Gathering

Data gathering helps uncover risks and clarify their characteristics before assessment begins.

How to do it:

- Use multiple data collection methods  
Interviews, surveys, document reviews, lessons learned, and market or technical research.
- Ask targeted questions  
Focus on triggers, dependencies, constraints, and historical problem areas.
- Consolidate findings  
Organize risks into categories (technical, external, organizational, etc.) to support consistent evaluation.

## Conduct Risk Data Analysis

Review and validate risk data. As a project moves forward, preliminary data is updated, which helps revise the understanding of risks. Remember to review risk data for level of detail, veracity, and validity at each stage in the project lifecycle.

### How to Do It

#### Hold Focused Meetings

Focused meetings identify new risks, clarify existing ones, assign clear ownership, align the team, and document the decisions and actions needed to complete risk assessment and response efforts.

#### Evaluate Data

- **Assess accuracy and completeness** – Confirm that risk descriptions, assumptions, and estimates are clear, consistent, and supported by evidence.
- **Evaluate reliability of sources** – Determine whether information is based on credible expertise, validated research, or outdated assumptions.
- **Survey knowledgeable stakeholders** – Ask subject-matter experts to rate their confidence in the data's accuracy, relevance, and consistency.
- **Flag weak data** – Identify risks that require additional investigation before meaningful analysis can occur.

#### Assess Probability and Impact

Qualitative assessment estimates each risk's likelihood and impact with descriptive, non-numerical scales. It applies expert judgment, comparative ranking, and structured criteria to prioritize risks and determine which require deeper analysis or immediate action.

#### Consider Additional Parameters

Some risks merit further evaluation beyond basic probability and impact—particularly those with reputational implications or heightened stakeholder sensitivity. Factors such as urgency, timing, manageability, conditionality, and significance help create a more complete picture and support more informed prioritization.

#### Employ Interpersonal and Team Skills

Effective facilitation is essential. Skilled facilitators keep discussions focused, help the team navigate differing viewpoints, and maintain objectivity through diplomacy. They address biases, encourage open participation, and build the trust needed for candid, constructive dialogue.

#### Categorize Risks

Grouping related risks into categories—standard or project-specific—helps streamline assessment, reporting, and response planning. Categories should reflect the project's unique challenges and information needs.

#### Represent Data Visually

Visualization techniques help teams interpret and compare risks.

For example, a probability-impact matrix plots risks by likelihood and potential impact, displaying a clear overall risk profile and highlighting which risks require the most attention. (See Exhibit 3-4 through Exhibit 3-10.)

### 3-1.3 Qualitative Risk Analysis Outputs

#### Project risk ranking

Prioritization of project risks provides a list of risks ranked in order of significance. This may be all that is required to inform contingency estimating for very basic projects, but it also serves as an important input leading to more sophisticated risk-based estimating and risk management processes.

#### Lookout List

A list containing any discovered risks that are not slated for further processing. Include appropriate details and some reasoning behind the decision to curtail full processing.

#### Project Document updates

Information gathered in this process should be recorded in the Risk Register and any other affected documents. This may include accounts of assumptions and issues<sup>2</sup> as recorded in documents such as the Basis of Design and Basis of Estimate.

### 3-2 How to Perform Qualitative Risk Analysis

Once a risk is identified, it should be described in clear, specific terms, including its triggers, underlying conditions, and the circumstances under which it may occur. This level of definition enables a more accurate assessment of both probability and potential consequences. Risks considered minor or low-priority should be placed on a lookout list for periodic monitoring rather than active management. The steps below summarize how to perform qualitative risk analysis:

1. **Assemble the Project Team and Key Stakeholders**  
Bring together individuals with relevant knowledge, experience, and decision-making authority. Balanced representation ensures diverse perspectives and reduces blind spots.
2. **Review of Risk Management Planning Outputs**  
Confirm that the foundational elements are defined and approved, these include: Probability definitions, Impact definitions.
3. **Revisit Previously Identified Risks**  
Refine, update, or remove risks as appropriate. Ensure risk statements are clear—use the SMART criteria: Specific, Measurable, Attributable, Relevant, Time-bound; A SMART risk statement typically includes: The cause (why it might happen), the risk event (what might happen), and the effect (impact on objectives).
4. **Evaluate Each Risk as a Group**  
For every risk, collaboratively assess and document: Likelihood of occurrence Potential consequences for project cost, schedule, and other relevant objectives Group evaluation promotes shared understanding and reduces individual bias.
5. **Assess Additional Qualitative Factors**  
Depending on project context, consider: Urgency (how soon a response is needed), Timing (phase the risk might occur), Detectability (how easily it can be identified before impact), Other project-specific factors.

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<sup>2</sup> Project management guidance literature mentions Assumption Logs and Issue Logs.

- An assumption is a factor that is considered to be true, real, or certain, without proof or demonstration. A constraint is a factor that limits the options for managing a project, program, portfolio or process. An assumption log records all assumptions and constraints throughout the project.
- An issue is a current condition or situation that may have an impact on the project objectives. An issue log is used to record and monitor information on active issues. Issues are assigned to a responsible party for follow-up and resolution.

6. Assign a Risk Owner  
Designate the individual responsible for: Initiating response actions and monitoring the risk.
7. Prioritize the Risks  
Rank risks based on the qualitative assessment results. Group them by risk-breakdown structure categories such as: Environmental, Structural/Geotechnical, Construction, etc.

In qualitative risk assessments, cost and schedule impacts are typically evaluated and ranked independently. Other dimensions—such as quality or reputation—can also be assessed, but each added parameter increases complexity and may require a different approach to prioritization. The general guidance is to keep the framework simple to maintain clarity and usability.

[Exhibit 3-1](#) illustrates a five-level qualitative rating scale. It includes example percentage ranges for likelihood and impact, but each project team should tailor the scale to fit its own needs. Impact can be measured as a percentage of total project cost or schedule duration. It may also be expressed in units such as dollars or months.

**Exhibit 3-1 Example Probability and Impact Rating Scales with 5 Gradations**

| Probability<br>(likelihood) | Synonyms*      |             | Percent<br>Chance** |
|-----------------------------|----------------|-------------|---------------------|
| Very High (VH)              | Almost certain | Very Sure   | ≥ 80%               |
| High (H)                    | Likely         | Pretty Sure | 60 - 79%            |
| Medium (M)                  | Possible       | Maybe       | 40 - 59%            |
| Low (L)                     | Unlikely       | Seldom      | 20 - 39%            |
| Very Low (VL)               | Rare           | Improbable  | 0 - 19%             |
| Consequences<br>(impact)    | Synonyms*      |             | Impact Range**      |
| Very High (VH)              | Very Critical  | Very Strong | ≥ 10%               |
| High (H)                    | Critical       | Strong      | 8 - 9%              |
| Medium (M)                  | Moderate       | Average     | 4 - 7%              |
| Low (L)                     | Slight         | Mild        | 2 - 3%              |
| Very Low (VL)               | Very Little    | Very Mild   | ≤ 1%                |

\* Synonyms are offered as example alternative scales and are not needed in practice.

\*\* Suggested, adjust as needed.

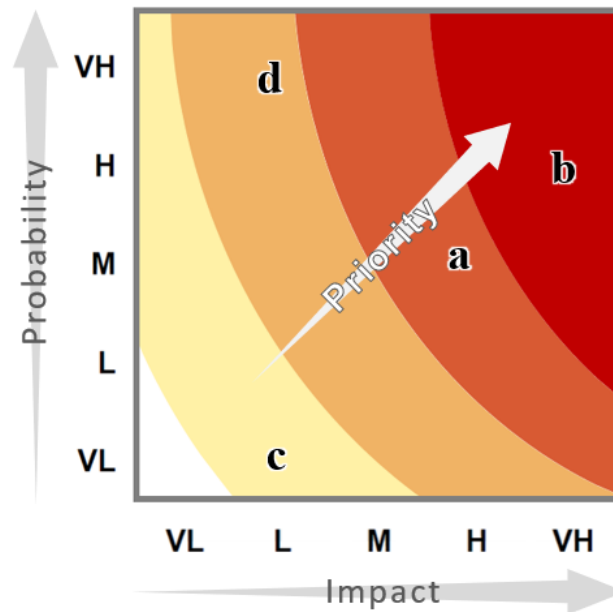
[Exhibit 3-2](#) is an example of a simplified risk register with probability and impact assessment results (for one parameter) recorded according to the rating scale shown in [Exhibit 3-1](#).

**Exhibit 3-2 Example Risk Register**

| Risk ID | RBS #    | Risk Title                         | Nature | Probability | Impact |
|---------|----------|------------------------------------|--------|-------------|--------|
| a       | ENV 30.1 | Permits and Permit Appeals         | Threat | M           | H      |
| b       | UTL 20.1 | Unidentified Utility Conflicts     | Threat | H           | VH     |
| c       | STG 20.4 | Change to Substructure Assumptions | Threat | VL          | L      |
| d       | ROW 40.1 | Managed Access challenge           | Threat | VH          | L      |

Following assessment, risks are plotted together by probability and impact on a matrix, as shown in [Exhibit 3-3](#).

**Exhibit 3-3 Example Risk Probability and Impact Matrix (with above risks plotted)**



| Rank | Risk ID | RBS #    | Risk Title                         | Nature | Probability | Impact |
|------|---------|----------|------------------------------------|--------|-------------|--------|
| 1    | b       | UTL 20.1 | Unidentified Utility Conflicts     | Threat | H           | VH     |
| 2    | a       | ENV 30.1 | Permits and Permit Appeals         | Threat | M           | H      |
| 3    | d       | ROW 40.1 | Managed Access challenge           | Threat | VH          | L      |
| 4    | c       | STG 20.4 | Change to Substructure Assumptions | Threat | VL          | L      |

Exhibit 3-4 offers another format for display information graphically.

**Exhibit 3-4 Probability Impact Matrix (Double 4 x 4)**

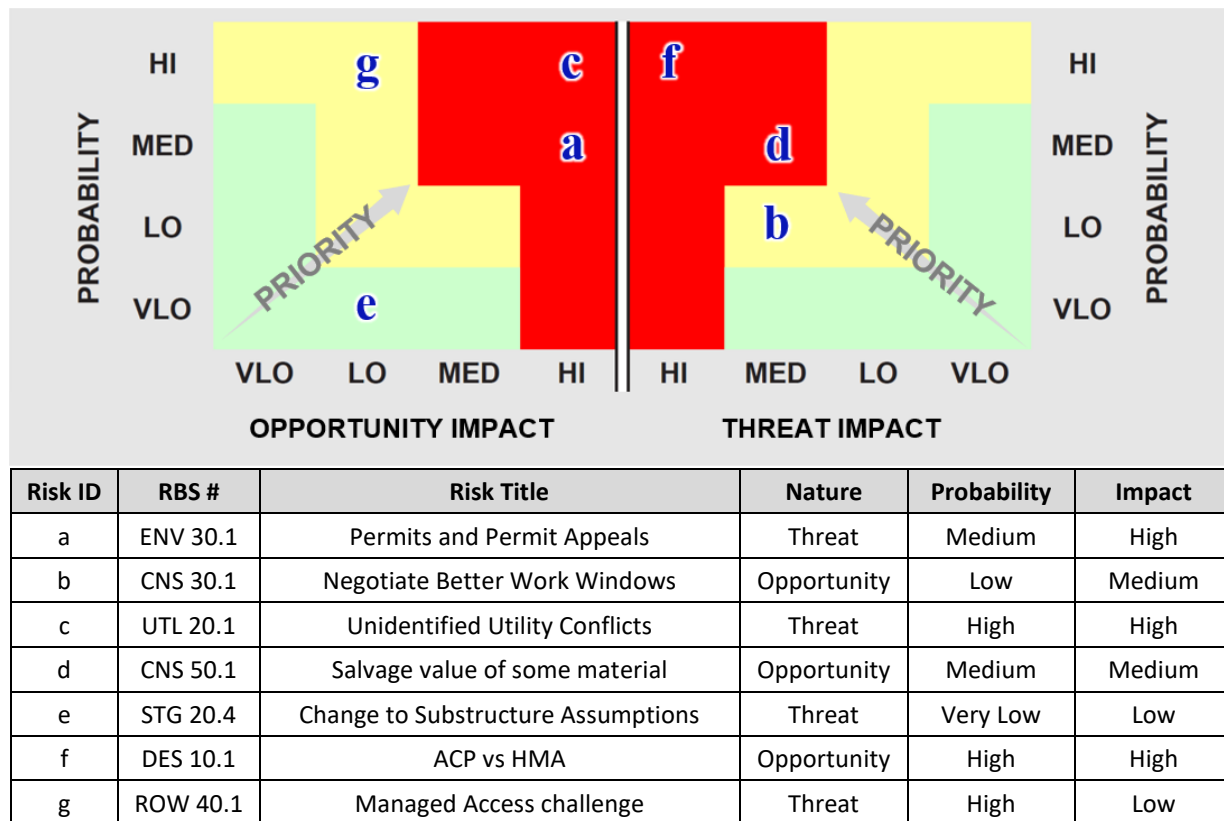


Exhibit 3-5 is an example risk register with individual 2 x 2 matrices.

**Exhibit 3-5 Example 2 x 2 Probability Impact Matrix**

|                                        |  |                                                                                                                                                                           |
|----------------------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Probability<br>H<br>L<br>Impact<br>L H |  | High (probability): more likely than not to happen.<br>High (impact): Substantial impact on cost, schedule, or technical. Substantial action required to alleviate issue. |
|                                        |  | Low (probability): less likely than not to happen.<br>Low (impact): Minimal impact on cost, schedule, or technical. Normal management oversight is sufficient.            |

Qualitative risks are typically prioritized by impact, with the highest-impact risks addressed first; probability is then used to rank risks within similar impact levels; impact drives the order, probability refines it.

Exhibit 3-7 features 5 x 5 matrices. If there are many risks, it may be useful to present risks in one chart as in Exhibit 3-8, which displays both threats and opportunities on both cost and schedule objectives. The further from center, the greater the significance of the risk.

Exhibit 3-6 Sample Risk Register Spreadsheet with individual 2 x 2 Probability Impact Matrices

| Project Name<br>Project Manager  |                                                                                                                                                                                                                                                            | EXAMPLE<br>example | Project Identification Number (PIN)                                  |  | Name of Risk Owner:                                                                                 |  | Date:                                                                                                                                                                                                                            |                                                                                                                            |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <b>RISK IDENTIFICATION</b>       |                                                                                                                                                                                                                                                            |                    | <b>QUALITATIVE ANALYSIS</b>                                          |  | <b>RISK RESPONSE</b>                                                                                |  | <b>MONITOR and CONTROL</b>                                                                                                                                                                                                       |                                                                                                                            |
| <b>STATUS</b>                    | <b>RISK EVENT NAME:</b> unknown utilities                                                                                                                                                                                                                  |                    |                                                                      |  | 10 Very High<br>9<br>8 High<br>7<br>6 Medium<br>5<br>4<br>3 Low<br>2<br>1 Very Low<br>probability ↑ |  | <b>STRATEGY</b><br>Mitigate<br><b>ACTION TO BE TAKEN</b><br><br>Begin subsurface utility investigations immediately. Assign team member to this issue full time until we are confident all utility conflicts have been resolved. | <b>Date, Status and review comments</b><br><br>Next check and update report is at the next Quarterly Project Report (QPR). |
| <b>Active Risk</b>               | <b>RISK TRIGGER:</b> multiple (see below)                                                                                                                                                                                                                  |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RBS CATEGORY</b>              | <b>THREAT</b>                                                                                                                                                                                                                                              |                    | 1 2 3 4 5 6 7 8 9 10<br>Very Lo to Lo some Hi to Very Hi<br>Impact → |  | RISK 1                                                                                              |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>UTL</b>                       | Description of Risk Event: areas outside of R/W have not been investigated for conflicts.                                                                                                                                                                  |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RISK NUMBER</b>               | Additional work is required for sewer/storm water, gas, power, water, fiber optic, telecommunications etc. TRIGGERS include: if found late in preliminary engineering could delay ad; if found during construction could stop work.                        |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>20</b>                        |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>PROJECT PHASE</b>             |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Design</b>                    |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Date Risk Identified</b>      |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>May 32, 2929</b>              |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>NAME OF RISK OWNER</b>        |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Miss Example Risk Manager</b> |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RISK IDENTIFICATION</b>       |                                                                                                                                                                                                                                                            |                    | <b>QUALITATIVE ANALYSIS</b>                                          |  | <b>RISK RESPONSE</b>                                                                                |  | <b>MONITOR and CONTROL</b>                                                                                                                                                                                                       |                                                                                                                            |
| <b>STATUS</b>                    | <b>VENT NAME:</b> Noise wall                                                                                                                                                                                                                               |                    |                                                                      |  | 10 Very High<br>9<br>8 High<br>7<br>6 Medium<br>5<br>4<br>3 Low<br>2<br>1 Very Low<br>probability ↑ |  | <b>STRATEGY</b><br>Mitigate<br><b>ACTION TO BE TAKEN</b><br><br>Press for results of noise analysis ASAP. This is a high impact/high probability threat so knowing sooner rather than later is important.                        | <b>Date, Status and review comments</b><br><br>Analysis due August 39th.                                                   |
| <b>Active Risk</b>               | <b>RISK TRIGGER:</b> Type 1 analysis results                                                                                                                                                                                                               |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RBS CATEGORY</b>              | <b>THREAT</b>                                                                                                                                                                                                                                              |                    | 1 2 3 4 5 6 7 8 9 10<br>Very Lo to Lo some Hi to Very Hi<br>Impact → |  | RISK 2                                                                                              |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>ENV</b>                       | Description of Risk Event: There is a possibility that a noise wall will have to be added to the scope of work - pending the results of the Type 1 analysis.                                                                                               |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RISK NUMBER</b>               |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>90</b>                        |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>PROJECT PHASE</b>             |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Design</b>                    |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Date Risk Identified</b>      |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>May 32, 2929</b>              |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>NAME OF RISK OWNER</b>        |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Mr. Green Jeans</b>           |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RISK IDENTIFICATION</b>       |                                                                                                                                                                                                                                                            |                    | <b>QUALITATIVE ANALYSIS</b>                                          |  | <b>RISK RESPONSE</b>                                                                                |  | <b>MONITOR and CONTROL</b>                                                                                                                                                                                                       |                                                                                                                            |
| <b>STATUS</b>                    | <b>RISK EVENT NAME:</b> Cultural Resources                                                                                                                                                                                                                 |                    |                                                                      |  | 10 Very High<br>9<br>8 High<br>7<br>6 Medium<br>5<br>4<br>3 Low<br>2<br>1 Very Low<br>probability ↑ |  | <b>STRATEGY</b><br>Accept<br><b>ACTION TO BE TAKEN</b><br><br>monitor                                                                                                                                                            | <b>Date, Status and review comments</b><br><br>supplemental field investigation report due November 31.                    |
| <b>Item of Interest</b>          | <b>RISK TRIGGER:</b> find during clearing                                                                                                                                                                                                                  |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RBS CATEGORY</b>              | <b>THREAT</b>                                                                                                                                                                                                                                              |                    | 1 2 3 4 5 6 7 8 9 10<br>Very Lo to Lo some Hi to Very Hi<br>Impact → |  | RISK 3                                                                                              |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>ENV</b>                       | Description of Risk Event: Could be triggered during design phase if field investigation reveals artifacts; this is deemed low probability due to the fact that this area has been investigated in the past and very little new ground is being disturbed. |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>RISK NUMBER</b>               |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>40</b>                        |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>PROJECT PHASE</b>             |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Design</b>                    |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Date Risk Identified</b>      |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>May 33, 2929</b>              |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>NAME OF RISK OWNER</b>        |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |
| <b>Mr. Green Jeans</b>           |                                                                                                                                                                                                                                                            |                    |                                                                      |  |                                                                                                     |  |                                                                                                                                                                                                                                  |                                                                                                                            |

Exhibit 3-7 Sample Risk Register Spreadsheet with individual 5 x 5 Probability Impact Matrices

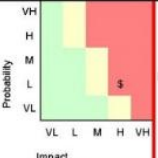
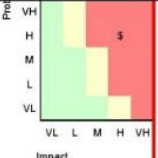
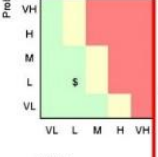
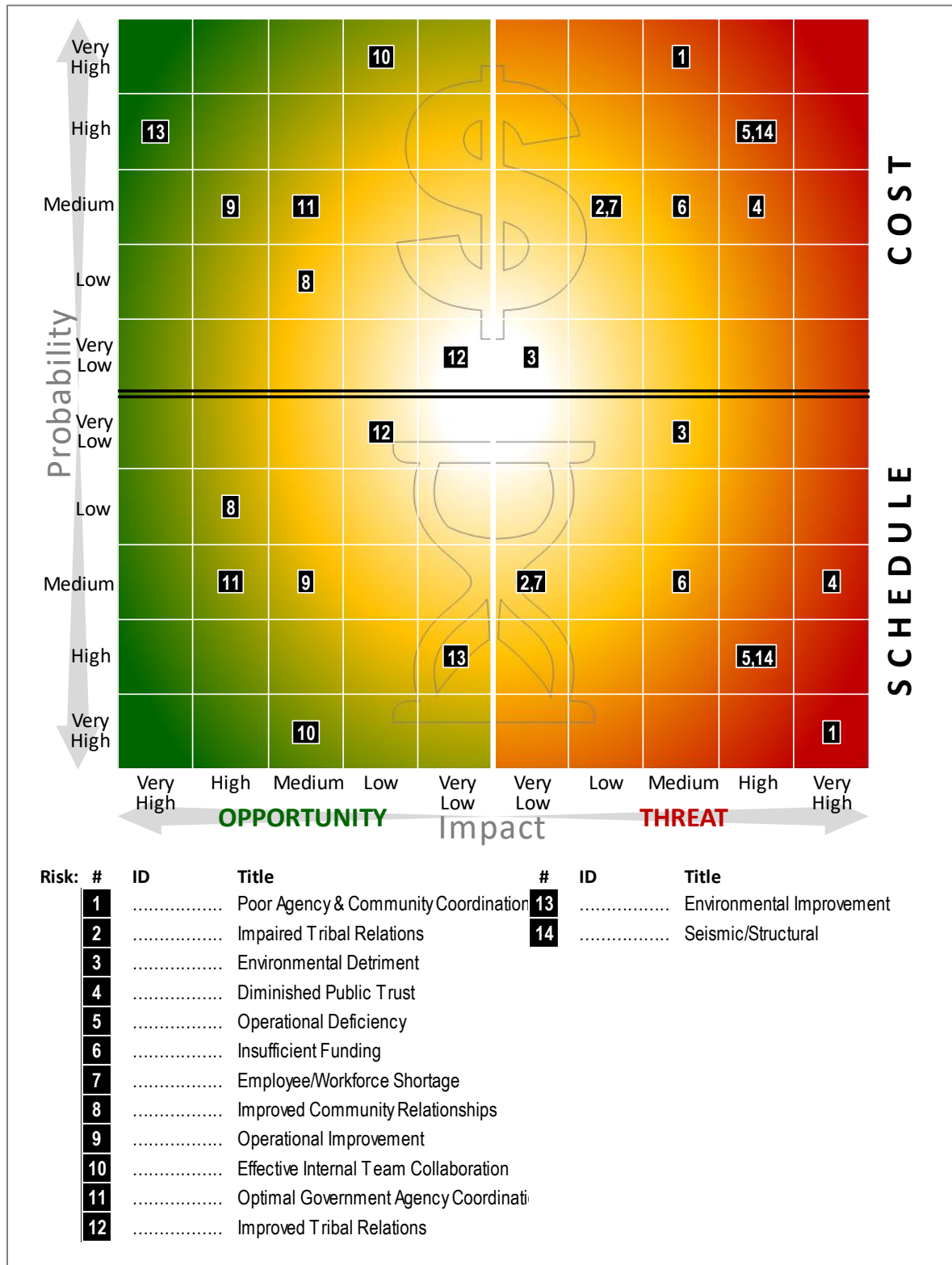
|                                                                                                                                                                                                                                                                   |                                                                                                                                                                                     |                                                                                                                                                     |                                  |                                                                                                                                                                                             |                                                                                                                                                                                                                                               |                                                                                                                                                                                                  |                                                          |                                                                                                                |                                                                            |                                                                                             |                                                                                                                                                                                                                |                                                                       |                                                                                                          |                                                                                                                                                                                                       |                                                                  |                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Project Title<br>Project PIN #<br>Date<br>Project Mngr                                                                                                                                                                                                            |                                                                                                                                                                                     | EXAMPLE for Risk Management Document<br>#####<br>Feb 31, 2029<br>Mgr                      Name                      Telephone Number (xxx) xxx-xxxx |                                  |                                                                                                                                                                                             |                                                                                                                                                                                                                                               |                                                                                                                                                                                                  |                                                          |                                                                                                                |                                                                            |                                                                                             |                                                                                                                                                                                                                |                                                                       |                                                                                                          |                                                                                                                                                                                                       |                                                                  |                                                                                                                                                                                                                                                                                      |
| PROJECT RISK MANAGEMENT PLAN                                                                                                                                                                                                                                      |                                                                                                                                                                                     |                                                                                                                                                     |                                  |                                                                                                                                                                                             |                                                                                                                                                                                                                                               |                                                                                                                                                                                                  |                                                          |                                                                                                                |                                                                            |                                                                                             |                                                                                                                                                                                                                |                                                                       |                                                                                                          |                                                                                                                                                                                                       |                                                                  |                                                                                                                                                                                                                                                                                      |
| Priority                                                                                                                                                                                                                                                          | Risk Identification                                                                                                                                                                 |                                                                                                                                                     |                                  |                                                                                                                                                                                             |                                                                                                                                                                                                                                               |                                                                                                                                                                                                  | Qualitative Analysis                                     |                                                                                                                |                                                                            |                                                                                             | Risk Owner                                                                                                                                                                                                     | Risk-Response Strategy                                                |                                                                                                          | Monitoring and Control                                                                                                                                                                                |                                                                  |                                                                                                                                                                                                                                                                                      |
|                                                                                                                                                                                                                                                                   | Status                                                                                                                                                                              | ID #                                                                                                                                                | Date Identified<br>Project Phase | Risk Event<br>(threat/opportunity)                                                                                                                                                          | SMART Column                                                                                                                                                                                                                                  | Risk Trigger                                                                                                                                                                                     | Impact Area                                              | Affected MDL/WBS<br>Level 2 process                                                                            | Probability                                                                | Impact                                                                                      |                                                                                                                                                                                                                | Risk Matrix                                                           | Strategy                                                                                                 | ACTION TO BE TAKEN<br>(include advantages and disadvantages)                                                                                                                                          | Status Interval<br>or Milestone<br>Check                         | Date, Status and Review Comments                                                                                                                                                                                                                                                     |
| (1)                                                                                                                                                                                                                                                               | (2)                                                                                                                                                                                 | (3)                                                                                                                                                 | (4)                              | (5)                                                                                                                                                                                         | (6)                                                                                                                                                                                                                                           | (7)                                                                                                                                                                                              | (8)                                                      | (9)                                                                                                            | (10)                                                                       | (11)                                                                                        | (12)                                                                                                                                                                                                           | (13)                                                                  | (14)                                                                                                     | (15)                                                                                                                                                                                                  | (16)                                                             | (17)                                                                                                                                                                                                                                                                                 |
| Instructions                                                                                                                                                                                                                                                      | Active-actively monitored & controlled.<br>Dormant-risk is not currently a high priority, but may become active in the future.<br>Retired-no longer a threat to project objectives. | E1                                                                                                                                                  | For example: 6/30/99 Scoping     | Risk is an uncertain event or condition that, if it occurs, has a positive (opportunity) or negative (threat) on a project.<br><br>For example, Wetland Mitigation requires additional ROW. | Detailed description of the risk that is <b>Specific, Measurable, Attributable, Relevant</b> and <b>Timebound</b> . Describe the consequences of the risk to scope, schedule, budget or quality.                                              | Triggers are indications that a risk has occurred or is about to occur. Used to determine when to implement the Risk Response Strategy.<br>For example: Wetland impact is greater than 1/2 acre. | Is the primary impact to the scope, schedule, or budget? | Which WBS element will be modified as part of the response strategy? For example: PC-19: Environmental Permits | Assessment of the likelihood of occurrence. Valid entries are Low or High. | The severity of the risk's effect on the project objectives. Valid entries are Low or High. | High: Substantial impact on cost, schedule, or technical. Substantial action required to avert/avoid issue.<br>Low: Minimal impact on cost, schedule, or technical. Normal management oversight is sufficient. | Name of the person or office responsible for managing the risk event. | Avoidance<br>Transference<br>Mitigation<br>Acceptance<br>(See PM Online Guide for strategy definitions.) | Develop options and determine actions to be taken in response to the risk event. Immediate action may be required at the time of identification. Estimate value of risk and estimate cost to respond. | For example: Completion of wetland delineation expected 2/28/00. | For example: Last status update 4/30/00. Wetland delineation completed 5/15/00. Over 1 acre of wetland was delineated; action is being taken to expedite meetings with regulatory agencies & expedite the effort to provide appropriate wetland mitigation & obtain project permits. |
|                                                                                                                                                                                                                                                                   | Active                                                                                                                                                                              | UTL 20.1                                                                                                                                            | mm/dd/yyyy<br>Design/PS&E        | Threat - Unknown utility impacts (MP 14.7 to MP 19.4).                                                                                                                                      | Areas outside of WSDOT ROW have not been investigated for utilities conflicts. Additional work is required for sewer/stormwater for Smarttown, additional investigation required for water, gas, power, fiber optic, telecommunications, etc. | Multiple Triggers: If found toward the end of design phase may require additional design work and/or ROW acquisition. If found during construction could potentially stop work.                  | Scope                                                    | WBS 185 Prepare Base Maps and Plan Sheets                                                                      | Low                                                                        | High                                                                                        |                                                                                                                             | Ms. Eunice Utility                                                    | Mitigation                                                                                               | Begin subsurface utility investigations immediately. Assign team member to this issue full time until we are confident all utilities have been identified.                                            | Next check is at QPR on 11/20/2008                               |                                                                                                                                                                                                                                                                                      |
|                                                                                                                                                                                                                                                                   | Active                                                                                                                                                                              | ENV 90.3                                                                                                                                            | mm/dd/yyyy<br>Design/PS&E        | Threat - Noise Wall                                                                                                                                                                         | May be required to build a permanent noise wall pending results of Type 1 Analysis.                                                                                                                                                           | Results of Type 1 Analysis will indicate the level of Noise mitigation required.                                                                                                                 | Scope                                                    | WBS 165 Perform Environmental Studies and Prepare Draft Environmental Document (DED)                           | High                                                                       | High                                                                                        |                                                                                                                             | Mr. Noiseman                                                          | Mitigation                                                                                               | Press for results of noise analysis ASAP. This is a high probability/high impact threat. Carry design as if the noise wall is going to be built (to minimize future rush design work).                | Analysis is due 9/30/2008                                        |                                                                                                                                                                                                                                                                                      |
|                                                                                                                                                                                                                                                                   | Active                                                                                                                                                                              | ENV 40.4                                                                                                                                            | mm/dd/yyyy<br>Construction       | Threat - Cultural Resources may be encountered on D Island                                                                                                                                  | During clearing and grubbing there is a potential for finding historical artifacts, particularly on the northside of D Hill near the water.                                                                                                   | Trigger during Design: Archival and/or field investigation reveals artifacts on site. Trigger during CN: Discovery of indicator items and/or artifacts during clearing/grubbing.                 | Scope                                                    | WBS 185 Prepare Base Maps and Plan Sheets                                                                      | Low                                                                        | Low                                                                                         |                                                                                                                            | Mr. History                                                           | Acceptance                                                                                               | Numerous construction work in and around the area has occurred in the past. No artifacts have been found.                                                                                             | Supplemental Field investigation report due: 11/1/2008           |                                                                                                                                                                                                                                                                                      |
| <a href="http://www.wsdot.wa.gov/Projects/ProjectMgmt/OnLine_Guide/Phase_Guides/Pre-Construction/PC_Plan_the_Work/PC_Plan_Risk.htm">http://www.wsdot.wa.gov/Projects/ProjectMgmt/OnLine_Guide/Phase_Guides/Pre-Construction/PC_Plan_the_Work/PC_Plan_Risk.htm</a> |                                                                                                                                                                                     |                                                                                                                                                     |                                  |                                                                                                                                                                                             |                                                                                                                                                                                                                                               |                                                                                                                                                                                                  |                                                          |                                                                                                                |                                                                            |                                                                                             |                                                                                                                                                                                                                |                                                                       |                                                                                                          |                                                                                                                                                                                                       |                                                                  |                                                                                                                                                                                                                                                                                      |
| EXAMPLE OF QUALITATIVE ANALYSIS WITH A 5X5 RISK MATRIX                                                                                                                                                                                                            |                                                                                                                                                                                     |                                                                                                                                                     |                                  |                                                                                                                                                                                             |                                                                                                                                                                                                                                               |                                                                                                                                                                                                  |                                                          |                                                                                                                |                                                                            |                                                                                             |                                                                                                                                                                                                                |                                                                       |                                                                                                          |                                                                                                                                                                                                       |                                                                  |                                                                                                                                                                                                                                                                                      |

Exhibit 3-8 Sample 5 x 5 Comprehensive Probability Impact Matrix





Quantitative Risk Analysis builds on the insight gained from qualitative assessment or judgment by assigning numerical values to probability and impact. The decision to use quantitative methods depends on project policy, project size, complexity, and the overall risk management approach.

Although numbers suggest precision, results are only as reliable as the inputs, therefore the priority is developing an accurate, unbiased, Base Estimate. To mitigate cognitive bias, hold risk discussions with diverse experts and stakeholders. A skilled facilitator should guide the discussions. Other uncertainties, such as market conditions and normal cost variability, should also be quantified.

### CAUTION

Quantitative analysis and modeling are valuable but must be applied correctly to avoid misleading results. Part II of this document outlines guidelines for Cost Risk Assessment (CRA) and Cost Estimate Validation Process (CEVP) to ensure consistency and accuracy.

*"Poor modeling can produce results that appear convincing—yet are dangerously misleading. On projects with unrealistic targets, flawed risk analysis may become a tool that fuels management's delusions about success."*

**Top-Down Techniques for Project Risk Management** by Martin Hopkinson, presented at the 2006 PMI Conference in Madrid

Once the Base Estimate is validated, the team updates documented risks with quantitative assessments. New risks are added, resolved risks are retired but retained for record, and minor risks are placed on a Lookout List for monitoring. Quantitative data from these discussions are inputs for Monte Carlo simulations, which model a wide range of possible outcomes. Results typically shown as histograms, cumulative curves, or percentile summaries.

Discussing potential risk responses during assessment can be helpful, however response planning for the project happens after the risk assessment is complete. For additional support, the Engineering Analysis Office at WSDOT HQ can assist with requirements, facilitation, and tools for quantitative analysis.

### 4-1 General Process

Project risk identification, as outlined in [Chapter 2](#), encompasses the risk description, triggers, probability of occurrence, and potential consequences. Since this information serves as critical input for Quantitative Risk Analysis, it should be thoroughly reviewed for accuracy and completeness.

### 4-1.1 Process Inputs

Information sources are vital for Qualitative Risk Assessment/Analysis, including:

- Project Management Plan
- Project Estimate and Basis of Estimate
- Project Schedule
- Communications Plan
- Discipline Reports (such as environmental, hydraulics, structures, geotechnical, etc.)

### 4-1.2 Tools and Techniques

#### 4.1(2)(a) Data Collection and Representation

- Interviews: Conducted in either formal or informal settings, ranging from small group discussions to larger structured workshops.
- Subject Matter Expert Input: Experts collaborate with the project and cost-risk teams, contributing insights through interviews, surveys, or questionnaires.
- Data Representation: Expressed in terms of probability and impact, using either discrete or continuous distributions to model potential variations.

#### 4.1(2)(b) Quantitative Risk Analysis and Modeling

Project Simulation applies the Monte Carlo method to simulate thousands of project scenarios, generating a probability distribution for cost and schedule outcomes based on uncertainty and risk factors

### 4-1.3 Quantitative Risk Analysis Outputs

#### 4.1(3)(a) Risk Register

The risk register is created during risk identification and continues to evolve through qualitative and quantitative analysis. The risk register is a key component of the Project Management Plan and serves as a dynamic tool for tracking and managing project risks.

#### 4.1(3)(b) Risk-Based Estimating Meeting

For smaller, low-risk projects, the project engineer may hold a focused meeting with the core team. As project complexity increases, specialty experts—such as environmental, geotechnical, structural, or scheduling staff—can be brought in to clarify uncertainties, refine estimates, and support key decisions. Keeping the meeting targeted but inclusive ensures the right input without unnecessary delays.

Quantitative Risk Analysis must lead to clear, actionable risk responses. Their effectiveness can be evaluated through pre- and post-analysis to support continuous improvement.

A full understanding of any project requires separating known information from uncertainties. In transportation projects, many specialized groups contribute essential data—such as surveying, site investigations, environmental assessments, geotechnical analysis, right-of-way coordination, utilities, structures, hydraulics, railroad coordination, tribal engagement, planning, construction, economic analysis, and stakeholder outreach. Their input forms the foundation for reliable risk evaluation.

*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.*

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

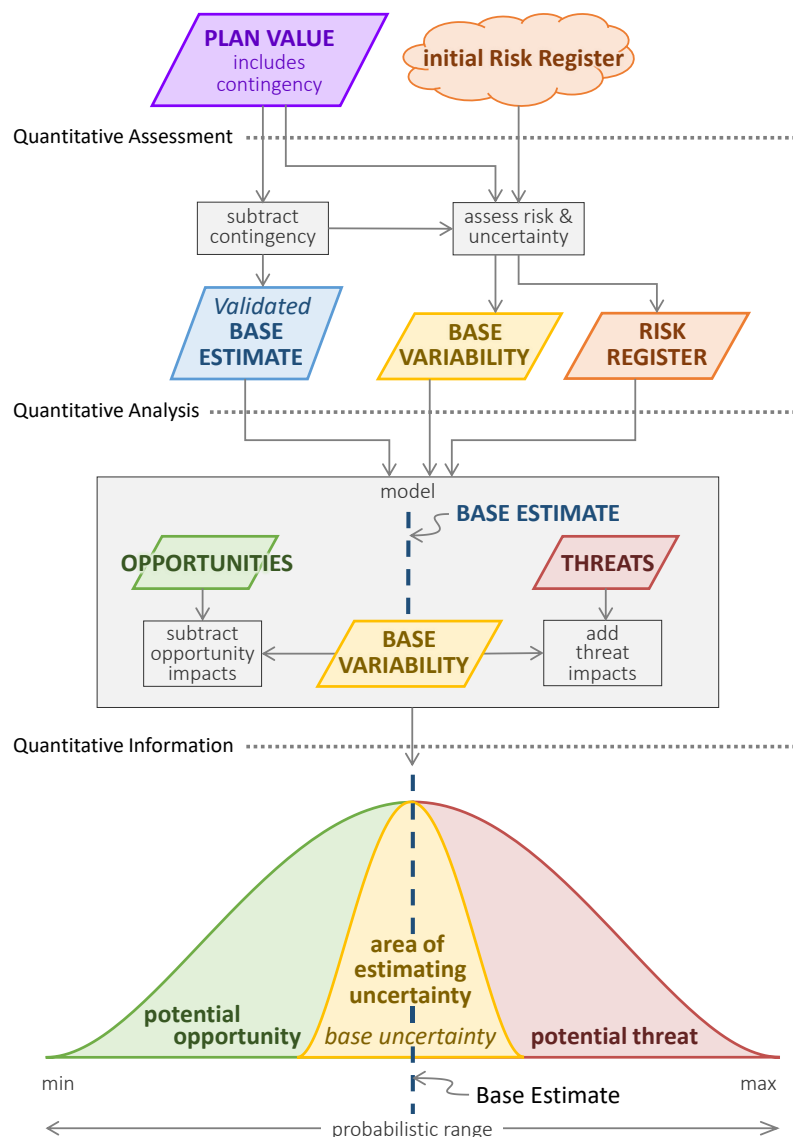
Effective project risk management starts with a well-structured, fully reviewed base cost estimate. Because every project carries uncertainty, risk management adds realism—it doesn't assume cost overruns are inevitable, but it prepares the team for potential deviations and supports proactive planning.

Exhibit 4-1 shows how a risk-based estimate range is developed. The initial “plan value” often contains built-in contingency from explicit or implicit threat risks. To create a neutral, unbiased base estimate, these risks must be identified, removed, and documented in a risk register for formal analysis. When developing a probabilistic risk-based estimate, these key elements must be accounted for separately:

- added cost or time from threat risks
- variability in base estimates and schedules
- reduced cost or time from opportunity risks
- market conditions

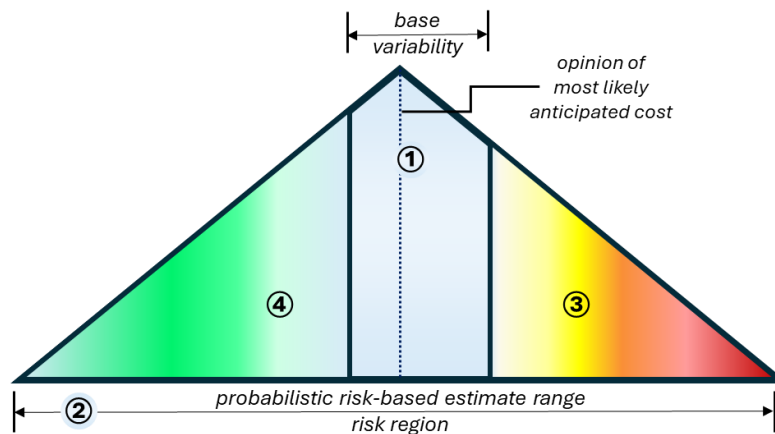
Risk management should be intentional and systematic. It is essential for determining appropriate project contingency and supporting sound decision-making.

#### Exhibit 4-1 Creating a Probabilistic Estimate



At the center of the triangle lies the deterministic estimate — the project’s stable core, capturing the base cost and its ordinary variability — flanked by probabilistic threats on one side and opportunities on the other.

**Exhibit 4-2 Regions of an Estimate**



1. **Deterministic Region – base estimate and variability**  
The neutral, unbiased project estimate. It captures all known, quantifiable costs and forms the foundation before adding risk.
2. **Risk Region – probabilistic range**  
The range of outcomes. For year-of-expenditure estimates, this reflects risks, base variability, inflation, and market conditions.
3. **Threats (negative factors)**  
Adverse events that may increase cost or delay the schedule, such as overruns, setbacks, or unexpected issues.
4. **Opportunities (positive factors)**  
Favorable uncertainties that may reduce cost or shorten the schedule, such as efficiencies or better-than-expected conditions.

## 4-2 Putting It All Together

**Assessment** The team identifies a risk, describes it, estimates probability and impact, assigns an owner, and records it in the risk register. This establishes the baseline understanding for deeper analysis.

**Modeling** Documented risks are then analyzed using Monte Carlo simulation, running thousands of iterations to model uncertainty, quantify cost and schedule effects, and generate probability distributions. This converts qualitative judgments into measurable results.

## 4-3 Impact vs Probability

Impact merits priority in project risk management because it determines whether a project absorbs a setback, suffers major disruption, or collapses entirely. While perspectives vary, the case for elevating **impact** over **probability** rests on a simple truth: consequences are concrete and measurable, whereas likelihood is often uncertain, unstable, and based on limited information. Several principles reinforce why impact consistently outweighs probability across complex projects.

### Impact drives real project outcomes

Probability never halts construction, inflates a budget, or provokes political scrutiny. Impact does. A low-probability but catastrophic event—a 5% chance of a \$500 million geotechnical failure—remains a \$500 million crisis if it materializes. A high-probability but minor issue, a 70% chance of a \$2 million utility delay, may be frustrating but rarely existential. Projects fail because of the scale of consequences, not the statistical likelihood of encountering them.

### Impact can be bounded; probability is speculative

Impact estimates can be anchored in engineering judgment, historical analogues, physical limits, and scenario analysis. Teams can define maximum credible landslide volumes, plausible steel price escalation ranges, or realistic permitting-driven schedule slips. These assessments are grounded in observable constraints.

Probability, by contrast, frequently lacks reliable data. Political shifts have no stable frequency. Environmental or community-driven risks arise from context, not statistics. Geotechnical surprises are sparse-data events. In many cases, probability becomes a numerical guess that conveys false precision.

### Probability is unstable in dynamic project environments

Large projects evolve amid shifting regulations, stakeholder interests, market conditions, and design maturity. Under these circumstances, past frequencies rarely predict future outcomes. Probability estimates often degrade into subjective judgments or modeling conveniences. Impact, however, remains tied to physical, financial, and institutional realities that do not fluctuate as easily.

### High-impact events define true project risk

Major project failures—such as the Big Dig ceiling collapse, Channel Tunnel overruns, Sydney Light Rail utility conflicts, California HSR land acquisition delays, or Seattle’s Bertha TBM breakdown—were not “likely” events. Their significance stemmed from their **consequences**, not their probability. The tail of the risk distribution, where low-probability, high-impact events reside, is where the most serious threats emerge, and that tail is defined entirely by impact magnitude.

### Impact matters even more in complex, long-duration projects

Extended timelines magnify consequences. Inflation, commodity volatility, regulatory change, and political turnover compound over a decade or more, turning moderate impacts into major ones. Interdependencies create cascading failures: one severe event can trigger design rework, contractor claims, schedule compression, cost escalation, and public backlash. Oversight bodies and funders focus on outcomes—overrun size, delay duration, accountability—each of which is impact-driven.

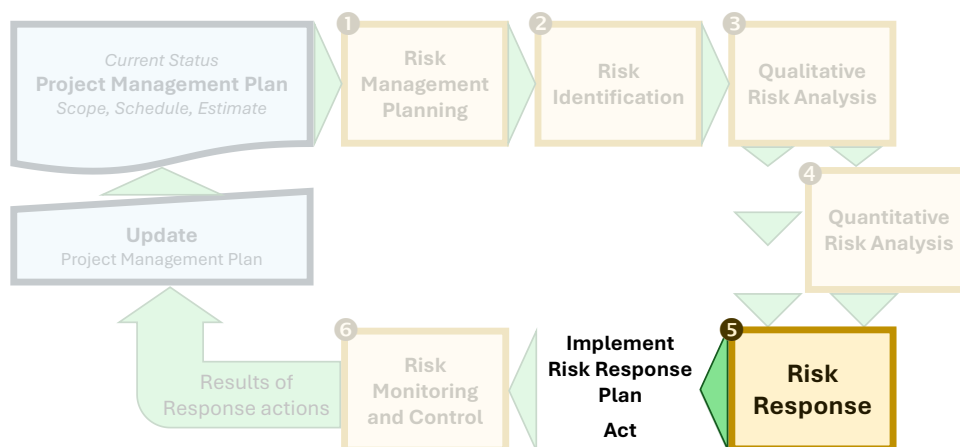
### Impact-focused thinking improves decision quality

Prioritizing impact encourages planners to ask: What is the worst credible outcome? Can the project withstand it? What design, procurement, or investigative actions reduce maximum loss? This mindset aligns with resilience engineering, antifragility, safety-critical systems, financial stress testing, and climate adaptation—disciplines that emphasize consequences because complex systems rarely allow reliable probability estimates.

### The essential asymmetry

Probability adjusts expected value; **impact determines existential threat**. A low-probability, high-impact event can destroy a project. A high-probability, low-impact event cannot.

This asymmetry is why impact deserves primacy in project risk management.



## 5-1 Risk Response

Risk response is the second pillar of effective project risk management—it’s the moment analysis becomes action. Embedding responses in both the RMP and the project schedule ensure they are carried out with intention and discipline, not left to chance.

[Exhibit 5-1](#) introduces the key strategies for managing threats while [Exhibit 5-2](#) highlights responses for opportunities. To make these ideas easier to apply, [Exhibit 5-2](#) offers a sample Risk Management Planning spreadsheet that records each response and the related monitoring activities.

### Exhibit 5-1 Threat Responses

| Action          | Goal      | Description                                                                                                              | Example                                                             |
|-----------------|-----------|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <b>AVOID</b>    | Eliminate | Remove the root cause of a threat to prevent it entirely; may require scope or schedule changes                          | Change project alignment to avoid environmental impacts.            |
| <b>TRANSFER</b> | Assign    | Shift risk ownership to another party through contracts, insurance, or other means. Note: risk transfer comes at a cost. | Use insurance to cover financial exposure.                          |
| <b>MITIGATE</b> | Reduce    | Decrease the probability or impact of a threat through proactive measures such as design improvements or early testing.  | Conduct enhanced geotechnical investigations to reduce uncertainty. |
| <b>ACCEPT</b>   | Tolerate  | Acknowledge the risk and take no action; appropriate if impacts are minor or mitigation is impractical.                  | Take no action, proceed and monitor if the threat is low-risk.      |

## Exhibit 5-2 Opportunity Responses

| Action         | Goal     | Description                                                                                                              | Example                                                    |
|----------------|----------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| <b>EXPLOIT</b> | Maximize | Take deliberate action to ensure the opportunity occurs and secure its full benefit.                                     | Fast-track construction to shorten project duration.       |
| <b>SHARE</b>   | Partner  | Partner among other parties to jointly reap benefits. Often used if benefits can only be realized through collaboration. | Form a joint venture to co-develop innovative technology.  |
| <b>ENHANCE</b> | Amplify  | Boost the likelihood or impact of an opportunity by improving its drivers or trigger conditions.                         | Improve workflow to increase chances of early completion.  |
| <b>ACCEPT</b>  | Observe  | Acknowledge the opportunity and take no action if the pursuit not cost-effective or highly uncertain.                    | Allow passive benefit if the opportunity arises naturally. |

## Exhibit 5-3 Risk Management Planning, RMP Spreadsheet

| Project Title    |                       | SR 1234 Great Project                                                                  |                                 |           |     | Value   |       | Variability       |                 | Risk Markups               |        | Ad-Bid-Award Process |        | Market Conditions |           | Confidence Level |          | Total Cost |  | Schedule Dates |  |
|------------------|-----------------------|----------------------------------------------------------------------------------------|---------------------------------|-----------|-----|---------|-------|-------------------|-----------------|----------------------------|--------|----------------------|--------|-------------------|-----------|------------------|----------|------------|--|----------------|--|
| Estimate Date    | 04/03/25              | <div>Click this button to<br/><b>Run Model</b><br/>Do not stop it while running!</div> | Advertisement (Ad) Date →       | 03-09-27  | 20% | Mob →   | 10.0% | Duration →        | 3 Mo            | Probability                | Impact | 10%                  | Chance | 36.38 \$M         | 38.00 \$M | Jan-2027         | Nov-2027 |            |  |                |  |
| Project PIN #    | G6                    |                                                                                        | Construction (CN) Duration →    | 18.0 Mo   | 20% | Tax →   | 8.4%  | Non-WSDOT rates ↓ | Spent to date ↓ | Favorable                  | 5%     | 5%                   | 20%    | that              | 37.63 \$M | 39.32 \$M        | Feb-2027 | Jan-2028   |  |                |  |
| Last Review Date |                       |                                                                                        | Prelim. Engineering (PE) Cost → | 3.78 \$M  | 20% | CE →    | 10.0% | PE →              | 1.98M           | Unfavorable                | ###    | ###                  | 30%    | if                | 38.65 \$M | 40.37 \$M        | Mar-2027 | Feb-2028   |  |                |  |
| Project Manager  | Ehis                  |                                                                                        | Right-of-Way (RW) Cost →        | 0.57 \$M  | 20% | PE →    | 11.0% | RW →              |                 | Construction               | ###    | ###                  | 40%    | will              | 39.61 \$M | 41.40 \$M        | Apr-2027 | Mar-2028   |  |                |  |
| Base Form        | ← Make Revisions Here |                                                                                        | Construction (CN) Cost →        | 34.39 \$M | 20% | C.O.C → | 4.0%  | CN →              |                 | Pre-construction (PE & RW) | ###    | ###                  | 50%    | not               | 40.58 \$M | 42.42 \$M        | Apr-2027 | Apr-2028   |  |                |  |
|                  |                       |                                                                                        |                                 |           |     |         |       |                   |                 |                            |        | 60%                  | exceed | 41.59 \$M         | 43.46 \$M | May-2027         | Jun-2028 |            |  |                |  |
|                  |                       |                                                                                        |                                 |           |     |         |       |                   |                 |                            |        | 70%                  |        | 42.70 \$M         | 44.61 \$M | Jun-2027         | Jul-2028 |            |  |                |  |
|                  |                       |                                                                                        |                                 |           |     |         |       |                   |                 |                            |        | 80%                  |        | 44.05 \$M         | 46.07 \$M | Jun-2027         | Sep-2028 |            |  |                |  |
|                  |                       |                                                                                        |                                 |           |     |         |       |                   |                 |                            |        | 90%                  |        | 46.72 \$M         | 48.84 \$M | Aug-2027         | Dec-2028 |            |  |                |  |

| Risk Identification |        |                              |               | Quantitative Assessment            |            |                                                                                                                |                                     | Qualitative Rendition |                                                                          |                 |                        | Risk Response Plan |                         |          |            | Monitor and Control                                                                                                                                   |                  |            |                                                                                     | Critical Issue                   |                           |
|---------------------|--------|------------------------------|---------------|------------------------------------|------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------|-----------------------|--------------------------------------------------------------------------|-----------------|------------------------|--------------------|-------------------------|----------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------|-------------------------------------------------------------------------------------|----------------------------------|---------------------------|
| Risk ID             | Status | Conditionality w/ Precedence | Project Phase | Risk Nature: Threat or Opportunity |            | Detailed Description of Risk                                                                                   | Risk Trigger                        | Duration Link         | Probability                                                              | Impact: Cost \$ | Expected Impact (PERT) | Probability        | Impact                  | Heat Map | Strategy   | Response Action(s) to be taken                                                                                                                        |                  | Risk Owner | Next Review Date                                                                    | Date, Status and Review Comments | In Risk on Critical Path? |
|                     |        |                              |               | Risk Title                         | Risk Title |                                                                                                                |                                     |                       | Correlation                                                              | Duration        |                        |                    |                         |          |            | Connection                                                                                                                                            | Impact: Schedule |            |                                                                                     |                                  |                           |
| 1                   | Active |                              | Construction  | Threat                             |            | Change in federal lead has resulted in additional NEPA needs and project may need an Environmental Assessment. | USCG determines project needs an EA | 10%                   | \$ Minimum: 0.10 \$M<br>\$ Maximum: 0.18 \$M<br>\$ Most Likely: 0.12 \$M | 0.01 \$M        | Very Low Probability   | Very Low \$ Impact | VH<br>H<br>M<br>L<br>VL |          | Mitigation | Maintain regular communications and check-ins with the federal lead and USCG. Bring additional expertise to the team for this element of the project. | Mr. Green, Jeane | 06-2025    | 5/1/2025 - recruiting expert in EA and coordinating Federal Lead approval and USCG. | Yes                              |                           |
| ENV 10.20           |        |                              |               |                                    |            |                                                                                                                |                                     |                       |                                                                          | ↑EV↓            | Very High \$ Impact    |                    |                         |          |            |                                                                                                                                                       |                  |            |                                                                                     |                                  |                           |
| TOC                 |        |                              |               |                                    |            |                                                                                                                |                                     |                       |                                                                          | 1.3 Mo          | Very Low Probability   |                    |                         |          |            |                                                                                                                                                       |                  |            |                                                                                     |                                  |                           |
|                     |        |                              |               |                                    |            |                                                                                                                |                                     |                       |                                                                          |                 |                        |                    |                         |          |            |                                                                                                                                                       |                  |            |                                                                                     |                                  |                           |

Risk Identification

(description/trigger)

Risk Analysis

(qualitative/quantitative)

Risk Response

actions owner date

Monitor and Control

status updates results

# 5-2 Risk Response Tools and Techniques

Key risk identification tools play a vital role in project risk management. Risk registers and probability-impact matrices provide a systematic approach to monitoring risks and implementing response strategies such as avoidance, mitigation, transfer, and acceptance.

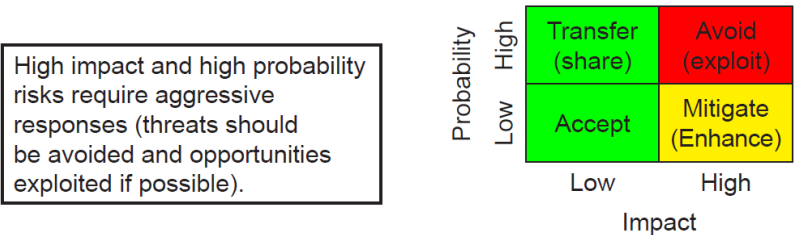
## 5-2.1 Documentation of Response Actions

Document the response action in detail, outlining its scope, the activities it encompasses, and associated costs. Identify the individual or team accountable for ensuring its successful execution. Evaluate how this action may influence project timelines, dependencies, and overall operational efficiency. Finally, consider its broader impact on project outcomes, including potential ripple effects on related risks and interconnected elements.

## 5-2.2 Planning Risk Response Actions

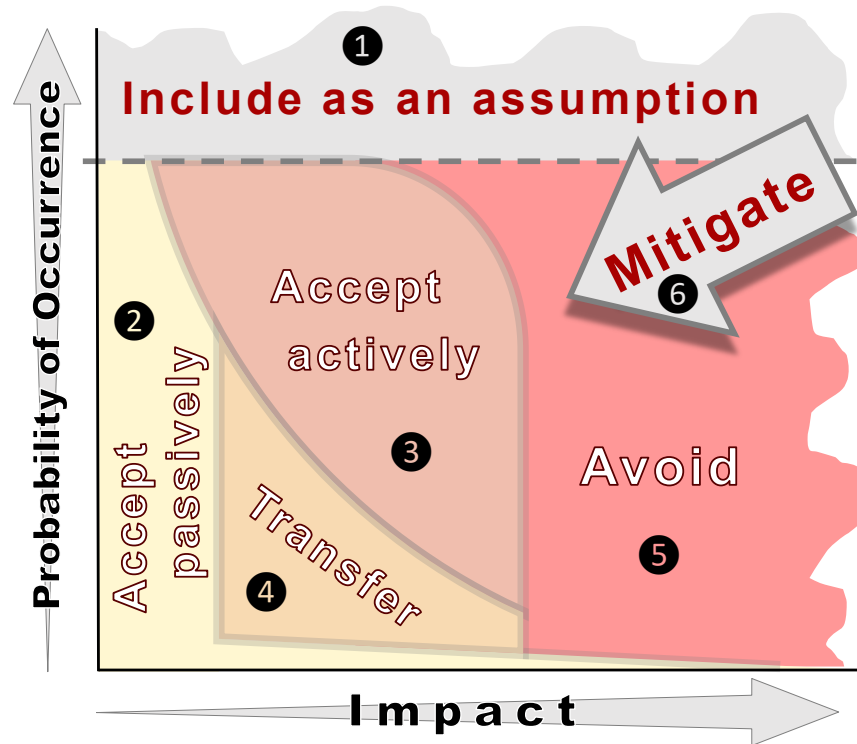
**Select a response action** – The action selected is influenced by the level of the risk; consider [Exhibit 5-4](#):

**Exhibit 5-4 Simple Response Matrix**



[Exhibit 5-2](#) and [Exhibit 5-3](#) depict typical response actions for threats and for opportunities depending on the region of probability and impact in which the risk resides.

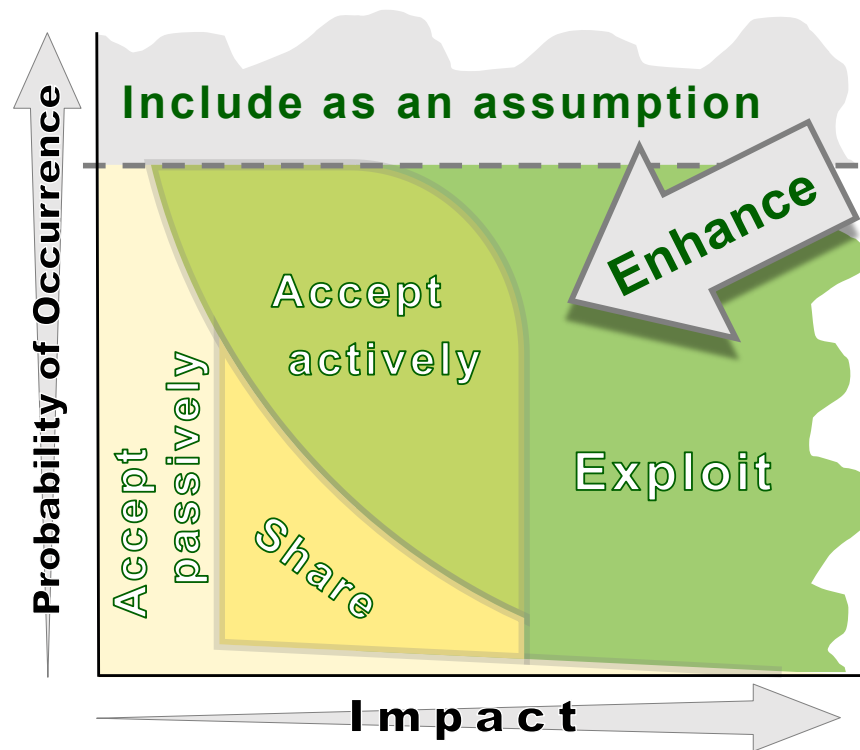
Exhibit 5-5 Typical Risk Response Planning Chart for Threat Risks



credit: Risk Response Planning: Selecting the Right Strategy, Piney, 2002

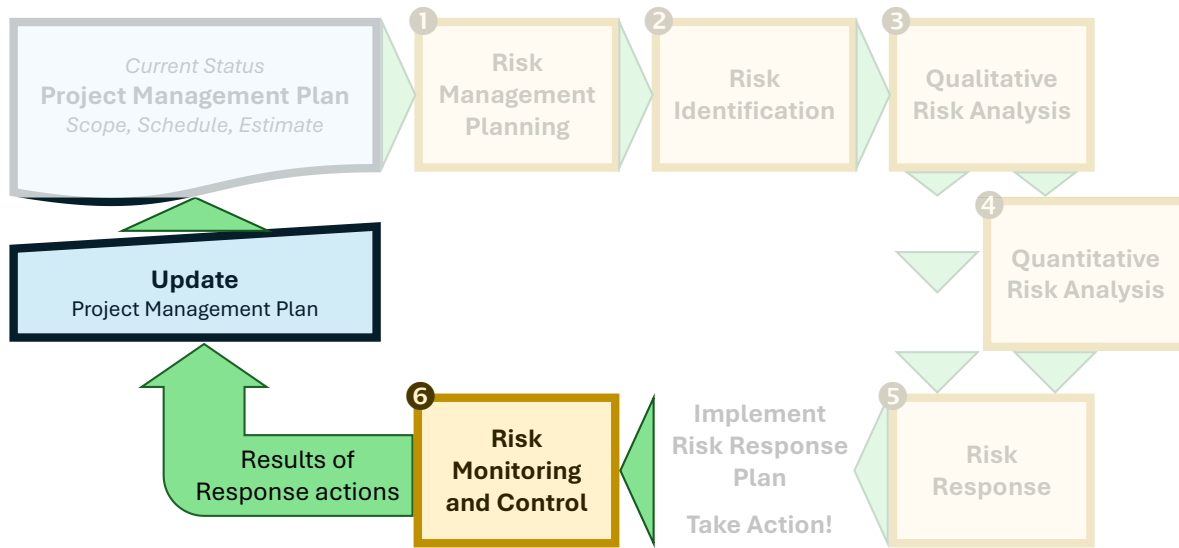
1. **Base Assumption**  
If a risk is effectively certain to occur, it belongs in the base estimate. As a practical guideline, risks having a likelihood of 90% or higher are typically incorporated directly into the base.
2. **Passive Acceptance**  
The risk is acknowledged, but no action is taken. The organization is prepared to accept the consequences and absorb the impact (time delays or cost overruns) if the risk occurs.
3. **Active Acceptance**  
The risk is recognized and though not mitigated; some preparatory actions are taken to manage its potential impact. This could involve actions such as monitoring or adjusting project timelines.
4. **Transfer**  
Risk transfer shifts the impact of a threat to a third party without eliminating it. Some examples of how this is done include contracts, insurance, or outsourcing.
5. **Avoid**  
Proactively eliminate the risk by modifying design, objectives or execution. This may involve altering scope, alternative approaches, or implementing protective measures to prevent potential threats.
6. **Mitigation**  
Mitigation is a common risk response focusing on reducing impact or likelihood. Examples of mitigation include designing reinforced drainage systems to prevent flooding, or soil stabilization.

Exhibit 5-6 Typical Risk Response Planning Chart for Opportunity Risks



credit: Risk Response Planning: Selecting the Right Strategy, Piney, 2002

1. **Base Assumption**  
A high likelihood opportunity risk becomes an assumed condition. As such, it should be integrated into the project scope and directly factored into planning, cost estimation, and scheduling.
2. **Passive Acceptance**  
Recognizing a potential benefit without adjusting the project strategy, as its impact isn't significant enough to justify using resources to pursue it.
3. **Active Acceptance**  
For high-likelihood opportunity risks, proactively plan to maximize the benefit. Example, if forecasts predict a dry period, adjust schedules to accelerate road paving rather than remaining idle.
4. **Share**  
Some opportunities, to be fully realized, may need another party to capture the benefit. For example, completing a pedestrian route may require coordination among multiple agencies.
5. **Exploit**  
Exploitation eliminates uncertainty to secure the benefit. Example: Accelerated Bridge Construction requires specialized knowledge, so experts are hired to integrate the approach into the design.
6. **Enhance**  
Enhancing an opportunity means taking action to increase the likelihood of occurrence or amplify the beneficial impacts if it does occur.



There is a saying, “Control is an illusion,” which is often true in project environments. Projects are an attempt to apply control to the environment, and are greatly influenced by uncertainty, but we aren’t powerless to anticipate and respond to the unforeseen. Strength in project management shows itself through creative and intentional responses to the challenges that arise, and that strength is demonstrated through documented decisions where documentation becomes more than a record of actions; it serves as a source of insight, preserving lessons that inform future decisions.

Once response actions are implemented, it is essential to monitor their effectiveness. Did they impact project objectives? If so, detail the effect in the RMP.

### 6-1 Documenting Response Actions

Documenting risk response actions is essential. It strengthens transparency and accountability and supports informed decision-making. A clear record of the risk management process also demonstrates how identified risks have been addressed and provides a foundation for evaluating the effectiveness of those actions.

Below is a closer look at the importance and value of documenting risk response activities:

- **Policy Compliance and Legal Requirements**  
Documentation shows adherence to policy and demonstrates and affirms that legal and regulatory obligations have been met.
- **Transparency and Accountability**  
Documentation promotes transparency by recording risk response actions, allowing others to understand the process. It fosters accountability by assigning ownership for risk response actions and ensuring that they are tracked and monitored.
- **Effective Decision-Making**  
Documentation allows for more informed decision-making and helps to track the effectiveness of implemented actions; adjusting as needed.
- **Knowledge Management and Continuous Improvement**  
Documentation creates a knowledge base to learn from past experiences. It allows tracking changes in risk through time and provides a framework for continuous improvement in project risk management.

- **Demonstrates Risk Management Efforts**

Documenting risk response actions demonstrates a clear commitment to effective risk management. It provides evidence that proactive steps were taken to identify, assess, and address risks—an important safeguard when negative outcomes occur, as it shows that reasonable mitigation efforts were made.

Documentation considerations include:

- Defining the response action, including related costs and affected project activities.
- Identifying the individual(s) accountable for implementation.
- Assessing schedule impacts and noting how the response may influence the broader project or introduce secondary risks.
- Establishing project-specific performance metrics that support effective evaluation.
- Setting clear criteria for the use of risk reserves to ensure consistent and justified application.

### **Documentation Considerations**

- Clearly outline the response action, including associated costs and affected work activities.
- Identify the responsible individual(s) overseeing implementation.
- Consider time impacts and how the response may influence the overall project or trigger other risks.
- Define project-specific metrics ensuring they enhance performance.
- Establish clear parameters for utilizing project risk reserves.

### **6-1.1 Monitoring and Managing Project Risk**

The Project Manager and team apply the RMP through continuous monitoring. This involves tracking status, evaluating the effectiveness of response actions, interpreting trends, and recognizing early signals that indicate shifts in execution.

#### **Core Monitoring Actions:**

- Communicate emerging insights clearly and promptly.
- Maintain an accurate record of project evolution.

#### **Helpful Hints:**

- Keep communication open and consistent, enabling timely, informed decisions.
- Gather risk status updates thoroughly, ensuring information is complete and current.
- Track trends across scope, schedule, cost, and quality, concentrating on areas prone to change.
- Address risks proactively, raising potential concerns early and discussing them before they escalate.

### **6-1.2 RMP Spreadsheet**

The RMP spreadsheet is a tool that aids in the tracking and monitoring of risk responses. [Exhibit 6-1](#) and [Exhibit 6-2](#) highlight the portion of the spreadsheet that captures this information and shows the difference between the **qualitative** and **quantitative** risk responses.

These spreadsheets are available on WSDOT's CRA website: [WSDOT Cost Risk Assessment](#)

Exhibit 6-1 Example RMP Spreadsheet (Qualitative)

|                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                    |                                 |                                                                                                                                                                       |                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>Status</b><br>Active Risk<br><b>RBS Category</b><br>U/L<br><b>Risk Number</b><br>20<br><b>Project Phase</b><br>Design<br><b>Date</b><br>May 32, 2025<br><b>Risk Owner</b><br>M. Example | <b>RISK EVENT NAME:</b> unknown utilities<br><b>RISK TRIGGER:</b> discovery<br><b>THREAT</b><br>Areas outside of R/W have not been investigated for conflicts. Additional work is required for sewer, storm, water, gas, power, communications.<br><b>Triggers include:</b> utilities found late in design or during construction. | <b>QUALITATIVE ANALYSIS</b><br> | <b>RISK RESPONSE</b><br><b>STRATEGY</b><br>AVOID<br><b>ACTION TO BE TAKEN</b><br>subsurface utility investigations immediately; assign team member to this full time. | <b>MONITOR and CONTROL</b><br><b>Date, Status and review comments</b><br>update at the next Quarterly Project Report (QPR) meeting |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                                                       |                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RISK RESPONSE</b><br><b>STRATEGY</b><br>avoid<br><b>ACTION TO BE TAKEN</b><br>subsurface utility investigations immediately; assign team member to this full time. | <b>MONITOR and CONTROL</b><br><b>Date, Status and review comments</b><br>update at the next Quarterly Project Report (QPR) meeting<br>Name of Risk Owner: |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|

Exhibit 6-2 Example RMP Spreadsheet (Quantitative)

|                                                                                                                                                                                                                                                                                               |                                                                                                                                                                         |                                                                                                                                                                                           |                                                                                                                                                                                                |                                                                                                                                                                                                                  |                                                                                                                                                                                                                    |                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Project Title</b><br>SR 1204 Grant Project<br><b>Estimate Date</b><br>6/6/2025<br><b>Project Phase</b><br>CR<br><b>List Review</b><br>JPR<br><b>Project Manager</b><br>Ella<br><b>Save Form</b><br>Click this button to Run Model! Do not stop it while running!                           | <b>Value at Risk</b><br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo | <b>Variability</b><br>Variability: 20%<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo | <b>Risk Matrix</b><br>Risk Matrix: 10.38 Mo<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo | <b>Market Conditions</b><br>Market Conditions: 10.38 Mo<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo       | <b>Confidence</b><br>Confidence: 10.38 Mo<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo                       | <b>Summary Table</b><br>Summary Table: 10.38 Mo<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo |
| <b>Risk ID</b><br>1<br><b>Status</b><br>Active<br><b>Project Phase</b><br>Construction<br><b>Risk Title</b><br>Change in Federal Lead<br><b>Detailed Description of Risk</b><br>Change in federal lead has resulted in additional USCG tasks and increasing cost of Environmental Assessment. | <b>Risk Trigger</b><br>USCG Assessment report received.                                                                                                                 | <b>Probability</b><br>Probability: 10%<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo | <b>Impact</b><br>Impact: 10.38 Mo<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo           | <b>Qualitative Analysis</b><br>Qualitative Analysis: 10.38 Mo<br>Construction (CR) Duration: 10.38 Mo<br>Construction (CR) Cost: 3.78 Mo<br>Right of Way (ROW) Cost: 0.57 Mo<br>Construction (CR) Cost: 34.38 Mo | <b>Risk Response Plan</b><br>Response Action(s) to be taken: Maintain regular communications and check-ins with the federal lead and USCG. Bring additional expertise to the team for this element of the project. | <b>Monitor and Control</b><br>Date, Status and Review Comments: 5/1/2025 - recruiting expert in EA and coordinating Federal Lead approval and USCG.                                                |

| Risk Response Plan |                                                                                                                                                       | Monitor and Control |                  | Critical Issue                                                                      |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------|-------------------------------------------------------------------------------------|
| Strategy           | Response Action(s) to be taken                                                                                                                        | Risk Owner          | Next Review Date | Date, Status and Review Comments                                                    |
| Mitigation         | Maintain regular communications and check-ins with the federal lead and USCG. Bring additional expertise to the team for this element of the project. | Mr Green Jeans      | 06-20-25         | 5/1/2025 - recruiting expert in EA and coordinating Federal Lead approval and USCG. |
|                    |                                                                                                                                                       |                     |                  | Is Risk on Critical Path? Yes                                                       |

## **6-2 Summary: Risk Monitoring and Management**

Through continuous observation, trend analysis, and timely communication, the project team detects shifts in performance, evaluates the effectiveness of response actions, and identifies emerging risks before they escalate.

Documentation plays a central role, preserving the history of decisions, actions, and outcomes so the team can learn, adjust, and improve.

Agency managers and staff need project estimates they can use with confidence, ones that give a clear sense of cost and time, guide choices, and show that early figures shift as the project gains detail. The public also deserves to understand these cost and time ranges, both agencies and the public need shared expectations about careful use of tax dollars for major infrastructure efforts. Cost Risk Assessment (CRA) and the Cost Estimate Validation Process (CEVP®) help answer these questions by replacing single-value estimates with realistic ranges that reflect uncertainty. As the saying goes, *it is better to be approximately right than precisely wrong*.

WSDOT's CRA and CEVP® practices align with AACE International principles by emphasizing integrity, transparency, accountability, confidentiality, and professionalism. Estimators are expected to remain independent, document assumptions clearly, validate estimates rigorously, and uphold ethical standards throughout the process.

### 7-1 Framework and Purpose

CRA and CEVP® use a structured process:

1. Select the project and the appropriate method
2. Organize the project team
3. Define and evaluate the base cost estimate and schedule
4. Identify uncertainties and risks
5. Quantify how those risks affect cost and schedule
6. Run probabilistic analysis and document the results
7. Implement risk responses and monitor their effectiveness

Results are typically communicated using year-of-expenditure dollars; however, the current-year dollar results are also produced as part of the output.

The purpose of these meetings is to give project teams a chance to step back from day-to-day work and look at the project objectively. They help teams:

- Review cost and schedule estimates, validate that they are realistic
- Understand project risks and uncertainties
- Identify risks early
- Build shared awareness across disciplines

### 7-2 Probabilistic Risk-Based Estimating (PRBE)

PRBE, such as CRA and CEVP, replaces fixed contingencies with expert-informed probabilistic analysis. Using Monte Carlo simulation, it “models a broad range of possible outcomes” and produces realistic cost and schedule distributions. The results highlight risks with the greatest influence, helping project managers prioritize responses.

Because PRBE reflects conditions at a specific point in time, results must be updated as the project evolves. WSDOT implements PRBE through CEVP® and CRA, both of which follow the same seven-step framework listed earlier.

### 7-2.1 Base Estimate and Risk

The base estimate represents the expected cost if the project proceeds exactly as planned. It must be neutral, unbiased, and validated. ISO 31000 defines risk as the “effect of uncertainty on objectives”. PRBE develops a sound and objective base cost estimate for the project and captures risks; this combination Base + Risk serves as input for the Monte Carol model to generate the range, this output serves to measure the impact of risk and its effect on cost and schedule. [Exhibit 7-1](#) depicts the two pillars of project risk management and [Exhibit 7-2](#) provides an at-a-glance summary of activities.

**Exhibit 7-1 Pillars of Risk Management**

| <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;"> <p>The two pillars of<br/>Project Risk Management</p> <p>IDENTIFY &amp; ANALYZE<br/>and<br/>RESPOND, MONITOR, &amp; CONTROL</p> </div>  </div> |                                                                                                                                                                                      |                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pillar                                                                                                                                                                                                                                                               | Identify and Analyze                                                                                                                                                                 | Respond and Monitor                                                                                                                                            |
| <b>Primary Focus</b>                                                                                                                                                                                                                                                                                                                                  | understand project risks                                                                                                                                                             | implement and track risk responses                                                                                                                             |
| <b>Key Activities</b>                                                                                                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>identify risks, probability &amp; impact</li> <li>perform Monte Carlo analysis</li> <li>produce ranked risk registers &amp; ranges</li> </ul> | <ul style="list-style-type: none"> <li>develop and implement responses</li> <li>monitor response effectiveness</li> <li>update risk management plan</li> </ul> |
| <b>Role in Process</b>                                                                                                                                                                                                                                                                                                                                | preparation, elicitation, and analytical                                                                                                                                             | act, integrate into management plan                                                                                                                            |
| <b>Outcome</b>                                                                                                                                                                                                                                                                                                                                        | understanding risk exposure                                                                                                                                                          | active management of risks                                                                                                                                     |

### 7-3 CEVP® Team

A CEVP® Team is a multidisciplinary group assembled to rigorously evaluate a project’s cost, schedule, and risk exposure. The strength of CEVP® comes from bringing together diverse expertise, independent perspectives, and structured facilitation to challenge assumptions and uncover uncertainties that traditional estimating often misses.

#### 7-3.1 Core Composition

A mature CEVP® Team typically includes:

- **Risk Analysts** - Experts in probabilistic modeling, uncertainty analysis, and risk quantification and facilitation meetings. They Lead the development of risk registers, probability distributions, and Monte Carlo simulations.
- **Cost Estimating Specialists** - Professionals with deep experience in construction cost estimating, unit pricing, quantity development, and cost-driver analysis. Review and validate the base cost estimate, challenge assumptions, and ensure alignment with industry benchmarks.
- **Subject Matter Experts (SMEs)** - Technical experts in disciplines relevant to the project—engineering, construction, environmental, operations, geotechnical, procurement, etc. These experts provide insight into constructability, sequencing, design maturity, permitting, and operational constraints.

## 7-4 Meeting Preparation

“The human element introduces an additional layer of complexity into the risk process, with a multitude of influences both explicit and covert. These act as sources of bias...which affect every aspect of risk management.” *Understanding and Managing Risk Attitude* by Hillson and Murray-Webster.

In our processes, we attempt to facilitate an understanding of cognitive bias so that participants can take steps to avoid and reduce bias.

Effective risk meetings typically include 6–12 participants, balancing expertise and efficiency. Larger or more complex projects may require more. Participants should be selected based on their ability to identify meaningful risks and contribute constructively.

### Typical Roles

- Project Manager – oversees resources and decisions
- Estimator – develops and documents cost estimates
- Scheduler – maintains the schedule
- Lead Designer – provides design inputs
- Technical Experts – discipline-specific insight
- Internal/External SMEs – validate risks and assumptions
- Risk Lead & Cost Lead – facilitate elicitation and validate base estimates
- CREM Coordinator – advises management of logistics and engagement

Not all participants attend every meeting; attendance is tailored to the agenda.

Before the risk meetings, participants should understand both what to expect and what’s expected of them. They are reminded to (1) remain impartial, (2) listen openly to all views, and (3) avoid promoting predetermined positions. Risk and Cost Leads should stay alert to potential bias during their respective sessions.

Participants are expected to remain impartial, listen openly, and avoid advocating predetermined positions.

Preparation includes:

- Understanding the purpose of the assessment
- Reviewing cost and schedule assumptions
- Conducting early risk brainstorming
- Aligning expectations about uncertainty, especially in early design phases

### 7-4.1 Cognitive Bias

In any group talk, our brains can play tiny tricks on us. These habits, often called “cognitive bias,” are part of being human. Below are a few common ones that can sneak into project chats, and tips to keep them from steering the group off track.

#### 7.4(1)(a) Anchoring

The first number or idea we hear can stick in our minds more than it should.

Helpful tip: Begin by talking about the full range of possible outcomes, not just the first idea tossed out. This helps the group stay open to more than one path.

#### 7.4(1)(b) Availability Bias

Fresh stories, especially dramatic ones, can feel bigger than they truly are.

Helpful tip: Pause and ask, “Is this based on one recent event, or long-term experience?” This quick check keeps things in balance.

### 7.4(1)(c) Representativeness Bias

It's easy to compare a new project to something that "feels similar," even if the match is not exact. Helpful tip: Ask for more than one example and talk through how each one fits—or doesn't fit. This keeps the group from jumping to fast conclusions.

### 7-4.2 Conflict Resolution

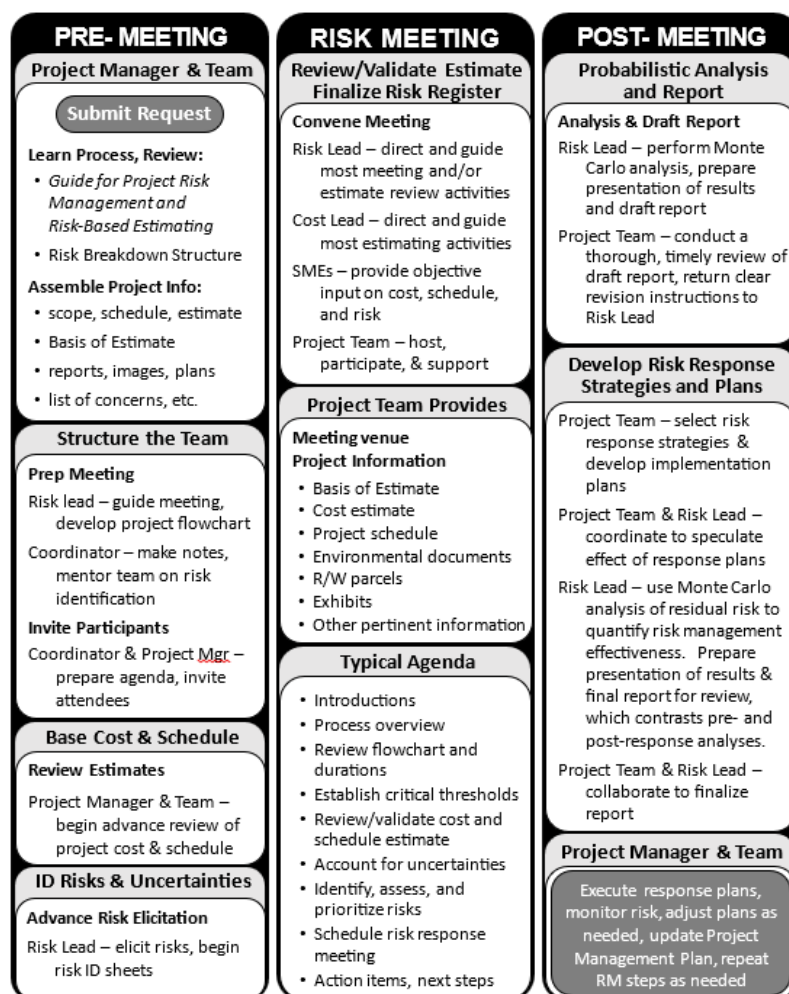
As disagreements arise:

1. Capture differences as a range
2. Explore alternative scenarios sparingly
3. Review data with SMEs and document final decisions, including dissent if needed

### 7-4.3 Information Reliability

Analysts must distinguish between high-certainty and low-certainty information. Reliable information is reproducible, well documented, and contextually similar. Less reliable information may be anecdotal, sparse, or missing assumptions. A key question is: "How much confidence should I place in this data?"

### Exhibit 7-2 Summary of Activities



## Pre-Meeting

Effective risk management starts before the meeting. The pre-meeting can help align people on objectives, and flag key concerns—setting the stage for a focused and productive discussion. Cross-functional teams—engineers, cost analysts, risk specialists—if they come prepared, bring clarity, challenge assumptions, and drive better decisions.

Coordination goes beyond scheduling, it ensures the right people have the right information at the right time. Effective preparation clarifies roles, reinforces process awareness, and aligns expectations across teams.

| Item                                  | Objective                                                                  | Action                                                                     |
|---------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| <b>Determine Strategy</b>             | Define scope and depth of risk assessment process.                         | Identify minimum required process; develop timeline.                       |
| <b>Build Understanding</b>            | Align participants on roles and expectations.                              | Use orientation sessions to confirm familiarity of process and objectives. |
| <b>Assemble Information</b>           | Establish a clearly defined base project.                                  | Validate scope, schedule, and cost. Determine if there are alternatives.   |
| <b>Prep Session</b>                   | Determine risk meeting details, attendees, areas of concern.               | Risk/cost leads and core project team discuss agenda& attendees.           |
| <b>Invite Participants</b>            | Ensure attendance by appropriate participants.                             | Project team & HQ Engineering Analysis send invites.                       |
| <b>Review Estimate &amp; Schedule</b> | A current cost and schedule estimate that has been reviewed and validated. | Cost Lead and SMEs asse base estimates.                                    |
| <b>Advance Elicitation</b>            | Identify high-impact risks through early engagement.                       | Risk leads conduct interviews with key technical and specialty groups.     |

Note: The most effective meetings are supported by thorough advance preparation

## 7-5 Risk Meeting

Risk assessment frameworks such as CRA/CEVP® provide a forum for project teams to share cost and schedule insights, step back from day-to-day operations, and thoughtfully assess the project's status and risks. Producing a dependable estimate and schedule is not a one-off task, it's a continuous discipline that begins at kickoff. The project schedule must intentionally allocate time and resources for updating cost estimates and risk assessments at each milestone.

The main risk meeting for CRA and CEVP, brings together the project team, cost-risk team, and SMEs to:

- Confirm understanding of the process
- Validate scope and assumptions
- Establish model parameters
- Review base cost and schedule
- Identify and assess risks
- Capture potential response strategies

Risks are defined by subject-matter experts and the project team as they work together to identify areas of concern, and these are documented in a risk register to support Monte Carlo modeling. In some cases, it can be useful to convene smaller subgroup sessions before or during the main risk meeting; this can speed up the process, sharpen the focus and quality of the input, and create space for more candid, productive conversation.

## Meeting Dynamics

Effective meetings require:

- Appropriate group size (8–20)
- Clear orientation for participants
- Scaling effort to project complexity
- Suitable meeting space
- Active bias mitigation by elicitors

## Report Preparation

The risk report documents inputs, including:

- Base cost and schedule estimates and their variability
- Identified risks, including correlations, dependencies, likelihoods, and impacts
- Market conditions
- Inflation

Reports also provide modeled outputs, including:

- A one-page summary
- Tornado diagrams
- Risk breakdown charts
- A lookout list
- Probabilistic cost and risk distributions in both CY and YOY dollars

The Risk Lead, Cost Lead, SMEs, and project team all contribute, but the project team ultimately owns the report and its implementation.

## Results and Budget Data Needs

To support agency systems, program management requires milestone dates and cost estimates in current-year dollars for design, right-of-way, and construction.

## 7-6 QA/QC

Prior to the meeting, the Project Manager should use the Cost and Risk QC checklist to confirm readiness. Attendees are expected to review and comment on the scope, schedule, and cost estimate in advance, as these will be the focus of assessment during the CRA or CEVP®. If checklist items are incomplete, the CREM Unit, regional Risk Manager, or Project Manager may postpone the meeting.

### Cost Lead Review

1. Basis of Estimate is complete.
2. All available backup has been reviewed and incorporated.
3. Estimate scope is validated.
4. Unit costs are validated by judgment and/or historical data.
5. Spreadsheet formulas and totals are verified.
6. Costs and durations are assigned to flowchart activities.
7. Contingencies are removed from the base estimate and included in the risk estimate.
8. Design allowances are validated; high-variability items moved to the risk estimate.
9. Markups are verified and appropriate.
10. Estimate assumptions and clarifications are documented.
11. Base uncertainty is assessed and documented.

### Risk Lead Review

- Risk process is presented to the team.
- Team issues and concerns are explored.
- Consensus reached on the initial risk list.
- Key risks are prioritized; minor issues screened out.
- Risks are quantified for likelihood and consequences.
- Mitigation measures are captured.
- Contingencies and allowances are coordinated with the cost team.
- Cost Lead confirms no risks are included in the base estimate.
- Issues, impacts, likelihoods, and mitigations are consistently documented.
- Assumptions and clarifications are documented.
- Team consensus reached on all risk items.
- Risk estimate backup includes date, page number, and estimator's name.

### 7-6.1 During and After Meetings

- **Check for Reasonableness:** Review early draft results to confirm they make sense.
- **Review the Model:** Modelers verify that model inputs are accurate.
- **Capture Risk Data:** The Risk Lead ensures all risk information is correctly recorded for analysis.
- **Capture Cost Data:** The Cost Lead ensures all cost information is correctly recorded for analysis.
- **Prepare the Report:** The Risk Lead runs the model and assemble the risk assessment reports.

## 7-7 Risk Response

After risks are identified, analyzed, and prioritized, the Project Manager and project team must act—especially on the highest-priority risks. CRA and CEVP® are snapshots in time; they reflect what is known at the time of the assessment. The focus is on risks that can be identified and measured.

Large, unpredictable events—often called “Acts of God,” such as natural disasters—are typically excluded. Any assumptions or exceptions should be clearly documented in the report. Risk-based estimating highlights uncertainty and shows how risks may affect cost and schedule. This gives project teams the insight needed to act early, reduce uncertainty, and improve the likelihood of project success.

## 7-8 Helpful Hints

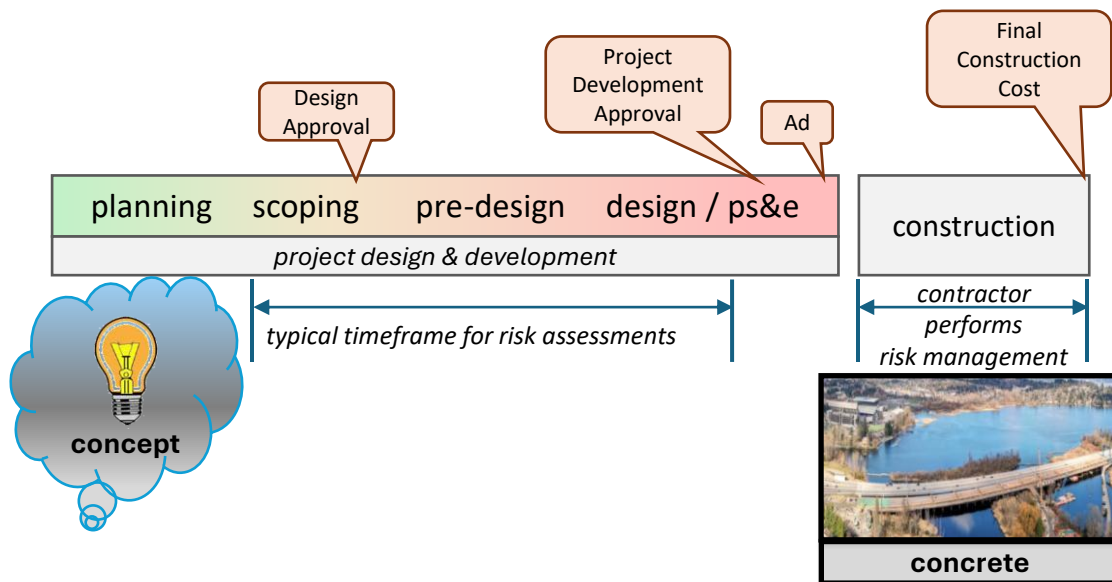
- **Be Prepared:** Clearly define the project scope. Ensure the schedule and cost estimate are organized, current, and appropriate for the project stage.
- **Know the Limits:** Risk assessments are only a snapshot. Update them as risks, markets, and project conditions evolve.
- **Learn Early:** Ensure project team members receive training and orientation before risk assessment meetings.
- **Use Established Processes:** Refer to the Project Management Guide and the Project Risk Management Guide.
- **Follow Through:** Add agreed-upon risk response actions to the Risk Management Plan and use them to guide decisions.
- **Include Leadership:** The Project Engineer or Assistant Project Engineer should attend to provide the owner-agency perspective.
- **Optimize Attendance to be Manageable:** Invite *essential* participants to keep meetings focused and productive.
- **Plan Ahead:** Submit requests for risk assessments early—ideally 4 months, or more, before the first preparation meeting.

## Chapter 8

## Project Team Members and Tasks

The project team owns the final cost and schedule estimates, but risk-based forecasting is a shared responsibility involving cost specialists, risk specialists, and other technical experts. Risk assessments typically begin early in design, and the identified risks must be actively managed and revisited at key milestones as conditions change. Effective project risk management continues throughout the entire project lifecycle (see [Exhibit 8-1](#)). Project managers and teams should plan early for risk assessments and response strategies, as these efforts improve the accuracy and reliability of cost and schedule estimates and help set realistic expectations.

**Exhibit 8-1 Cost Risk Estimating Management: Concept to Concrete**



### Role of Project Teams, Engineers, and Managers

Project Engineers and Project Managers are responsible for ensuring that their teams use cost data that is accurate, current, and well-documented for risk assessments. The project team prepares and reviews the estimates and ultimately owns the final cost and schedule.

All contributors must provide clear, realistic information and keep schedules and estimates up to date. Risk meetings offer a chance to confirm assumptions, validate data, and strengthen planning. Realistic estimates are built from the following:

**Base Cost**—the expected cost if the project proceeds as planned—and,

**Risk Events**—represent uncertainties that may affect cost or schedule.

These risk events must be evaluated separately during the risk assessment process and addressed during risk meetings. Major risks may require involvement from senior leadership.

## 8-1 Before the CRA/CEVP®

The team must submit the approved scope, schedule, cost estimate, project maturity, and a summary of key concerns. The objectives are to validate the base estimate, identify risks, and document them in the risk register.

### Planning requirements

- Submit request forms at least 4 months in advance
- Provide updated plans, schedule, cost estimate, and scope 2 weeks before the workshop

## 8-2 Team Responsibilities

Key participants—Project Management, Engineering, Cost Estimating, Scheduling, and Environmental—must attend consistently and be prepared to discuss risks, likelihoods, impacts, delivery methods, funding, exclusions, and modeling needs.

### 8-2.1 Materials

Teams provide:

- Org chart, contacts, maps, and photos
- Project definition, design criteria, and alternatives
- Basis of Estimate and current cost estimates
- Preliminary risk list and project flowchart
- Current schedule and cost details for engineering, right-of-way, and construction

## 8-3 Risk Lead

The Risk Lead prepares the team, sets expectations, and ensures understanding of the CRA/CEVP® process and how risks affect cost and schedule.

Duties:

- Coordinate planning and align assumptions
- Set the agenda and confirm attendees
- Lead risk identification and flowchart development
- Support cost and schedule validation
- Facilitate sessions and adjust as needed
- Produce summaries, risk registers, reports, and action items
- Provide training on methods and assumptions

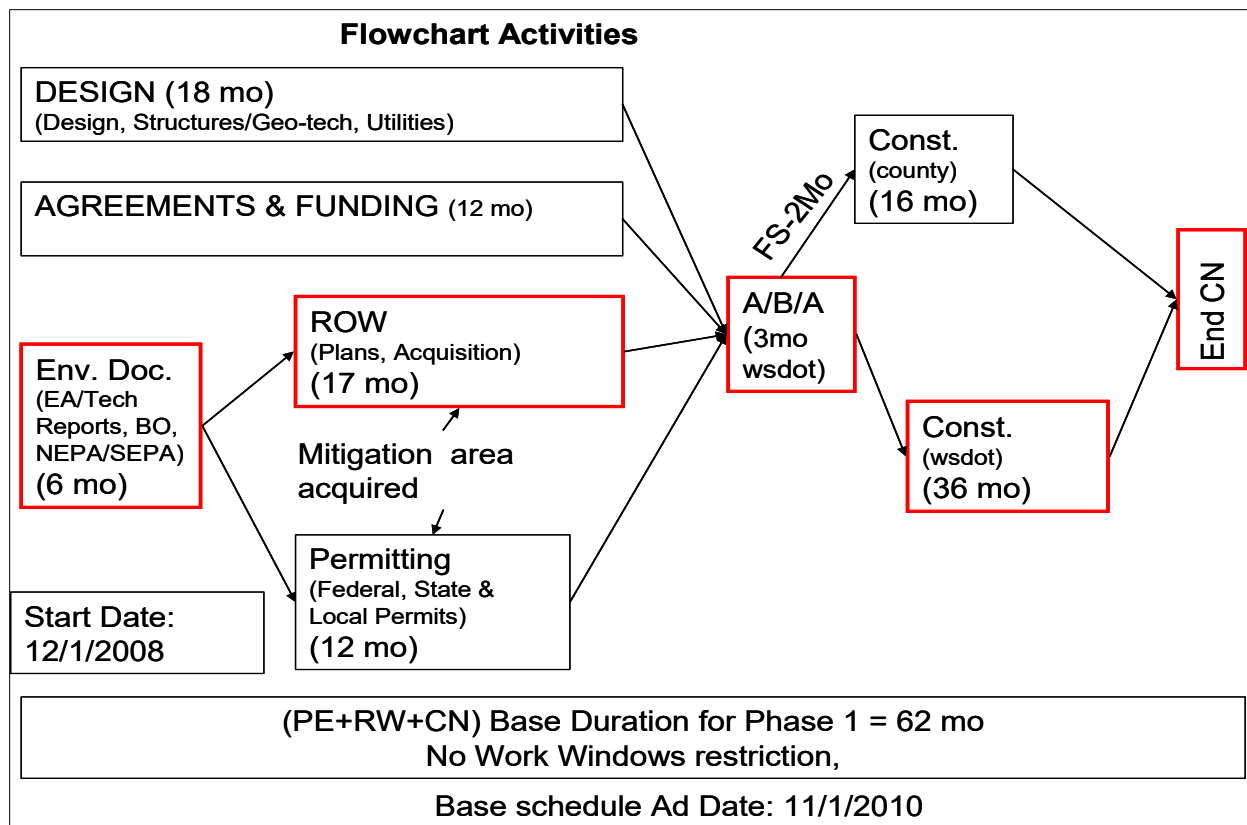
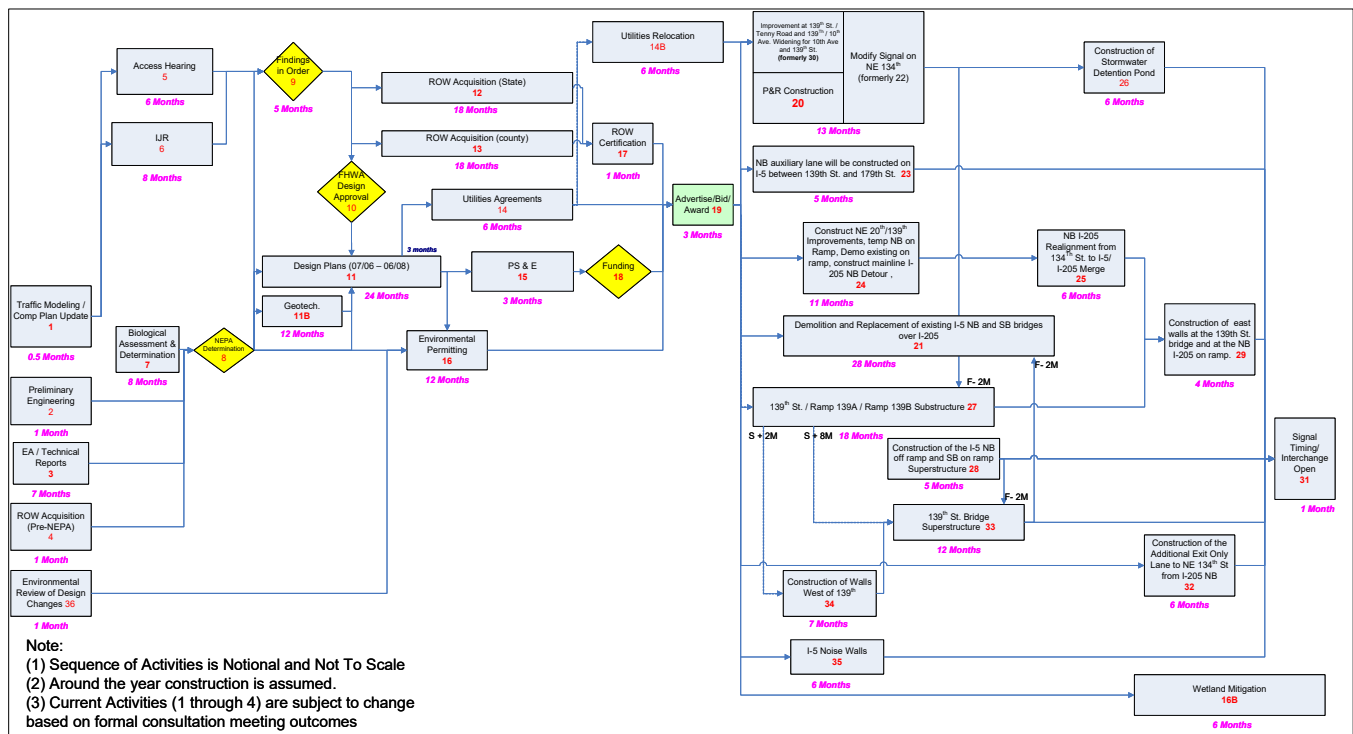
### 8-3.1 Prep Meeting

Objectives: Introduce the project and CRA/CEVP®, review the flowchart, identify major issues, define scenarios, begin estimate review, confirm participants, and set deadlines.

Deliverables:

- Project flowchart
- Preliminary Base Estimate review

## Exhibit 8-2 Flowchart Examples



### **8-3.2 Pre-Meeting Activities**

The Risk Lead reviews project information, past reports, and interviews SMEs to identify potential risks.

Activities:

- Review previous CRA/CEVP® reports and team inputs
- Conduct SME risk-elicitation interviews

Deliverables: Draft risk register, Initial Base Estimate, Basis of Estimate, and schedule

### **8-3.3 Risk Meeting**

During the CRA/CEVP® session, the team confirms assumptions, reviews the cost and schedule, and discusses uncertainties and market conditions. The Risk Lead guides identification of key risks, estimates their impacts, and assigns responsibility. The team agrees on next steps and follow-up actions.

Deliverables: Updated Base Estimate, risk register, and meeting notes

### **8-3.4 Analysis and Modeling**

After the meeting, the Risk Lead finalizes inputs, completes the risk register, and builds the quantitative model, including a 10,000-iteration Monte Carlo simulation to show how uncertainty affects cost and schedule.

Deliverables Integrated cost/schedule models, Validated inputs, Documented modeling process

### **8-3.5 Materials for a Results Briefing**

Prepare clear, simple materials summarizing findings, including cost and schedule ranges, key risks, and cost breakdowns by phase (PE, ROW, Construction) in CY and YOY dollars.

Deliverables: Presentation materials and notes

### **8-3.6 Reports**

The Risk Lead prepares the draft report, incorporates SME and reviewer feedback, and finalizes content for accuracy and clarity before delivering it to the Project Manager.

Deliverables Final report, including the one-page summary and resolved comments

### **8-3.7 Response Meeting**

The team develops and evaluates response strategies and documents the post-response outcomes.

Deliverables: Post-response risk register and response analysis

## **8-4 Cost Lead**

The Cost Lead validates the project's cost estimate and schedule, identifies cost and schedule risks, and confirms the final estimate used in the risk model.

Deliverables: Cost review notes suitable for reports

### **8-4.1 Major Cost Questions**

Cost reviews check whether the estimate is complete, realistic, and based on reliable information:

- Is the Basis of Estimate current and is design sufficiently developed?
- Have field investigations, geotechnical work, and ROW surveys been completed?
- Are assumptions clear for soils, utilities, staging, erosion control, and special conditions?

- Are overhead, insurance, bonding, QA/QC, and profit handled consistently?
- Are materials, logistics, and production rates realistic?
- Are traffic control, staging, mitigation, and contingencies included?

### 8-4.2 Major Schedule Questions

Schedule reviews assess whether the timeline is achievable:

- Is the duration realistic compared to similar projects?
- Are burn rates and workforce needs achievable?
- Is the start date seasonally appropriate?
- Are landscaping windows, mobilization, phasing, and traffic plans included?
- Are production rates realistic for major work items?

### 8-4.3 Tips for Cost Leads

- Focus on major cost drivers—avoid overanalyzing minor items.
- Ensure everyone understands how the estimate is organized.
- Remember: the project team owns the estimate; the Cost Lead reviews and validates it.

### 8-4.4 Base Cost

Cost estimates evolve; understanding how they were built ensures accuracy. Meet with the team to confirm assumptions and alignment with scope.

#### Confirm the Cost Matches the Scope

- Understand project limits and major elements
- Ensure drawings, scope, and estimate align
- Validate design assumptions (e.g., bridge type, materials)

#### Confirm Unit Prices

- Check prices against local conditions and recent projects
- Avoid outdated bid data
- Pay attention to bridge costs and major cost drivers
- Ensure taxes, ROW, mobilization, and markups are correct

#### Identify Contingency

- Remove contingency from the base estimate
- Document allowances

#### Align Flowchart

- Structure the estimate to match standard categories
- Coordinate with the risk team and workshop participants

#### Determine Risk Costs

- Identify risk items collaboratively
- Describe clearly
- Assess probability, impact, correlations and dependencies

#### Subject Matter Experts (SMEs)

SMEs provide technical insight, identify risks and cost drivers, and help clarify assumptions and impacts.

SME Expectations:

- Provide objective, discipline-specific input
- Encourage creative thinking aligned with project goals
- Understand CRA/CEVP® processes and document assumptions
- Participate in follow-ups and prepare concise summaries
- Include at least one SME with contractor-side estimating experience

## 8-5 CRA Coordinator – Duties (HQ/Region)

CRA Coordinators guide teams through the CRA/CEVP® process, ensure compliance with policy, and help teams access tools and information.

### Region Coordinator Duties

- Identify projects needing risk reviews in the next 12–24 months
- Assist with request forms
- Stay current on agency rules and training
- Promote early risk action
- Maintain clear records of risks and actions
- Reserve and set up space for in-person sessions

### Guide for a Typical Project

- Meet the team, identify tasks needing review, and set dates 4+ months ahead
- Ensure cost and risk steps are included in the project plan
- Submit the online risk request form
- Brief engineers and design staff
- Work with CREM to assign Cost Leads, Risk Leads, and SMEs
- Send invites, prepare project information, and ensure readiness
- Join prep sessions and risk meetings
- Track action items, update the risk register, and close tasks

### Tips

- Encourage teams to begin early when planning risk assessments
- Seek early input from structures, geotech, environmental, and other technical groups
- Keep scope, dates, and cost data current and organized by phase (PE, RW, CN)
- Create clear agendas so everyone understands the plan

## 9-1 Probabilistic Risk-Based Estimating Principles

These principles demonstrate mature and nuanced concepts that affect risk modeling. They encourage realism, precision, and strategic thinking—key ingredients for successful project delivery. By combining continuous modeling for cost/schedule with discrete treatment of event-based risks, PRBE offers a balanced framework that enhances forecasting accuracy and decision-making.

### 9-1.1 Treat Cost and Schedule as Continuous Variables

Cost and time change across a range as scope, market shifts, and team output change. Treating them as continuous inputs enables the use of tools, such as Monte Carlo, that show real ranges, not just one guess. This gives a truer sense of risk and avoids the false certainty that comes from a single fixed estimate.

### 9-1.2 Describe Risks Properly

Risk descriptions must be clear, use a simple title, and have an assigned owner. Major transportation infrastructure projects face many risks, from soil limits and permit delays to utility shifts, land needs, and more. It is also important to guard against mental habits that can harm judgment, such as being overly optimistic or too confident in the base estimate or the size of each risk. This is especially true for early project estimates based on limited design detail.

### 9-1.3 Risk Inputs

Most cost and time risks fit best as continuous inputs. This gives a fuller, truer sense of the range you might see. Use discrete inputs only for risks that hit in one clear step. Continuous inputs show all points from low to high. Major transportation projects show this same pattern. Costs rise bit by bit. Time slips in small steps. Crews gain or lose speed. Prices rise in tiny jumps. These changes do not fit into simple “yes/no” or “three-step” bins. If you force a smooth effect into a hard, fixed bin, you get false precision. It may look neat, but it does not match real project change.

## 9-2 Guidance

Risk-based estimating helps teams see the range of possible cost and time outcomes by simulating a project many times. A risk model captures the natural ups and downs that occur during delivery and forms the basis for cost ranges and schedule forecasts. Base variability reflects normal shifts in price or quantity that happen in daily activity, not from any risk event. It is usually shown as a modest range, often tilted upward since cost growth is more common than cost drops. This captures the normal uncertainty present in any project.

### Exhibit 9-1 Base Variability Guidance by Level of Design

| Level of Design | Typical Variability Range | Example Characterizations for modeling |
|-----------------|---------------------------|----------------------------------------|
| 90% +           | 0 to $\pm 5\%$            | -5% to +5%                             |
| 60% to 90%      | $\pm 5\%$ to $\pm 10\%$   | -5% to +8%                             |
| 30% to 60%      | $\pm 10\%$ to $\pm 15\%$  | -8% to +12%                            |
| Pre 30%         | $\pm 10\%$ to $\pm 20\%$  | -8% to +16%                            |

Market conditions come from supply and demand and affect prices, labor, and the bidding climate. They are separate from inflation. These conditions include the strength of the labor pool, the supply of materials, the number of bidders, the size and setup of the job, and the timing of the bid. Each of these factors can raise or lower prices and shape how firms respond. These factors are shown in [Exhibit 9-2](#). Then [Exhibit 9-3](#) illustrates Inflation, Base Variability and Market Conditions.

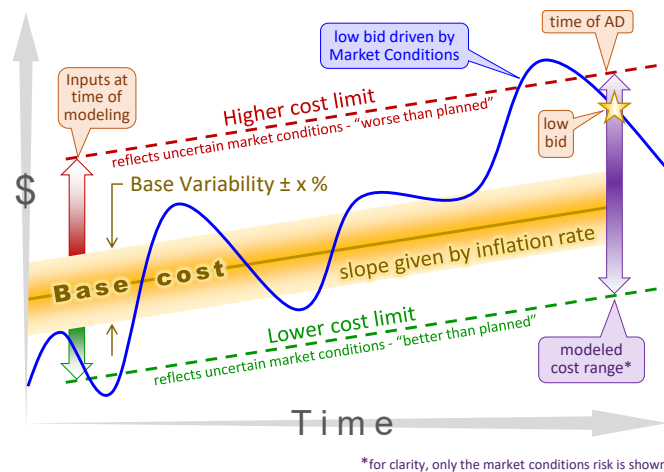
**Exhibit 9-2 Capturing Base Market Conditions**

| Model inputs            | Probability | Impact |
|-------------------------|-------------|--------|
| Better than planned [1] | 10%         | 10%    |
| Worse than planned [2]  | 40%         | 20%    |

[1] **Better than planned:** Favorable market conditions create a strong bidding climate. There is a 10% chance that bids may come in up to 10% below the Engineer's Estimate.

[2] **Worse than planned:** A noncompetitive bidding climate creates upward pressure on prices. There is a 40% chance that bids may come in up to 20% above the Engineer's Estimate.

**Exhibit 9-3 Inflation, Base Variability, and Market Conditions**



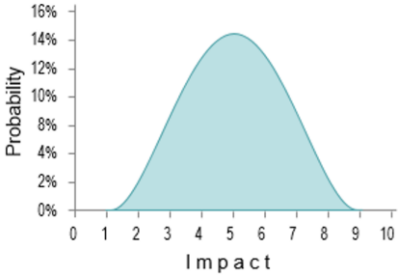
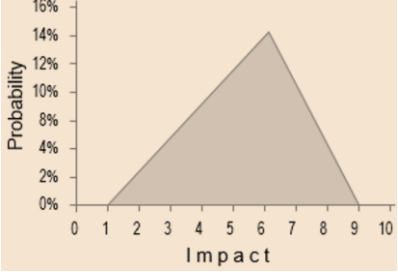
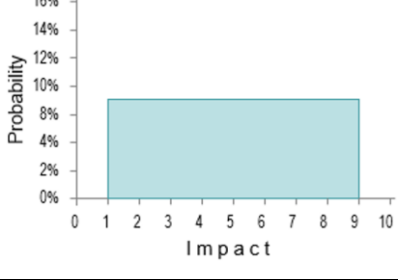
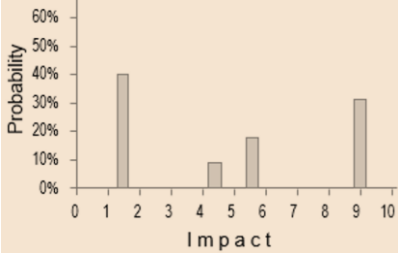
### 9-2.1 Base Schedule Variability

Base schedule variability adds a small allowance for normal shifts in task durations. Set this in coordination with the scheduling team. It reflects early uncertainty in how long activities may take, even if no specific risks occur, and is especially important for large, complex project schedules.

### 9-2.2 Distributions

The Risk Lead selects the distribution that best reflects each risk. Distributions show the range and shape of uncertainty. The Risk Lead elicits the likelihood of the event and, in most cases, its impact as a minimum, maximum, and most likely value. Each risk has two core parts: its probability of occurring and its impact on cost or schedule if it does. Exhibit G-4 shows four common distributions.

## Exhibit 9-4 Common Model Distributions

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <p><b>Continuous Distribution (PERT / Beta)</b></p> <p>A continuous distribution defined by minimum, most likely, and maximum values. The PERT (Beta-PERT) form is widely used because it places greater weight on the most likely value and reduces the influence of extreme values.</p> $\text{Mean} = \frac{\text{min} + 4(\text{most likely}) + \text{max}}{6}$ <p>Example - Geotechnical settlement risk: soil settlement may vary, but engineers have sense of the most likely value, and less certainty at the extremes. PERT—smooths the curve and avoids over-emphasizing worst-case values.</p> |    |
| <p><b>Triangular Distribution</b></p> <p>A simple three-point distribution defined by minimum, most likely, and maximum values. Unlike PERT, the triangular distribution gives equal weight to the slopes on each side of the peak.</p> $\text{Mean} = \frac{\text{min} + \text{most likely} + \text{max}}{3}$ <p>Example - Utility relocation duration: the team may know the shortest, longest, and most likely time needed, but the uncertainty is not complex enough to justify a smoother PERT curve. Triangular is simple and appropriate.</p>                                                      |    |
| <p><b>Uniform Distribution</b></p> <p>A continuous distribution defined only by minimum and maximum values. Every value in the range is equally likely. Used when there is no basis to favor one outcome over another.</p> $\text{Mean} = \frac{\text{min} + \text{max}}{2}$ <p>Example - Minor material price fluctuation: if asphalt suppliers indicate that prices could fall anywhere between two bounds and there is no clear trend, a uniform distribution is appropriate.</p>                                                                                                                      |   |
| <p><b>Multi-Point Discrete Distribution</b></p> <p>Used if a risk can only take specific, discrete outcomes, each with its own probability. Probabilities must sum to 100%. It models “either/or” situations.</p> $\text{Mean} = \sum(p_i \cdot x_i)$ <p><math>p_i</math> = probability of outcome <math>i</math><br/> <math>x_i</math> = impact of outcome <math>i</math></p> <p>Example - Environmental permit approval outcome:<br/>         60% chance of no delay   30% chance of 3-mo. delay   10% chance of 12-mo. Delay</p>                                                                       |  |

## 9-2.3 Risk Conditionality

Risk conditionality refers to how risks are connected or correlated. These relationships fall into three main types:

- Independent - One risk can occur regardless of whether another does.
- Example: Rolling one die has no effect on the outcome of a second die.
- Mutually Inclusive (Dependent-Inclusive)- One event can occur only if another event occurs first.
- Example: Rolling double-sixes requires the first die to show a six.
- Mutually Exclusive (Dependent-Exclusive) - One event can occur only if another event does not occur.
- Example: If you miss the boat, you cannot get seasick on the trip.

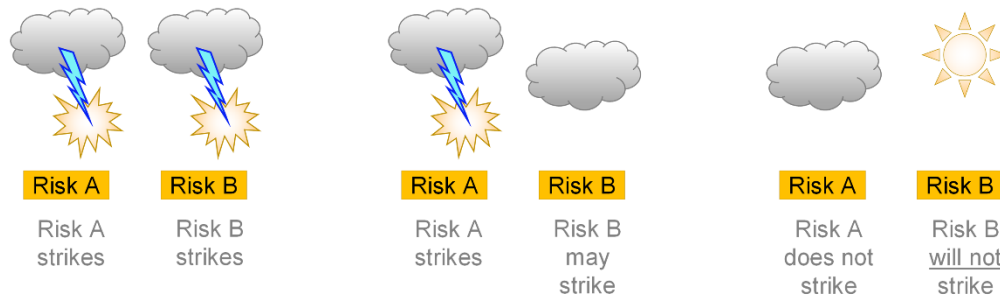
## Exhibit 9-5 Risk Dependency Scenarios

**Mutually Inclusive Risks:** Risk B can occur **only if** Risk A occurs. In other words:

- Risk A occurs → Risk B occurs
- Risk A occurs → Risk B may occur
- If Risk A does *not* occur → Risk B cannot occur

This is a *dependency* relationship: **A is a prerequisite for B.**

**Mutually Inclusive – Risk B can strike only if Risk A strikes**



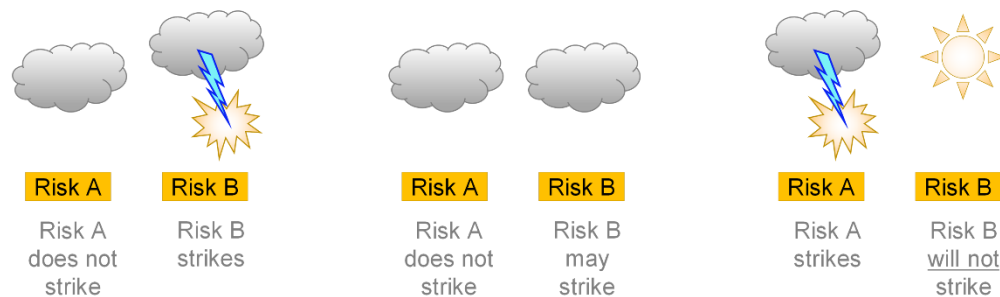
### Mutually Exclusive Risks

Risk B can occur **only if** Risk A does **not** occur. In other words:

- Risk A does not occur → Risk B occurs
- Risk A does not occur → Risk B may occur
- If Risk A occurs → Risk B cannot occur

This is an **exclusion** relationship: **A prevents B.** If A happens, B is ruled out.

**Mutually Exclusive – Risk B can strike only if Risk A does not strike**

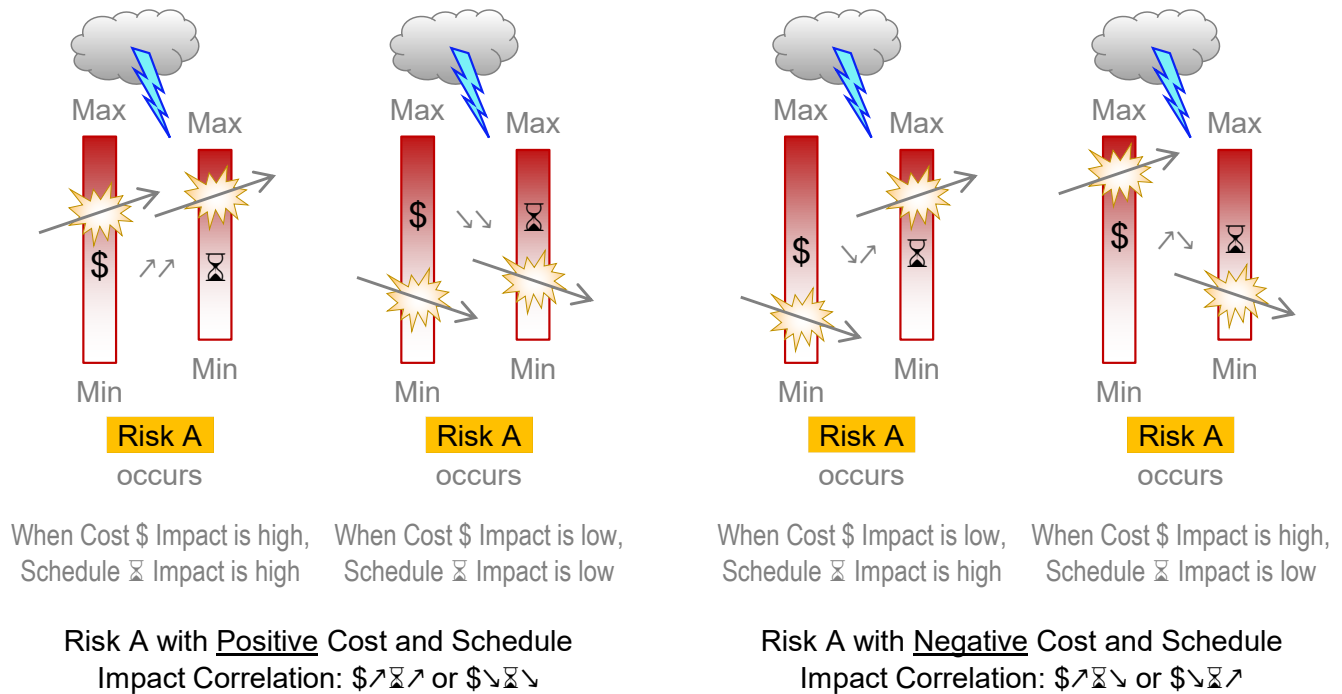


Correlation may be present within a single risk's cost and schedule impact variables (see [Exhibit 9-6](#)), or between the impact variables of two or more discrete risks (see [Exhibit 9-7](#)). It is a statistical description of an apparent or expected parity or disparity of impact severity—severity being a possible outcome within the quantified impact range distribution. For example, a high severity cost impact would be more towards the maximum value than the most-likely value. It is statistically expressed as  $r$ , a coefficient between negative one and one (-1 and 1). Like Dependency, it also has three cases:

- Not Correlated has a statistical expression of zero (0). It means that the severity of cost and schedule impacts of a risk have no bearing on one another. Within a single risk, the severity of cost impact may be low while the schedule impact may be high, low, or relatively the same, and versa visa.

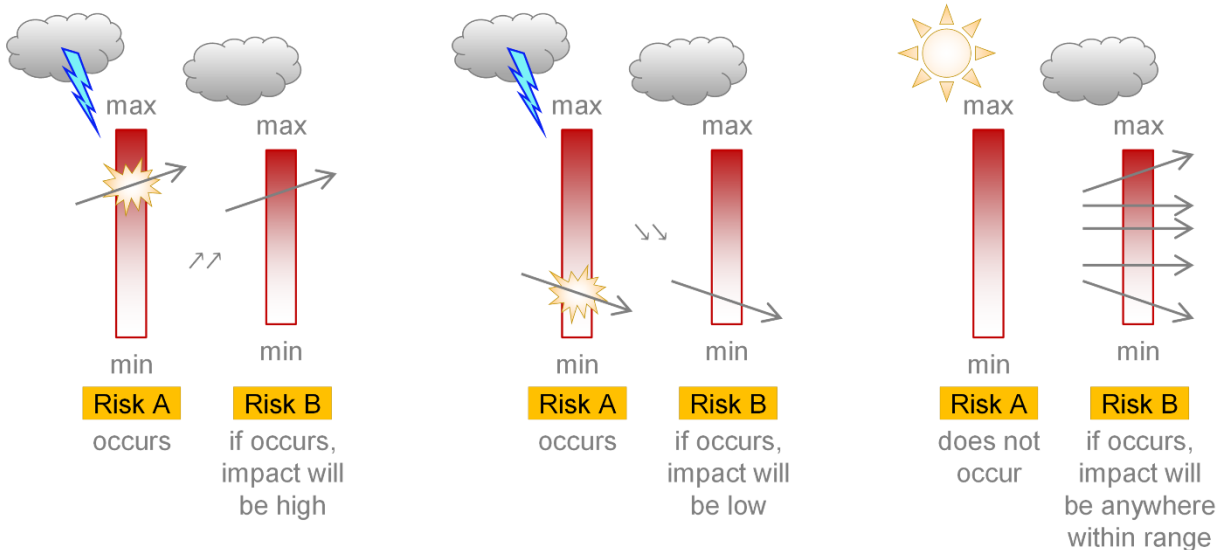
- Positively Correlated has a coefficient greater than zero but no more than one ( $0 < r \leq 1$ ). It means that when one impact severity variable is high the other is high ( $\nearrow \nearrow$ ), or when one is low the other is also low ( $\searrow \searrow$ ). A one (1) indicates that this always happens, and less than means less certainty, less synchronized tendency.
- Negatively Correlated has a coefficient less than zero but no less than negative one ( $-1 \leq r < 0$ ). It means that when one impact severity variable is high the other is low ( $\nearrow \searrow$ ), or when one is low the other is high ( $\searrow \nearrow$ ). A negative one (-1) indicates that this always happens, and closer to zero (0) means less certainty, less synchronized tendency.

Exhibit 9-6 Correlation between Impact Variables within a Single Risk

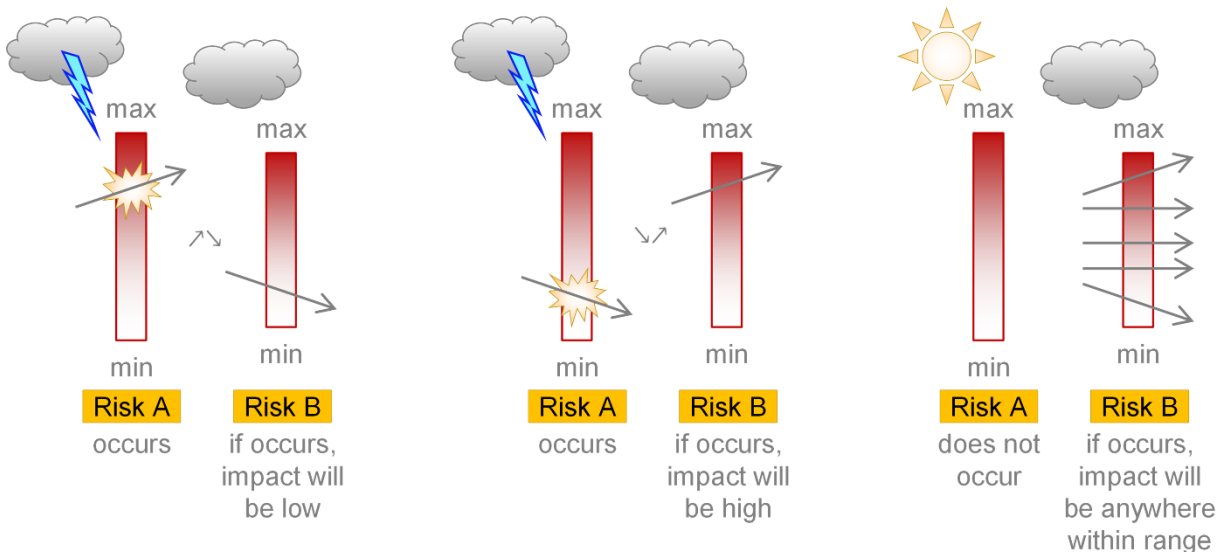


## Exhibit 9-7 Correlation between Risk Impact Variables between Risks

Risks A and B with Positive Impact Correlation: ↗↗ or ↘↘



Risks A and B with Negative Impact Correlation: ↗↘ or ↘↗

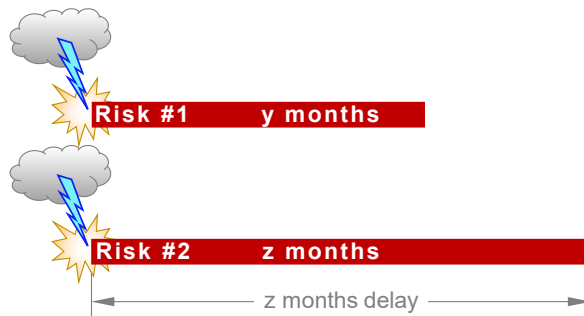


Dependency can readily be modeled with analysis logic. Correlation can be modeled statistically or the relationship among correlated events can be described in terms of conditional probability networks. The conditional probability “event tree” has been used successfully in many transportation-oriented risk evaluations.

**Risk Schedule Impacts** – The better risk models integrate cost and schedule but be aware that schedule impacts between risks may manifest in parallel or in series. Indicating this, if expected, is important when modeling in order to generate realistic simulation outcomes. See [Exhibit 9-8](#).

## Exhibit 9-8 Risk Schedule Impacts: Parallel and Series

## Parallel Schedule Impacts



## Series Schedule Impacts



## 9-2.4 Other Typical Model Considerations

**Design-Build vs. Design-Bid-Build** - The delivery method influences several model inputs, most notably the Change Order Contingency. Design-Bid-Build typically uses 4%, while Design-Build uses 5%. Design-Build also allows concurrent pre-construction and construction activities, which can affect schedule and risk modeling.

**Estimate Date vs. Model Date** - Ideally, these dates should match or be very close. If they differ, the estimate should be updated so it is current for the workshop and aligns with the model's assumptions.

**Inflation Points** - The default practice is to inflate costs to the midpoint (50%) of each phase. If project delivery is uneven—such as front-loaded or back-loaded progress payments—the inflation point should be adjusted to reflect the actual expenditure pattern.

**Inflation Rate** - When producing a year-of-expenditure forecast, the model must apply an inflation rate. Some models use a single rate across all phases, while others allow phase-specific rates or reference external inflation tables maintained by agencies or services.

**Number of Iterations or Simulated Realizations** - Typical Monte Carlo simulations use 5,000 to 10,000 iterations to achieve stable and statistically meaningful results.

**Risk Markups** - Some models incorporate additional peripheral costs associated with risk impacts—such as Mobilization, Sales Tax, or Engineering. These are usually applied as a percentage markup on the simulated cost impact of each risk.

**Spent-to-Date** - When modeling after expenditures have already occurred, the spent-to-date amount must be accounted for in total reporting. However, past expenditures should not be inflated when calculating the year-of-expenditure forecast; only future costs should be escalated.

### 9-2.5 Model Outputs and Risk Response

Likely there is some anecdotal or intuitive awareness of the big project risks among the project team members before any quantitative risk assessment or modeling; however, the formal analysis offers a more objective, probabilistic presentation. Like a microscope, Monte Carlo simulation results can reveal more than was visible unaided.

Risk assessment is only half of risk management; the other half is response. Because response requires resources, it must be optimized. Assessment data should be used to identify which risks and strategies deliver the greatest value. A common approach is to rank risks, then address those most suitable for mitigation until benefits diminish. Impact and probability both matter—yet impact is typically more important.

Expected Value (EV) is one method of generating a value to use for prioritizing and ranking risks. It integrates a risk's probability and impact, as shown in [Exhibit 9-9](#). It serves well, but one should be warned that this calculation could de-emphasize a high impact risk that has low probability, placing it lower on a priority list—perhaps below an arbitrary cut-off—prompting less attention than it deserves and thus, if the impact is great enough, potentially devastating the project.<sup>3</sup>

#### Exhibit 9-9 Expected Value Formula

The expected value of individual random variables is the probability-weighted average of input values.

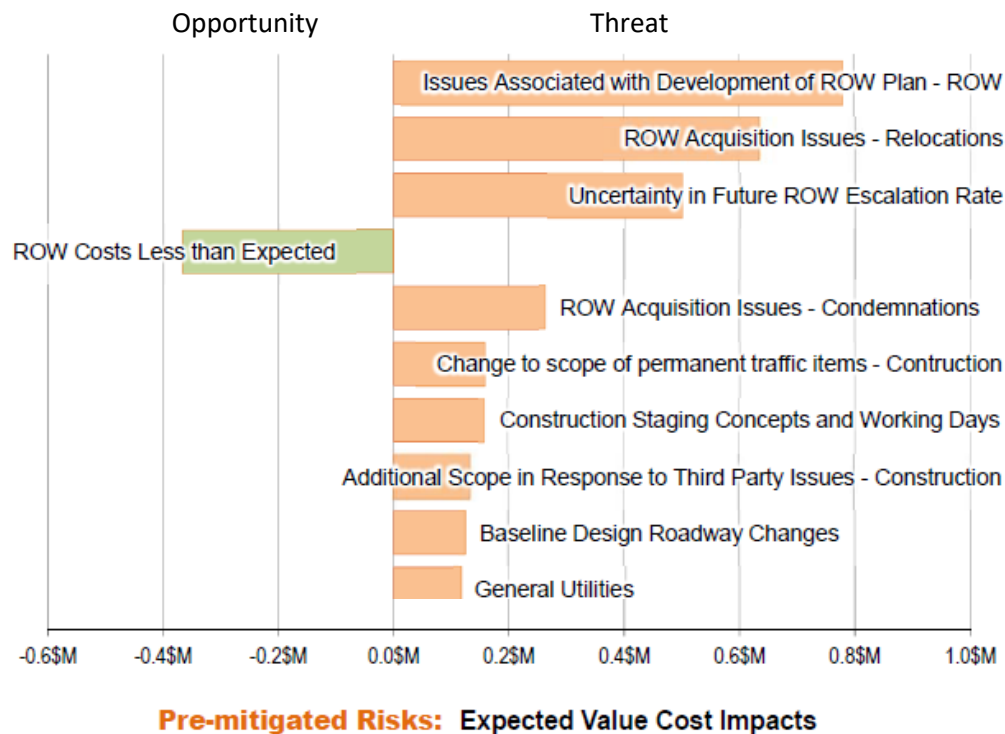
$$\text{Expected Value} = \text{Probability} \times \text{Impact:} \left( \frac{\text{min} + 4(\text{most likely}) + \text{max}}{6} \right)$$

*In a three-point estimate, impact can be calculated using the Project Evaluation and Review Technique (PERT) formula, in parenthesis above.*

Tornado Diagram (also called a “regression sensitivity chart”) is an effective visualization to aid decision making. It usually employs Expected Value calculations, and it readily conveys a sense of relative risk magnitude. See example, [Exhibit 9-10](#).

<sup>3</sup> If this happened, in retrospect, some might call it a “Black Swan” event, after Taleb (2007), but that more strictly applies to major-consequence, unpredictable, “unknown-unknown” category of events, like the Fukushima nuclear disaster. In our case, this would more properly, and more embarrassingly be called a “Grey Swan”; a “known-unknown” event, foreseeable, but with underappreciated probability and impact. See *Glossary*.

Exhibit 9-10 Example Tornado Diagram



### 9-2.6 Risk Response Analysis

After prioritizing, strategizing, and planning risk responses, it is useful to estimate the effectiveness of the response. One purpose is to determine the value of the response, which is analogous to the value of risk management (RM) for the project.

Quantifying the value of risk management not only gratifies the institution, but it also incentivizes the careful performance of initial and subsequent RM activities. The response analysis quantifies and measures the promise of the return on investment of proactive risk management.

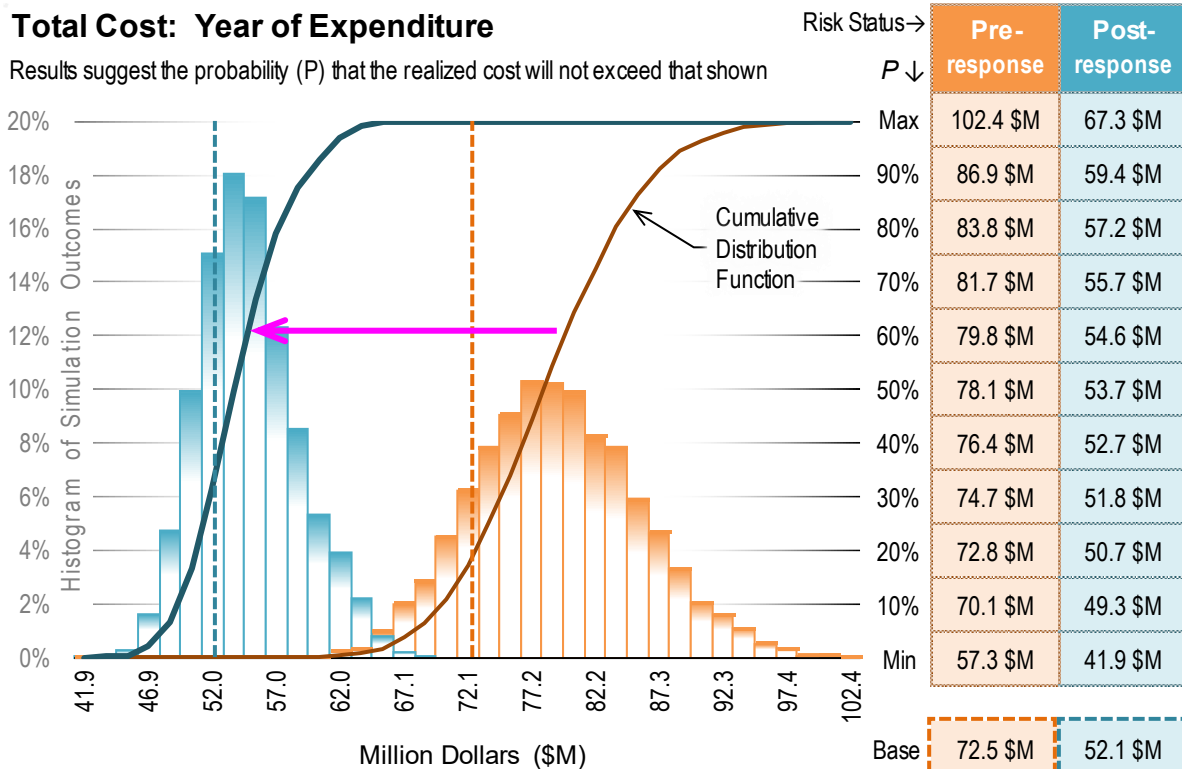
A model output is a snapshot in time of a dynamic project progression. Many things change between the present and when the project is under construction. Recommended practice is to quantify the effect of risk response actions as soon as practicable following the initial analysis.

Quantifying and modeling the risk response and noting the difference between that output and the initial risk assessment model output, demonstrates the potential time and money savings that could be realized through risk management.

The team goes through each significant risk and determines how effective the response plan is in reducing threats and maximizing opportunities. Although speculative, it is no less valid than the initial assessment, particularly when developed by the same assessment team.

Modeling may be done using a separate model or an application that can handle both risk and risk response. Communicating the findings, may be done using numbers, like the difference between the 60th percentile outputs, but the most compelling output presentations contrast the two in some manner. See example, [Exhibit 9-11](#).

## Exhibit 9-11 Example Model Output Contrasting Risk Analysis with Risk Response Analysis



Graphical model output displaying the distribution shift from Risk Analysis (Pre-response) results to Response Analysis (Post-response) results.

As the project design progresses, or the scope changes, it may be necessary to update the risk model. Care must be taken when comparing model outputs to ensure they are relevant to the project under study – to ensure we are not comparing apples with oranges.

Risk management sets the stage for success, beginning at the project kickoff meeting and continuing through every phase. The RMP outlines how risks will be identified, assessed, and mitigated. It serves as a reference guide for project teams and evolves based on project complexity and scope.

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*“A formal risk management plan is a detailed plan of action for the management of risk. Risk management planning involves thoughtful development, implementation, and monitoring of appropriate risk response strategies. It is the process to develop and document an organized, comprehensive, and interactive risk management strategy; determine the methods to be used to execute a risk management strategy; and plan for adequate resources.” NCHRP 658*

---

The RMP varies based on the size and complexity of the project, but many projects include an outline like the following:

| Item                          | Description                                     | Resource                               |
|-------------------------------|-------------------------------------------------|----------------------------------------|
| 1. Introduction               | Risk management process overview.               | Ch. 1                                  |
| 2. Definitions                | Explanation of terms used.                      | CREM Glossary                          |
| 3. Organization               | Roles and responsibilities.                     | Exhibit 7.1 and Sections B, C, D, E, F |
| 4. Risk Identification        | Methods for Identifying risks.                  | Ch 2                                   |
| 5. Risk assessment & analysis | Describe/assess risk impacts and likelihood.    | Ch 3 & 4                               |
| 6. Risk Response/allocation   | Develop and implement response actions.         | Ch 5                                   |
| 7. Risk Monitoring & Control  | Track risks and adjust as necessary.            | Ch 6                                   |
| 8. Documentation              | Record/communicate project risks and responses. | Ch 6 & 7                               |

Like other structured components of the project design schedule, risk management follows a standard breakdown format outlined in the [Master Deliverables List](#) (MDL). This list is part of the broader suite of resources within the [Project Management Guide](#). Specifically, the Cost Risk Estimating Management activities can be found under the Project Management tab, identified as PM.04 – Cost Risk Estimating Management. This section provides essential guidance for planning and executing effective cost risk analysis throughout the project lifecycle.

The Project RMP should include regular assessments, tracking, updates, and milestone-based reviews. [Exhibit 10-1](#) summarizes key responsibilities.

The Uncertainty Performance Domain, as defined by PMI, empowers project teams to navigate complexity with confidence. Proactive risk management drives agility and sharpens decision-making. Uncertainty happens; success lies in being prepared.

## Exhibit 10-1 Roles and Responsibilities in Project Risk Management

### Project Manager

- Serves as the project's strategic lead and oversees all risk management efforts.
- Approves the Risk Management Plan (RMP).
- Coordinates stakeholder communication and ensures alignment across teams.
- Promotes a proactive, risk-aware culture throughout the project lifecycle.
- Approves and monitors response actions effectiveness.
- Leads regular RMP reviews and risk meetings.
- Communicates key risk issues and updates to senior management.

### Project Team Member

- Supports project execution by performing assigned tasks and contributing to risk awareness.
- Proactively identifies and assesses risks in their area of responsibility.
- Implements assigned response actions and supports mitigation efforts.
- Documents risk-related actions and communicate updates to the Project Manager.
- Monitors and evaluates the impact of response actions on project outcomes.

### Project Risk Manager

- Develops and maintains the project's overall risk management framework.
- Prepares and updates the Project RMP, including check-in milestones.
- Coordinates the planning and facilitation of pre- and post-risk meetings.
- Identifies, analyzes, and prioritizes project risks in collaboration with stakeholders.
- Oversee daily risk management tasks and ensure high data quality.
- Facilitates external support (e.g., consultants) when needed.
- Tracks and reports on the effectiveness of response actions.

### Risk Owner (Action Owner)

- Responsible for executing specific risk response actions.
- Implements assigned actions and provide regular updates.
- Monitors outcomes and identifies any emerging risks related to the response.
- Communicates ongoing progress and any changes in risk status.

## 10-1 RMP (Simplified)

1. Choose Your Risk Approach
  - a. Qualitative: Quick, non-numerical ranking of risks.
  - b. Quantitative: Data-driven analysis. Use tools like:
    - i. Risk-Based Estimating Meeting
    - ii. Cost Risk Assessment (CRA)
    - iii. Cost Estimate Validation Process (CEVP)
2. Build Risk into the Schedule
  - a. Use the Master Deliverables List (MDL) to add key risk tasks. Tailor them to your project milestones.
3. Align Risk with Core Project Work
  - a. Cost Estimating: Include risks in the Basis of Estimate.
  - b. Scheduling: Reflect risk events and buffers in timelines.
  - c. Quality Management: Link risks to quality checks and controls.
4. Track and Customize
  - a. Use something like [Exhibit 10-2](#) to track risks. Adapt it to suit your team's workflow and reporting needs.

## Exhibit 10-2 EXAMPLE Risk Management Activities

| MDL Code    | Name                              | Description                                                                                                                                                                                                                                                                                                               |
|-------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PM.04       | Cost Risk Estimating & Management | Cost Risk Estimating and Management (CREM) involves developing the project cost and schedule estimates and assessing project risk.                                                                                                                                                                                        |
| PM.04.10    | CEVP®                             | Cost Estimate Validation Process (CEVP) - a team of experienced engineers and risk managers conduct a thorough review of costs, schedules, and risks. Experts from private firms and public agencies bring firsthand knowledge of large-scale projects. Using systematic methods, they assess risks and evaluate impacts. |
| MDL Code    | Name                              |                                                                                                                                                                                                                                                                                                                           |
| PM.04.10.10 |                                   | Preliminary communications, meetings, and activities                                                                                                                                                                                                                                                                      |
| PM.04.10.20 |                                   | Prep Meeting and documentation                                                                                                                                                                                                                                                                                            |
| PM.04.10.30 |                                   | Pre-CEVP Activities   review reports, advance risk elicitation                                                                                                                                                                                                                                                            |
| PM.04.10.40 |                                   | CEVP Meeting                                                                                                                                                                                                                                                                                                              |
| PM.04.10.50 |                                   | Perform Risk Analysis (develop and run the Monte Carlo model)                                                                                                                                                                                                                                                             |
| PM.04.10.60 |                                   | Prepare results presentation                                                                                                                                                                                                                                                                                              |
| PM.04.10.70 |                                   | Prepare Draft and Final reports                                                                                                                                                                                                                                                                                           |
| PM.04.10.80 |                                   | Risk Response Meeting and Analysis                                                                                                                                                                                                                                                                                        |
| PM.04.10.90 |                                   | Risk Monitoring and Control                                                                                                                                                                                                                                                                                               |

Exhibit 10-4 offers a format for the opening pages of a project risk management plan.

## 10-2 Master Deliverables List

The Master Deliverables List (MDL) is a standardized work breakdown structure that WSDOT has developed as an organized and consistent list of WSDOT milestones and deliverables. The MDL is structured into 3 levels as follows:

**Level 1: Process** — Actions or steps taken to achieve an objective; (contrast with phase which is a distinct period of development or funding, for example PE, RW, CN)

**Level 2: Group** — Identifies specialty groups or major element of work that will achieve milestones and produce deliverables.

**Level 3: Milestones & Deliverables** — A milestone marks a major point in a timeline and serves as a reference point for major project decisions or events; a deliverable is a product or service - a project may contain multiple deliverables.

Additional Levels (added as necessary) Activities or groupings that are added and defined by the project team.

Deliverables Examples:

- Basis of Design (signed and approved).
- Design Approval.
- Environmental Documentation Complete.
- Project Development Approval.
- Right of Way Certification.

Milestones Examples:

- Ad Date,
- Construction Start,
- Issue RFP.

### 10-2.1 How to Use the MDL

Tailor the MDL to your specific project by carefully reviewing the groups and deleting those not needed for your project. Those that remain comprise the initial work breakdown structure for the project. For each group in your project review the deliverables to ascertain those needed for your project.

MDL tabs are organized by significant work processes; they may be arranged or combined in any fashion to represent the project delivery process. For example, community engagement efforts may take place in scoping, design and construction on a project. Users of this tool should use it in the manner that works best for the project.

**Exhibit 10-3 Schematic of MDL Structure**

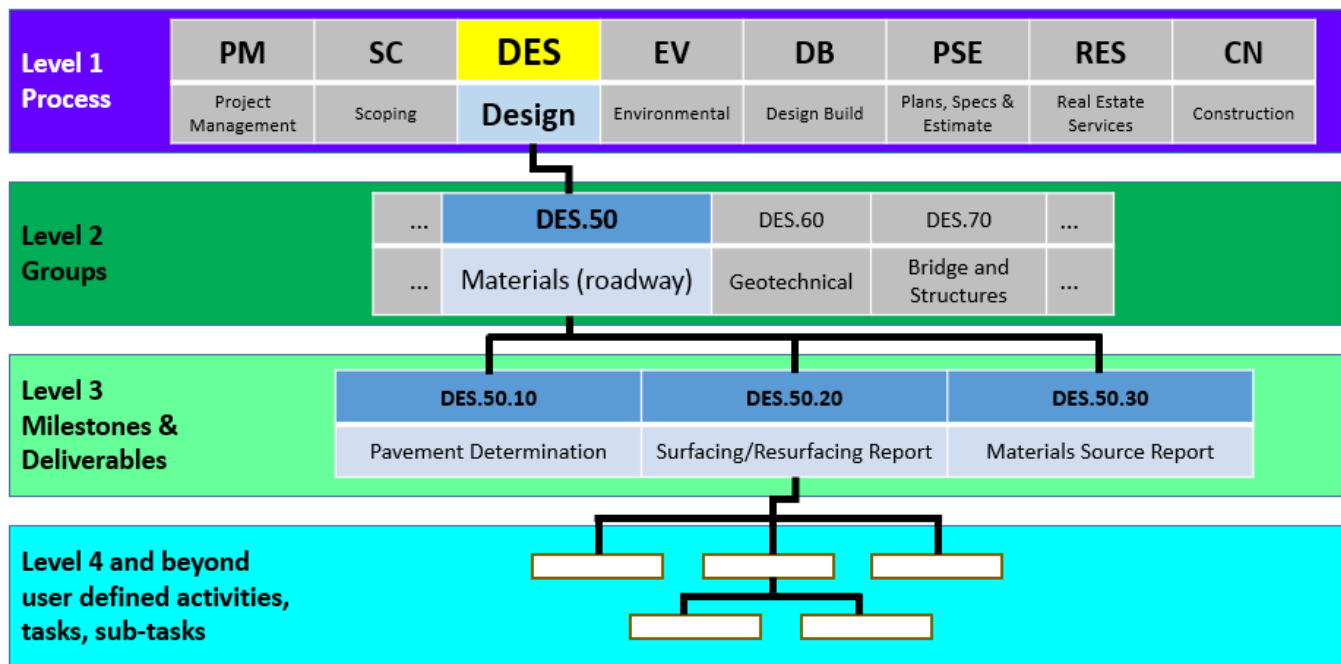


Exhibit 10-4 Project Risk Management Plan *SAMPLE* page 1

## Project Risk Management Plan

Official Project Title: \_\_\_\_\_

State Route: \_\_\_\_\_ Project Manager: \_\_\_\_\_

MP Limits: \_\_\_\_\_ Risk Manager: \_\_\_\_\_

PIN: \_\_\_\_\_ WIN: \_\_\_\_\_ L#: \_\_\_\_\_

### Introduction

This Risk Management Plan serves as the structure for identifying, assessing, and proactively responding to risks throughout the project's lifecycle. The Project Manager holds primary responsibility for maintaining and reviewing this plan, ensuring that all identified risks are appropriately managed by the project team. Regular updates and assessments will be conducted to adapt to evolving project conditions and maintain risk preparedness.

### Project Manager Review

Initial and date after each review and update of this Risk Management Plan:

| Year | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|------|-----------|-----------|-----------|-----------|
| 2026 |           |           |           |           |
| 2027 |           |           |           |           |
| 2028 |           |           |           |           |

Project Risk Management Plan *SAMPLE* page 2

| <b>Project Risk Management Performance</b>      |                           |                           |                           |                           |
|-------------------------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>Date:</b> _____                              |                           |                           |                           |                           |
|                                                 | <b>CEVP</b><br>Meeting #1 | <b>CEVP</b><br>Update     | <b>CEVP</b><br>Update     | <b>CEVP</b><br>Update     |
| <b>Date(s)</b>                                  |                           |                           |                           |                           |
|                                                 | <b>CEVP</b><br>Meeting #1 | <b>CEVP</b><br>Update     | <b>CEVP</b><br>Update     | <b>CEVP</b><br>Update     |
| <b>Base Cost Estimate</b>                       |                           |                           |                           |                           |
| <b>Validated Base Cost Estimate</b>             |                           |                           |                           |                           |
|                                                 | <b>CRA</b><br>Workshop #1 | <b>CRA</b><br>Workshop #2 | <b>CRA</b><br>Workshop #3 | <b>CRA</b><br>Workshop #4 |
| <b>Total # of Risks Identified</b>              |                           |                           |                           |                           |
| Total \$ Threats                                |                           |                           |                           |                           |
| Total \$ Opportunities                          |                           |                           |                           |                           |
| \$ Savings of Response                          |                           |                           |                           |                           |
| \$ Cost of Risk Response                        |                           |                           |                           |                           |
| \$ Cost Avoided through Proactive Risk Response |                           |                           |                           |                           |

| <b>RBS Code</b> | <b>Risk Break Down Structure Group</b> | <b>Number of Risks</b> | <b>Value of Threats \$</b> | <b>Value of Opportunities \$</b> |
|-----------------|----------------------------------------|------------------------|----------------------------|----------------------------------|
| ENV             | Env and Hydraulics                     |                        |                            |                                  |
| STG             | Structures and Geotechnical            |                        |                            |                                  |
| DES             | Design/PS&E                            |                        |                            |                                  |
| ROW             | Right of Way and Access                |                        |                            |                                  |
| UTL             | Utilities                              |                        |                            |                                  |
| RR              | Railroad                               |                        |                            |                                  |
| PSP             | Partnerships & Stakeholders            |                        |                            |                                  |
| MGT             | Management and Funding                 |                        |                            |                                  |
| CTR             | Contracting & Procurement              |                        |                            |                                  |
| CNS             | Construction                           |                        |                            |                                  |
| PRE             | Premiums                               |                        |                            |                                  |

These terms are to clarify context for readers of this manual.

## 11-1 Acronyms

|       |                                                                                        |        |                                                                       |
|-------|----------------------------------------------------------------------------------------|--------|-----------------------------------------------------------------------|
| AACE  | Association for the Advancement of Cost Engineering International (AACE International) | PMBOK™ | Project Management Body of Knowledge (PMI's PMBOK)                    |
| BIN   | Budget Item Number                                                                     | PMI    | Project Management Institute Combined Standards Glossary              |
| BOD   | Basis of Design                                                                        | PMP    | Project Management Plan                                               |
| BOE   | Basis of Estimate                                                                      | PRE    | Premiums                                                              |
| CEVP® | Cost Estimate Validation Process®                                                      | PRM    | Project Risk Management                                               |
| CREM  | Cost Risk Estimating Management                                                        | RBS    | Risk Breakdown Structure                                              |
| CY    | Current Year                                                                           | RMP    | Risk Management Plan                                                  |
| DB    | Design Build                                                                           | ROD    | Record of Decision; Revenue Operations Date (FTA)                     |
| DBB   | Design Bid Build                                                                       | ROW    | Right of way                                                          |
| EA    | Environmental Assessment                                                               | TAG    | Transportation Analysis Group                                         |
| EIS   | Environmental Impact Statement                                                         | TDM    | Transportation Demand Management                                      |
| FEIS  | Final Environmental Impact Statement                                                   | TEIS   | Transportation Executive Information System                           |
| FHWA  | Federal Highway Administration                                                         | TPA    | Transportation Partnership Act (Washington State Program of Projects) |
| FRA   | Federal Railroad Administration                                                        | TRAC   | Transportation Center (WSDOT research center)                         |
| FTA   | Federal Transit Administration                                                         | TSM    | Transportation System Management                                      |
| FY    | Fiscal Year                                                                            | VE     | Value Engineering                                                     |
| ISO   | International Organization for Standardization                                         | WIN    | Work Item Number                                                      |
| GSP   | General Special Provisions                                                             | WSDOT  | Washington State Department of Transportation                         |
| NTP   | Notice to Proceed                                                                      | YOE    | Year of Expenditure                                                   |
| PIN   | Program Item Number                                                                    |        |                                                                       |

## 11-2 Terms

### A

#### accuracy range

An expression of an estimate's predicted closeness to final actual costs or time. Typically expressed as high/low percentages by which actual results will be over and under the estimate along with the confidence interval these percentages represent. *See also:* **Confidence Interval; Range.**

(1)  
Dec  
2011

#### actual cost

Total *costs* actually incurred and recorded in accomplishing *work* performed during a given time period for a *schedule activity* or *work breakdown structure component*. Actual cost can sometimes be direct labor hours alone, direct costs alone, or all costs including indirect costs. Also referred to as the actual cost of work performed (ACWP).

(15)

**“Acts of God”** aka. *act of nature* (2)

Inevitable, unpredictable, and unreasonably severe event caused by natural forces without any human interference, and over which an insured party has no control, such as an earthquake, flood, hurricane, lightning, snowstorm. Acts of God *can* be insurable accidents and valid excuses for non-performance of a contract. *Also see Force Majeure.*

**allowance** (19)

Additional resources included in an estimate to cover the cost of known but undefined requirements for an activity or work item. Allowance is a base cost item. Examples include Design Allowance, Change Order Allowance, etc.

**analysis**

The process of systematically examining the assessed information to generate insights, estimates, or predictions.

In a Monte Carlo context, it typically involves:

Running computations: executing simulations using the probability and impact ranges defined during assessment.

Processing results: aggregating outputs, calculating metrics (e.g., percentiles, ranges), and identifying patterns.

Supporting decisions: translating results into findings that inform decision-making, design, and risk management.

**anchoring bias** aka *focalism* (14)

A cognitive bias where an individual relies too heavily on an initial piece of information offered (considered to be the "anchor") when making decisions. (13)

The tendency of a person's estimates (or forecasts) to be influenced when they start with a "convenient" estimate in making their forecasts. This initial estimate (or anchor) can be based on tradition, previous history, or available data.

An unconscious reverence for the first piece of information presented, even if it is inaccurate or becomes obsolete.

This gravitational or limiting influence on judgement and imagination can hamper attaining the best estimate or solution.

*Sellers exploit this by posting a high asking price, expecting an offer at or above what they would settle for. To counter this bias, elicit the maximum value first, the minimum, and then the most likely value.*

**assessment**

Assessment is the process of identifying, evaluating, and characterizing risks or uncertainties.

It typically involves:

Defining inputs: such as probability ranges, impact ranges, and key assumptions.

Judging significance: determining how likely events are and how important their consequences might be.

Documenting rationale: capturing the basis for expert judgments and data used.

**alternative technical concept (ATC)**

An ATC (in Design Build contracts) is a proposal that offers savings in time or cost during design and construction of the project, and ultimately to obtain the best value for the public.

**authority bias** (18)

The tendency to attribute greater accuracy to the opinion of an authority figure (unrelated to its content) and be more influenced by that opinion, believing their views to be more credible, and hence place greater emphasis on the authority figure's viewpoint. *See cognitive bias*

*In a workshop setting, deference can subtly affect the team's thinking by dampening the inception of ideas that run contrary to or are critical of those stated or known to be held by the eminent person.*

*It is best practice to exclude, if possible, one in authority that would tend to pressure the team to not exceed a favored number, or to not stray from a favored solution.*

**availability heuristic**

The mind's tendency to readily recall memories of events that happened recently, or were extraordinary, combined with a subconscious inclination to inflate their significance; a bent to favor, revere and/or settle on those immediate thoughts and ideas. *See heuristic, cognitive bias.*

*Because every project is unique, we should remind ourselves to spend a bit more time dredging our minds for experiences and knowledge that best serves the outcome.*

**B****base cost estimate**

(31)

Base Cost represents the professional judgment of the estimator regarding the most probable and unbiased total project cost, assuming the project proceeds largely as planned. It includes Preliminary Engineering (PE), Right of Way (RW), and Construction (CN), and explicitly excludes costs associated with discrete risk events. Once reviewed and validated, the base cost serves as the foundation for cost risk assessment.

(32)

**base cost estimate validation**

A detailed examination of the estimated costs for a particular project under consideration to assess validity, reasonableness, consistency and accuracy of these costs.

*Review/validate estimates several times throughout project development.*

*For **quantitative project risk analysis**, the project costs are initially estimated by the Project Team and then reviewed/validated by independent cost experts prior to and/or during the cost risk workshop. The reviewed/validated estimate becomes the base cost estimate for analysis.*

**base variability**

A contributor to uncertainty is variability—the ordinary, expected, historic and tolerable noise of life. It is a range about which a deterministic, estimated quantity and/or cost may vary from that actually installed or billed. Itself an estimate, contributing factors in determining its magnitude stem from bid item history, engineering judgement, how mature the base estimate is, and how far into the future is bidding or construction. Arguably not a risk, it is accounted for in comprehensive RBE and is quantified then entered as input for analysis and modelling in PRBE. As in real life, variability is rarely symmetrical—the floor is closer than the ceiling—determine how much and how likely actuality will be less versus more than estimated.

EXAMPLE: When filling a gas tank there is an idea of what it will cost. It is not certain until the purchase. Uncertainty exists with respect to cost per gallon and quantity. If the gas tank capacity is 20 gallons and the gas gauge indicates half a tank—that approximates the gas needed. The actual amount likely falls between 9 and 11 gallons, not precisely 10.0 gallons.

**baseline cost estimate**

(2)

Cost projection performed early in a program or project to serve as the reference point for all subsequent tracking, comparing, and auditing.

**Basis of Estimate (BOE) estimate basis and assumptions**

(10)

Documentation to enable the agency to easily track changes to project scope, cost, and schedule. This document provides a trail about what is known about the project. This allows project “knowns” as well as “unknowns” to be clearly identified. This documentation is important because multiple estimators may be involved on the project; complex projects take years to develop, and estimates must be completed multiple times.

**benefit-cost ratio B/C**

Regarding projects: the ratio of the present worth of estimated project benefits to present worth of estimated project costs. If the ratio is 1.0 or higher (benefits > costs) the project is considered worthwhile; it does not mean that the project should be built, there are many projects and limited resources.

**bias** (33)

A lack of objectivity based on the individual's position or perspective. There may be system biases as well as individual biases. See cognitive bias.

**bid-based estimating** (26)

or historical bid-based estimating relies heavily on element or bid items, or both, with quantities and good historical bid data for determining item cost. The historical data normally is based on bids from recent projects. The estimator must adjust the historical data to fit the current project characteristics and location. The historical data must also be adjusted to reflect current dollars. With the use of historical bid data, estimators can easily and quickly prepare estimates. <sup>1st Ed.</sup>

**bidding environment**

See Market Conditions.

**Black swan events**

Black Swan events are rare, high-impact shocks that lie far outside normal estimating assumptions and cannot be meaningfully forecast or quantified. These include extreme geopolitical, economic, regulatory, or technological disruptions that can reshape market conditions, supply chains, labor availability, or funding environments. Because they are inherently unpredictable, they are treated as part of the broader uncertainty surrounding long-duration programs rather than as discrete risks.

## C

**change order** (18)

Work that is added to, changed from, or deleted from the original scope of work of a contract. See contingency.

**change order contingency**

A budgeted amount of money used to pay the cost of anticipated change orders during construction, typically expressed as a percentage of total above-the-line costs, added to the construction estimate, and a component of total engineer's estimate.

Usually 4% for WSDOT design-bid-build projects.

**cognitive bias**

A systematic error in perception, recall, and thinking that occurs when people are perceiving, processing, and interpreting information from the world around them, which thus affects the decisions and judgments that they make. This inherent susceptibility is universal, and stems from the human condition and its limitations.

See anchoring bias, authority bias, availability heuristic, confirmation bias, framing effect, heuristic, normalcy bias, motivational bias, optimism bias

**conceptual estimating** (26)

or parametric estimating techniques are primarily used to support development of planning or early scoping phase estimates when minimal project definition is available. Statistical relationships or non-statistical ratios, or both, between historical data and other project parameters are used to calculate the cost of various items of work (i.e., center lane miles or square foot of bridge deck area). <sup>1st Ed.</sup>

**confidence interval** (1)

The probability that a result will be within a range. See also: Accuracy Range; Range. Dec

An expression of uncertainty. The likelihood that the true value will be contained within a given interval. In forecasting the confidence, level refers to the uncertainty associated with the estimate of the parameter of a model while the prediction interval refers to the uncertainty of a forecast. See Prediction Interval. (13) 2011

**confirmation bias**

(18)

the tendency to search for, interpret, favor, and recall information in a way that confirms or supports one's prior beliefs or values. People display this bias when they select information that supports their views, ignoring contrary information, or when they interpret ambiguous evidence as supporting their existing attitudes. The effect is strongest for desired outcomes, for emotionally charged issues, and for deeply entrenched beliefs. Confirmation bias cannot be eliminated entirely, but it can be managed, for example, by education and training in critical thinking skills. See cognitive bias.

**construction administration costs**

The Base Costs of administration, management, reporting, design services in construction and community outreach etc., which are required in the construction phase.

**construction contingency**

Funds authorized at the time of contract award to be expended on unexpected, urgent, minor needs due to uncertainties in quantities, unit costs, and minor risk events that occur during construction.

**contingency**

(1)

An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience.

**control**

(8)

A measure that maintains and/or modifies risk.

Controls include, but are not limited to, any process, policy, device, practice, or other conditions and/or actions which maintain and/or modify risk.

**correlation**

A statistical measure of if and how much pairs of variables are related. It is indicated with a correlation coefficient, " $r$ ", that ranges from -1 to +1. The closer to +1 or -1, the stronger the linear relationship between two variables; 0 means there is no linear relationship. Positive  $r$  means correlation where the two variables increase or decrease in unison; negative  $r$  means a higher value in one variable accompanies a lower in the other. For example, temperature and the fluid in a thermometer; as it gets warmer, the fluid rises—a positive correlation.

*One should not assume a cause-and-effect relationship between variables solely on an observed correlation—correlation is not causation.*

**cost**

(1)

The expenses a contractor will incur in performing contract work.

**Cost + Profit = Price**

(20)

cost is the economic value of the human effort which is deployed to go, in a given environment, from situation A to situation B.

**cost-based estimating**

(26)

estimating considers seven basic elements: time, equipment, labor, subcontractor, material, overhead, and profit. 1<sup>st</sup> Ed. Generally, a work statement and set of drawings or specifications are used to "take off" material quantities required for each discrete work task necessary to accomplish the project bid items. From these quantities, direct labor, materials, and equipment costs are calculated based on calculated or assumed production rates. Contractor overhead and profit are then added to this direct cost.

**cost engineering** (3)

An area of engineering principles where engineering judgment and experience are used in the application of scientific principles and techniques to problems of cost estimation, cost control, business planning and management science.

**cost estimate** (1)

compilation of all the probable costs of the elements of a project or effort included within an agreed upon scope.

May  
2012

**Cost Estimate Validation Process (CEVP®)**

The Cost Estimate Validation Process (CEVP) is an expert-led project review in which senior engineers and risk managers from public agencies and private firms conduct an intensive evaluation of a project's costs, schedule, and risks. The team examines project details, assesses the quality of available information, and applies structured methods for risk identification and analysis.

During the CEVP meeting(s), the team identifies potential risks, estimates their probability and their potential cost and schedule impacts, and explores possible responses to those risks. The process produces a probabilistic range of cost and schedule forecasts and supports more informed decision making. *CEVP was created by WSDOT, in collaboration with industry experts, in 2002 for projects with anticipated costs exceeding \$100 million.*

**cost lead**

Leads the cost estimate review for a risk assessment workshop. Duties include leadership, facilitation, preparation, documentation; follow up, reconciliation of workshop results, technical report writing, process evaluation and communication. May participate in assessing new scenarios for the project.

**cost of quality** (14)

The costs incurred to ensure quality. These include: Prevention and appraisal costs (cost of conformance) include costs for quality planning, quality control (QC), and quality assurance to ensure compliance to requirements (i.e., training, QC systems, etc.). Failure costs (cost of non-conformance) include costs to rework products, components, or processes that are non-compliant, costs of warranty work and waste, and loss of reputation. See **1-10-100 Rule**.

**Cost Risk Assessment (CRA)**

A Cost Risk Assessment, CRA is a systematic process in which a project team identifies potential risks, evaluates their likelihood, estimates their possible cost and schedule impacts, and incorporates this information into a probabilistic model to determine a realistic range of project outcomes.

At WSDOT, a CRA follows the same general process as a CEVP, but it is intended for smaller or less complex projects. Industry input is recommended for a CRA, whereas it is required for a CEVP. *WSDOT: CRA workshops are for projects between \$25M and \$100M.*

**Cost Risk Estimating and Management (CREM)**

Cost Risk Estimating and Management (CREM) is the structured process of developing project cost and schedule estimates explicitly accounting for risk, uncertainty, and variability. It embeds risk analysis into estimating, enabling teams to anticipate discrete events, knowledge gaps, and natural fluctuations, plan contingencies, and make informed decisions. CREM integrates with project controls, value engineering, constructability, and quality management to ensure estimates are realistic and resilient. At its core, CREM applies risk-based estimating methods—such as Cost Risk Assessment (CRA) and the Cost Estimate Validation Process (CEVP) to quantify the likelihood and impact of potential cost and schedule deviations. Also see CRA

**Critical Path Method (CPM)**

A scheduling technique for projects with multiple stages and/or activities. A traditional, logic-driven scheduling method that identifies the longest sequence of tasks (the *critical path*) that determines the project's total duration. Also see Graphical Path Method

**critical path**

A path connecting all activities, which have minimum or zero slack times. The critical path is the longest path through the network.

**cumulative distribution function (CDF)**

is a way to report the outcome distribution of stochastically modelled project cost and schedule forecasts (See **Monte Carlo simulation**). It is a graph with percent of simulated realizations, 0 to 100%, on the y-axis and outcome values, dollars or dates, on the x-axis. It is usually S-shaped when the uniform outcome **histogram** is monomodal, that is, having one hump. A point on the curve represents a confidence level, per the y-axis, that the actual project can be delivered at or below the x-axis value.

**Current Year Dollars (CY)**

Today's price; the estimated cost of the project if the project were built and completed in the analysis year, in present-day dollars.

**D**

**deterministic**

(21)

Deterministic describes a definite... as opposed to ...probabilistic.

**distributions**

(16)

A characteristic statistical pattern of occurrences of values for a particular outcome when repeated many times. In statistical modeling, values are generated within a defined range according to a particular distribution, thought to be representative of the value being modeled. Normal, uniform, beta, and negative exponential are examples of distributions. Each of these distributions has characteristic shapes when values are plotted against frequency of occurrence. For example, a normal distribution has a bell shape, exponential curves from horizontal to vertical, and uniform has a straight horizontal line.

**E**

**Earned Value Analysis**

"Earned Value" is a project management technique. It measures what you got, for what you actually spent; the value of the work accomplished; the measured performance; the Budgeted Cost of Work Performed (BCWP).

**economic indicators**

(7)

Statistics or economic indices produced on an economy on a regular basis. They are important as barometers of economic activity and the state of the business cycle...

**80/20 Rule aka Pareto's Law**

(1)

A statistical principle named after Italian economist Vilfredo Pareto, who observed that 80% of the wealth in Italy was controlled by 20% of the population.

In cost management, it is commonly used to describe the situation where a small subset of cost items, activities, and so on, are the source of most of the total cost, duration, etc.

**elicit**

(12)

To draw forth...; To bring out... *from* the data in which they are implied. To extract, draw out (information) *from* a person...

**engineer's estimate**

The term is frequently used to mean the estimate at time of bid, but also used by some to mean any estimate done during the Preliminary Engineering phase.

See *WSDOT Plans Prep Manual Division 8, "Contract Estimate"*.

**escalation** (5)

The total annual rate of increase in cost of the work or its sub-elements. The escalation rate includes the effects of inflation plus market conditions and other similar factors. See inflation.

a persistent rise in the price of specific commodities, goods, or services due to a combination of inflation, supply/demand, and other effects such as environmental and engineering changes. (22)

**estimate** (14)

A quantitative assessment of the likely amount or outcome. Usually applied to project costs, resources, effort, and durations and is usually preceded by a modifier (e.g., preliminary estimate, conceptual estimate, etc.). An estimate is expressed as a range; it offers an indication of accuracy (i.e.,  $\pm x$  percent).

A project estimate is actually comprised of two components: the base cost estimate component and the risk/uncertainty component.

**estimate at completion (EAC)** (14)

The expected total cost of a project when the defined scope of work will be completed.

**estimate to complete (ETC)** (14)

The expected cost needed to complete all the remaining work for a project.

**expected value (EV)**

Probability  $\times$  Impact = EV

The best estimate of what should happen on average (that is, the mean outcome for cost, activity duration, and so on). The expected value for a probability distribution function is calculated by multiplying all possible values by their probabilities. (16)

*One method of prioritizing risks is to calculate EV for each and then rank by EV. Risks with higher probability and impact will rank higher.*

**F**

**force majeure events** (16)

Force majeure refers to rare, extreme events—natural or human-driven—that make it impossible for a party to carry out its contract duties despite reasonable effort. These events are outside the control of both parties and could not have been anticipated. Typical examples include acts of God, severe storms, fires, strikes, acts of conflict, or major economic disruptions. (1)

In contracts, a force majeure clause provides relief—usually extra time but not extra payment—when such events prevent performance. Its primary role is in contract administration, not cost-risk modeling. Also see Acts of God. (16)

**framing effect**

A cognitive bias where decisions are influenced by the way information is presented, consciously or not, by the presenter. Depending on what features are highlighted, an inferior option may gain preference over one that is more optimal.

Team members should strive to be neutral when presenting ideas and to consider this effect when receiving information or ideas.

**frequency distribution**

(30)

For discrete output distributions, a chart plotting values along the x-axis and the probability of occurrence for each value along the y-axis. For continuous output distributions, a histogram in which the x-axis is divided into a large number of “bins” of equal size and the y-axis shows the probability of occurrence of a value within any given bin.

**future costs**

Costs that are escalated by projected inflation rates to specific points in time, consistent with a particular project schedule.

**G****Graphical Path Method (GPM)**

A modern, visual scheduling method that uses interactive, time-scaled logic diagrams to show how tasks relate, shift, and float in real time. See [NetPoint by PMA Technologies](#)

**H****heuristic**

(1)

An experience-based technique used as a general way of solving a problem.

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Examples include an educated guess, an intuitive judgment, a guesstimate, profiling, Rule of Thumb, or common sense.

Sole reliance on heuristics in a unique, project assessment/analysis setting may lead to errors such as failure to identify a risk, or to inaccurately determine its likelihood and/or impact, and/or to settling on a solution that has always worked in the past but may not be optimal in this case.

(18)

See availability heuristic; cognitive bias

**histogram**

A graphical summary of a numerical dataset using rectangles, with width representing an interval or value range group, and height relative to quantity of samples within the group interval. It conveys an idea of spread and concentration—distribution—of dataset values. See frequency distribution.

**human resource planning**

(14)

The process of identifying and documenting project roles, responsibilities and reporting relationships, as well as creating the staffing management plan.

**I****impact**

(16)

The effect on the project objectives if a risk event should occur.

**inflation**

(4)

A persistent tendency for prices and money wages to increase; measured by the proportional changes over time in some appropriate price index...

(12)

A persistent tendency for nominal prices to increase. Inflation is measured by the proportional changes over time...

An increase in the volume of money and credit relative to available goods and services resulting in a continuing rise in the general price level.

The effect of inflation is loss of purchasing power over time.

See also: escalation.

J

K

L

**Linear scheduling**

Linear scheduling is a planning method used for projects where major tasks progress in a continuous, linear path over distance—such as highways, pipelines, rail lines, tunnels, or utility corridors. Instead of focusing only on time, it shows time and location together, making it easy to see how crews move along the project and how their production rates interact.

In simple terms: It is a schedule that shows how fast each activity moves so you can see where crews might overlap, conflict, or fall behind.

**lookout list**

a list of minor risks or issues identified during project risk assessment that were not deemed of concern to include in further analysis or modeling yet are recorded for project team awareness. In some instances, the list or select entries are included for modeling, with aggregated probability and impact.

M

**market conditions**

(23)

The consequence of supply and demand factors which determine prices and quantities in a market economy; separate from inflation. Market conditions include the bidding environment; the labor market; resource availability, etc.

(24)

Influences include: "availability of skilled labor"; "supply of steel is low because of high demand in multiple markets causing a temporary upswing in steel prices"; "the number of bidders is expected to be low therefore competition is reduced"; "the type, size, and/or 'packaging' of the work is anticipated to influence bids and/or the number of bidders"; "influences of timing of advertisement on bidders and their responses".

Market characteristics such as number of competitors, level of intensity of competitiveness...  
economic environment for business

Example of how market conditions are captured in WSDOT's modeling tool for probabilistic risk-based estimating:

| Market Conditions |             |        |
|-------------------|-------------|--------|
|                   | Probability | Impact |
| Favorable:        | 10%         | 10%    |
| Unfavorable:      | 20%         | 20%    |

**Master Deliverables List (MDL)**

A comprehensive listing of project elements intended as a starting point for the creation of work breakdown structures (WBS) for projects. The Master Deliverables List is organized in project phases to the deliverables level.

**Measures of Effectiveness (MOE)**

Measures or tests, which reflect the degree of attainment of particular objectives. MOEs are used to compare competing alternatives. MOEs are sometimes called performance measures.

**motivational bias**

A conscious or unconscious distortion motivated by one's incentives or motivations. Motivational biases can affect estimates and forecasts whenever those doing the estimating believe that the judgments expressed may affect (or reflect on) them personally.

prioritysystem.com

those in which judgments are influenced by the desirability or undesirability of events, consequences, outcomes, or choices.

Kunda Z. The case for motivated reasoning. *Psychological Bulletin*, 1990; 108(3):480–498.

**N****non-conformance-report**

a formal quality assurance document used to identify, record, and resolve deviations from contract requirements or specifications. It provides a structured process for documenting the issue, implementing corrective action, verifying resolution, and maintaining accountability within the project's quality management system.

**normalcy bias** aka: *normality bias, denial bias, analysis paralysis, the ostrich effect, the negative panic, (first responders)*

A cognitive bias where people tend not to acknowledge or fully appreciate the severity and/or likelihood of a threat situation. The opposite of over-reacting.

*Besides being most inconvenient, it was "unthinkable" that the Titanic should sink, thus preparations for that event were meager and passengers were reluctant to respond.*

In the workshop setting this may also manifest as the tendency of the group to more readily discuss and attend to risks of lower significance and to shy away from those more dire. People are disinclined to go looking for trouble, to imagine the "unthinkable", to dwell on it, or to plan for it. Attending to negative things is distasteful or considered bad form by some, and/or a betrayal of the team or the project's success—consciously or unconsciously.

**O****1-10-100 Rule**

A quality management concept developed by G. Loabovitz and Y. Chang (1992) that is used to quantify the hidden costs of poor quality. Essentially, risk management or QA/QC activities cost exponentially less than remediation, which costs exponentially less than failure; somewhat after Benjamin Franklin's ounce of prevention being worth a pound of cure. See cost of quality.

**opportunity**

Uncertainty that can positively affect project objectives (positive event risk). Examples include strategies to reduce cost or durations, beneficial funding decisions, improved revenue projections etc.

**optimism bias**

(13)

A state of mind that causes the respondent to forecast that favorable events are more likely to occur than is justified by the facts. We think we are more likely to experience positive than negative events.

"...unrealistic optimism can lead to risky behavior, to financial collapse, to faulty planning. The British government, for example, has acknowledged that the optimism bias can make individuals more likely to underestimate the costs and durations of projects. So, they have adjusted the 2012 Olympic budget for the optimism bias."

Tali Sharot, TED2012

*This tendency may interfere with one's perception and assessment of threats, while enhancing the number, likelihood, and value of opportunities.*

## P

**parametric estimating**

A method for predicting project cost or time by using measurable factors—called parameters—and applying a rate, formula, or model based on past data. Examples include cost per square foot, cost per lane mile, etc. *See conceptual estimating.*

**Participation Matrix**

A spreadsheet to plan the attendance and timing of workshop participants.

**percentiles from Monte Carlo simulation results range**

The Percentile of the Year of Expenditure from a Monte Carlo simulation indicates that the dollar amount of “x-percentile” will not exceed that amount. For example: the 70th percentile on a project is \$110M. This means there is a 70% probability the project will be delivered for \$110M or less, based on the information provided and analysis at that time. This is also referred to as the Probability Not to Exceed value.

**performance measurement baseline**

(14)

An approved integrated scope-schedule-cost plan for the project work against which project execution is compared to measure and manage performance. Technical and quality parameters may also be included. *See also configuration management. See Baseline.*

**post-response risk**

The risk after a response is determined and actions are taken to enhance opportunities and reduce threats to the project’s objectives. The response action identifies and assigns parties to take responsibility for each risk response. Risks are known as “pre-response” if no response action has yet been determined.

**prediction interval**

(13)

The bounds within which future observed values are expected to fall, given a specified level of confidence. For example, a 90% prediction interval is expected to contain the actual forecast 90% of the time. However, estimated prediction intervals are typically too narrow for quantitative and judgmental forecasting methods. Also see confidence interval.

**pre-response risk**

An identified risk before a response is determined and actions are taken to enhance opportunities and reduce threats to the project’s objectives.

**price**

(1)

The financial outlay made to pay for a product or service.

Price = Cost + Profit

**proactive risk response**

(16)

An action or set of actions to reduce the probability or impact of a threat (or delay its occurrence) or increase the probability or impact of an opportunity (or bring forward its occurrence). Proactive risk responses, if approved, are carried out in advance of the occurrence of the risk. They are funded from the project budget.

**probabilistic risk-based estimating (PRBE)**

a risk-informed estimating technique that integrates a project’s base cost estimate with quantified risk assessment information—such as the probability of risk events and their potential cost or schedule impacts—into a simulation model (commonly using Monte Carlo analysis) to forecast a range of possible project cost and schedule outcomes. *See CEVP and CRA.*

**Probability not to exceed (PNE)**

Probability Not to Exceed (PNE) is the chance that a project's cost or time span stays at or under a set target in probabilistic risk-based estimating (PRBE). In PRBE, PNE tells you: "How much chance is there that this project stays under this cost or time target?"

Relationship to "Probability of Exceedance"

PNE is the complement of the probability of exceedance:

$$\text{PNE} = 1 - \text{Probability of Exceedance}$$

If there is a 30% chance the project exceeds a cost target, the PNE is 70%.

**probable cost of risk events**

Costs associated with risk events, typically with substantial variability.

**profit**

(1)

In a broad sense business profit is whatever monies are left after all costs have been paid. When talking about a particular contract, profit is the additional amount a contractor receives above out-of-pocket costs; profit makes it worthwhile to do the particular contract work. It is the reward for undertaking the contract task in the first place.

Price = Cost + Profit

**project**

(15)

A temporary initiative in a unique context undertaken to create value.

**project manager**

Any person assigned to lead a team toward completion of a project. A project manager applies specialized knowledge, skills, tools, and techniques to meet defined goals and customer expectations for a project.

**project objectives**

(16)

A statement of specific and measurable aims by which the degree of success of the project will be assessed.

**project risk management**

Project Risk Management (PRM) is the broad discipline of identifying, analyzing, responding to, and monitoring risks across scope, schedule, cost, quality, safety, and other project dimensions. CREM supports PRM by quantifying cost-related uncertainties.

**project schedule**

The Schedule as presented by the Project Team, corresponding to the Project Team Estimate.

**project team**

A set of individuals performing the work of the project to achieve its objectives. PMBOK 7<sup>th</sup> Edition.

**Q****quality**

(14)

The degree to which a set of inherent characteristics fulfills requirements.

**quality assurance (QA)**

Actions and procedures performed at the management level, under the Project Engineer or Quality Manager, to ensure that quality-control practices are in place and effective, and that professional services meet the expectations of the Quality Management Plan.

**quality control (QC)**

Routine actions and procedures performed at the production and administrative levels, under the Project Engineer, to ensure work products meet required quality standards.

**quality verification**

Selective review of final products by HQ Project Development, under the State Design Engineer or designee, to confirm that the Quality Management Plan was followed and that the project development process is properly reflected in the final contract documents.

**qualitative risk assessment/analysis**

(16)

Assessment based on descriptive evaluation of risk characteristics.

A qualitative risk assessment evaluates the nature of a risk using descriptive, non-numerical information. It considers the risk's sources, causes, and potential consequences; expresses likelihood and impact using categorical or narrative terms; and documents relationships, dependencies, and triggers. The process relies on informed judgment, structured methods, and expert input to establish relative significance among risks.

**quantitative risk analysis**

(16)

Forecasts of project outcomes through probabilistic modeling of combined measures of project uncertainties, as identified and assessed by the project team and subject matter experts.

A quantitative risk analysis applies mathematical or statistical techniques to the assessed inputs to estimate the distribution of possible outcomes and the uncertainty associated with them. It uses methods such as probabilistic modeling and Monte Carlo simulation to generate numerical outputs, including likelihood distributions, expected values, and ranges of potential cost or schedule effects. The analysis provides a data-driven basis for evaluating overall risk exposure and informing decision-making.

**quantitative risk assessment**

(16)

Assessment based on numerical evaluation of risk characteristics.

A quantitative risk assessment determines the likelihood and consequences of a risk using measurable values—units of money and time. It defines the risk parameters, establishes numerical probability and impact ranges, and documents the data, assumptions, and relationships required for further analysis. The assessment uses validated information—such as historical data, performance metrics, and expert judgement—to produce objective inputs for quantitative analysis (modeling).

**R**

**range**

(1)

The absolute difference between the maximum and minimum (or some stated confidence interval) values in a set of values; the simplest measure of the dispersion of a distribution. See also: Accuracy Range.

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**range cost estimate**

A cost estimate that gives a range of costs, related to specific confidence levels.

**range estimating**

(1)

(1) A formalized risk analysis technology that synergistically combines Pareto's law (80/20 Rule) to identify the relatively few critical elements, heuristics governing the assignment of probabilistic ranges to such elements, and Monte Carlo Simulation to provide decision making information quickly and at reasonable effort.

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(2) A generic term variously used to define: a) estimating a variable in the form of a probabilistic range; b) application of Monte Carlo Simulation based on a set of probabilistic ranges applied to model variables; c) a synonym for stochastic or probabilistic estimating.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <b>residual risk</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        | (14)                |
| The risk that remains after risk responses have been implemented.                                                                                                                                                                                                                                                                                                                                                                                           | 6 <sup>th</sup> Ed. |
| <b>risk</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                 | (8)                 |
| The effect of uncertainty on objectives.<br>note 1: an effect is a deviation from the expected. it can be positive, negative or both, and can address, create, or result in opportunities and threats.<br>note 2: objectives can have different aspects & categories; can be applied at different levels.<br>note 3: risk is usually expressed in terms of risk sources (3.4), potential events (3.5), their consequences (3.6) and their likelihood (3.7). |                     |
| <b>risk analysis</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        | (1)                 |
| A risk management process step (part of risk assessment) and methodology for qualitatively and/or quantitatively screening, evaluating and otherwise analyzing risks to support risk treatment and control. See also: Risk Management.                                                                                                                                                                                                                      | Dec 2011            |
| <b>risk appetite</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        | (17)                |
| The degree of uncertainty an organization or individual is willing to accept in anticipation of reward. See risk tolerance.                                                                                                                                                                                                                                                                                                                                 | 6 <sup>th</sup> Ed. |
| <b>risk assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |
| The overall process of identifying, describing and analyzing risks. Its purpose is to develop agreed priorities for identified risks. Some interchange the term assessment with analysis or evaluation.                                                                                                                                                                                                                                                     |                     |
| <b>risk-based estimating (RBE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                          | (26)                |
| A cost estimating technique that combines (1) traditional estimating methods for known items and quantities with (2) <sup>1<sup>st</sup></sup> Ed. risk analysis techniques to estimate uncertain items, uncertain quantities, (uncertain costs), and risk events. See probabilistic risk-based estimating.                                                                                                                                                 |                     |
| <b>risk-based estimating meeting</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |
| The project team convenes to identify and assess project risks, potentially including other participants. The analysis can be qualitative, or quantitative utilizing WSDOT's Project Risk Analysis Model (PRAM). Support is available from the HQ Design Office.                                                                                                                                                                                            |                     |
| <b>risk events</b>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |
| Uncertain events that affect a defined project with impacts to cost, schedule, safety, performance or other characteristics. Risk events do not include minor variance inherent in Base Costs.                                                                                                                                                                                                                                                              |                     |
| <b>risk identification</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |
| Process of identifying, characterizing and quantifying potential risk events.                                                                                                                                                                                                                                                                                                                                                                               |                     |

**risk lead**

The risk lead(s) participate in a peer-level review or due diligence analysis on the scope, schedule and cost estimate for various projects to evaluate quality and completeness, including anticipated risk and uncertainty in the projected cost and schedule. The risk lead:

Leads the risk portion of the process including risk elicitation and project flowchart development for modeling.

Participates in cost validation or review and risk uncertainty workshops for selected projects.

Conducts prep sessions, follow-up meetings, and/or rerun sessions as necessary.

Provides reports and presentations documenting workshops.

Provides reports using report guide/table of contents.

Develops or implements workshops on topics such as project definition, and risk identification and management.

**risk management**

(17)

Refers to the culture, processes, and structures that are directed toward effective management of risks – including potential opportunities and adverse effects.

Risk Management Process – systematic application of management policies, processes, and procedures to the tasks of establishing the context, identifying, analyzing, assessing, treating, monitoring, controlling, and communicating risk.

**risk mitigation**

(17)

Establishes and implements management responses for dealing with risks in ways appropriate to the significance of the risk, benefit-cost of the responses and importance of the project.

**risk owner**

(8)

Person or entity with the accountability and authority to manage a risk.

**risk profile**

(8)

Description of any set of risks.

**risk register**

The risk register serves as a repository for identified project risks. It includes detailed information about the risk and is a “living” document that evolves as the project evolves. It typically records information such as: risk ID #, status of risk, risk categories, risk name, cause of the risk, effect of the risk, risk trigger, likelihood of risk occurrence, impact if risk does occur, response actions, and notes.

It serves as a project management and communication tool to aide decision-makers and facilitates risk analysis.

**risk reserve**

A reserve account to cover uncertainty and risk during project execution.

**risk response**

The process of identifying and implementing actions to enhance opportunities and reduce threats. The risk response assigns parties to take ownership and is accountable for the response actions. Risk responses aimed at the Risk Trigger can be highly effective.

Threat responses: Avoid, Mitigate (reduce), Transfer, Accept (retain)

Opportunity responses: Exploit, Enhance (increase), Share, Accept (retain)

**risk team**

Those CEVP® or CRA Team members plus Project Team members who focus on Risk for the particular project under consideration.

**risk tolerance**

defines the boundaries within which the firm is comfortable operating given its overall risk appetite.

Logicgate.com

*A person with a high-risk tolerance may not recognize a risk or not assess its likelihood and or impact as high as it may actually be, whereas one with low tolerance may clutter and dwell on risks of low significance.*

**risk trigger**

(1)

A measurable or observable event or condition that is a precursor to or indicator of a risk's occurrence.

An event or condition that causes a risk to occur. A trigger is a root cause of a risk event.

**S**

**scenario**

A scenario is a structured, plausible depiction of future conditions or sequences of events used to explore ideas and situations to evaluate how a project might perform under varying design assumptions, operational environments, and external influences.

By examining different pathways, scenarios help project teams anticipate risks, compare alternatives, understand system interactions, and make more resilient, informed decisions throughout planning, design, and construction.

**scope**

(14)

The sum of the products, services, and results to be provided as a project.

6<sup>th</sup> Ed.

**scope creep**

(14)

The uncontrolled expansion to product or project scope without adjustments to time, cost, and resources.

6<sup>th</sup> Ed.

**scope of work (SOW)**

Defines the work and activities necessary to deliver a project. Establishes context and boundaries for the work.

**secondary risk**

(14)

A risk that arises as a direct result of implementing a risk response.

6<sup>th</sup> Ed.

**sensitivity analysis**

(14)

An analysis technique to determine which individual project risks or other sources of uncertainty have the most potential impact on project outcomes, by correlating variations in project outcomes with variations in elements of a quantitative risk analysis model. See tornado diagram.

6<sup>th</sup> Ed.

**speculative**

(12)

Of the nature of, based upon, characterized by, speculation or theory in contrast to practical or positive knowledge.

...based on conjecture rather than knowledge  
lexico.com

**stochastic**

(18)

refers to the property of being well described by a random probability distribution. Although stochasticity and randomness are distinct in that the former refers to a modeling approach and the latter refers to phenomena themselves, these two terms are often used synonymously. See Monte Carlo method.

## T

**threat**

An event risk that has the potential to negatively impact project objectives.

**tolerance**

(25)

total allowable amount by which a measurement may vary. It is the difference between the maximum and minimum limits.

**tornado diagram**

(18)

a special type of bar chart, where the data categories are listed vertically instead of the standard horizontal presentation, and the categories are ordered so that the largest bar appears at the top of the chart, the second largest appears second from the top, and so on.

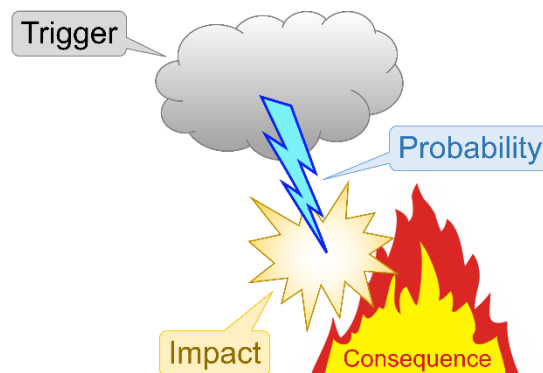
A display of sensitivity analysis which presents the calculated correlation coefficient for each element of the quantitative risk analysis model that can influence the project outcome... ..Items are ordered by descending strength of correlation, giving the typical tornado appearance. <sup>6<sup>th</sup> Ed.</sup> (14)

**trigger**

An essential component of actual risk manifestation—the circumstances required for a risk to have any possibility of occurring or of having any impact on project objectives.

Example: The atmospheric presence of a cumulonimbus cloud is required for any chance of a lightning strike.

Knowing this risk aspect informs risk management regarding when a risk response plan needs to be engaged or when specific risk monitoring resources may be reallocated.



## U

**ultimate cost**

Actual cost at completion of all work elements, including all outside costs, changes and resolution of risk and opportunity events.

**ultimate schedule**

Actual schedule at completion of all work elements, including all outside costs, changes and resolution of risk and opportunity events.

**uncertainty** (9)  
 The lack of knowledge of the outcome for a particular element or value. (12)  
 See also: variability

1: the quality or state of being UNCERTAIN : DOUBT  
 the state of not being known or perfectly clear; doubtfulness or vagueness.<sup>2a</sup>  
*Uncertainty reflects the state of mind about an unknown value and the probability that it will occur; it is based on information, evidence, and judgment.*

**Unforeseeable and Uncontrollable Major Events**  
 Cost and risk assessments for heavy civil infrastructure projects focus on known, identifiable, and quantifiable risks. These processes do not attempt to model or assign probability to major external events that are fundamentally unpredictable or beyond reasonable control. *For more information on such events see the following in this glossary: Acts of God, Black Swan Events, and Force Majeure events.*

V

**validation**  
 A process to confirm the reasonableness, accuracy and completeness of estimated costs and quantities.

**value engineering (VE)**  
 aka Value Methodology (VM) – A systematic process used by a multidisciplinary team, led by a qualified VM facilitator, to improve the value of a project, product, process, service or organization through the analysis of functions.

**variability** (12)  
 the fact of, or capacity for, varying in amount, magnitude, or value.<sup>2a</sup>  
 See: Base variability, uncertainty

**variance**  
 Inherent fluctuations due to random events that result in a range of potential values for a quantity.

**Value Engineering Change Proposals (VECP)** (6)  
 Post-award value engineering (VE) proposals made by construction contractors during construction under a VE clause in the contract.

**Value Engineering Risk Assessment (VERA)**  
 An approach that combines a cost risk assessment and value engineering into one coordinated process. Generally, a risk assessment/analysis is performed prior to the VE Study; results become input to the information phase of the VE study.

W

Y

**year of expenditure (YOE)**  
 The estimated year that money will be spent to complete project work elements.

**YOE dollars**

(2)

The estimated cost of the project when it is anticipated to be built. Typically, a forecast of the estimated YOE cost is determined by taking the estimate in current year dollars and inflating it to the anticipated midpoint of construction or activity.

**11-3 Glossary References**

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