Managing Project Risk

Implementing a Risk Management Program for your Project

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HDR Engineering, Inc
Objective of this presentation

- Identify how risk management techniques applied in other sectors of the construction industry can be applied to the construction of water/wastewater facilities
Agenda

- What do we mean by risk management
  - Why?
  - Benefits

- Identify who uses Risk Management

- Risk Management Program Elements
  - Identification of risks
  - Assessment of risks
  - Analysis potential risks
  - Developing mitigation plans
  - Allocation of risk
  - Tracking the effectiveness of those measures

- References

- Questions
What is risk management

1. A systematic approach for early identification of potential events (risks) that could affect your project’s outcome.

2. By identifying these risks, this process provides you an opportunity to develop a mitigation strategy before a “risk” adversely impacts your project.
Managing Risk

Denial is NOT an Option
Why were these risk management techniques developed?

- **Boston Central Artery**
  1985-2005, $14+ billion over estimate

- **Sidney Opera House**
  1,400% over estimate

- **Denver International Airport**
  233% over estimate

**The Seattle Times**

Costs Lead UW To Halt Project – Renovation Canceled As Overruns Hit Millions
Benefits of implementing a risk management plan

- Risk prioritization and ranking helps the project manager know where to concentrate efforts and resources.
- Establishes a pro-active approach to respond to risk and uncertainty.
- Provides pre-planned and efficient response strategies for major events when they occur.
- Promotes and establishes improved communications during the project.
Use of risk management techniques is increasing on public works projects

- Many State DOT’s throughout the United States are implementing risk management programs
- DOE has been a long time believer in using risk management in their projects
Several Industry References are Available
Risk management programs include six basic components

1. Identification of risks
2. Assessment of risks
3. Analysis potential risks
4. Developing mitigation plans
5. Allocation of risk
6. Monitor the effectiveness of those measures
Step 1 - Identifying Project Risks

- Project team should develop a list of potential risks to their specific project.
- List should be an honest assessment of the risks.
- Failure to consider a “risk” could jeopardize your project.

### Potential Project Risks

<table>
<thead>
<tr>
<th>Issues</th>
<th>Likelihood</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External Risks</strong></td>
<td></td>
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<tr>
<td>Local communities pose objections</td>
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<tr>
<td>Lack or mixed political support for the project</td>
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<tr>
<td>Unreasonably high expectations from stakeholders</td>
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<tr>
<td>Stakeholders request info changes</td>
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<tr>
<td>New stakeholders emerge and request changes</td>
<td></td>
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<tr>
<td>Landowners unwilling to sell</td>
<td></td>
<td></td>
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<tr>
<td>Threat of lawsuits</td>
<td></td>
<td></td>
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<tr>
<td>Increase in material cost due to market forces</td>
<td></td>
<td></td>
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<tr>
<td>Regulations change</td>
<td></td>
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<tr>
<td>New permits or additional information required</td>
<td></td>
<td></td>
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<tr>
<td>Reviewing agency requires longer than expected review time</td>
<td></td>
<td></td>
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<tr>
<td>Permits or agency actions delayed or take longer than expected</td>
<td></td>
<td></td>
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<tr>
<td>New information required for permits</td>
<td></td>
<td></td>
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<tr>
<td>Environmental regulations change</td>
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<td></td>
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<tr>
<td>Controversy on environmental grounds expected</td>
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<td>Pressure to deliver project on an accelerated schedule</td>
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<tr>
<td>Labor shortage or strike</td>
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<tr>
<td>Material / Equipment Shortages</td>
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<tr>
<td>Material cost escalation</td>
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<td>Equipment manufacturer changes/ownership</td>
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<tr>
<td>Embargoes</td>
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<tr>
<td><strong>Design Risks</strong></td>
<td></td>
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<tr>
<td>Design incomplete</td>
<td></td>
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<tr>
<td>Unexpected geotechnical or groundwater issues</td>
<td></td>
<td></td>
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<tr>
<td>Inaccurate assumptions or technical issues in planning stage</td>
<td></td>
<td></td>
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<tr>
<td>Surveys incomplete</td>
<td></td>
<td></td>
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<tr>
<td>Changes to materials/geotechnical foundation</td>
<td></td>
<td></td>
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<tr>
<td>Hazardous waste site analysis incomplete</td>
<td></td>
<td></td>
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<tr>
<td>Unforeseen design excursions required</td>
<td></td>
<td></td>
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<tr>
<td>Consultant design not up to Owner’s standards</td>
<td></td>
<td></td>
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<tr>
<td>Insufficient time to complete the design</td>
<td></td>
<td></td>
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<tr>
<td>Unforeseen constructability issues</td>
<td></td>
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<tr>
<td>Incorrect quantity estimates</td>
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<tr>
<td>Unforeseen construction window and/or rainy season requirements</td>
<td></td>
<td></td>
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<tr>
<td>New or revised design standard</td>
<td></td>
<td></td>
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<tr>
<td>Construction staging more complex than anticipated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design staff changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Risks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental analysis incomplete</td>
<td></td>
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<tr>
<td>Availability of project data and mapping at the beginning of the</td>
<td></td>
<td></td>
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<tr>
<td>environmental study is insufficient</td>
<td></td>
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<tr>
<td>New information after Environmental Documentation is completed may</td>
<td></td>
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<tr>
<td>require re-evaluation or a new document (i.e. utility relocation</td>
<td></td>
<td></td>
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<tr>
<td>beyond document coverage)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New alternatives required to avoid, mitigate, or minimize impact</td>
<td></td>
<td></td>
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<tr>
<td>Acquisition, creation or restoration of on or off-site mitigation</td>
<td></td>
<td></td>
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<tr>
<td>Environmental clearance for staging or borrow silt required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Historic sites, endangered species, riparian areas, wetlands and/or</td>
<td></td>
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</tbody>
</table>
Primary types of risks

- **Threats** — A Threat will have a negative impact on a project objective if it occurs (what might happen to jeopardize the project’s ability to achieve its objectives)

- **Opportunities** — An Opportunity will have a positive impact on a project objective if it occurs (what might happen to improve the project’s ability to achieve its objectives)
Risks can be further sub-divided into:

- **Residual risks** - Risks that remain even after developing responses to the project's original risks.

- **Secondary risks** – Secondary risks are caused by responses to the project's original risks.

- **Risk interaction** - The combined effect of two or more risks occurring simultaneously is greater than the sum of the individual effects of each free standing risk.
Step 2 – Risk Assessment

- The goal of risk assessment is to:
  1. Determine the likeliness of the event occurring
  2. Determine significance of the event if it occurs
  3. Be ready to react and respond when it occurs
Assessment of Risks

### Assessment Guide

**Level** | **Likelihood**
--- | ---
A | Remote
B | Unlikely
C | Likely
D | Highly Likely
E | Near Certainty

**Consequence**

<table>
<thead>
<tr>
<th>Level</th>
<th>Schedule</th>
<th>and/or</th>
<th>Cost</th>
</tr>
</thead>
</table>
a | Minimal or no impact | | Minimal or no impact |
b | Additional resources required; able to meet | | <5% |
c | Minor slip in key milestones; not able to meet need date | | 5-7% |
d | Major slip in key milestone or critical path impacted | | 7-10% |
e | Can’t achieve key team or major program milestone | | >10% |

**Risk Assessment**

- **High (Red)**
  - Unacceptable. Major disruption likely. Different approach required. Priority management attention required

- **Moderate (Yellow)**
  - Some disruption. Different approach may be required. Additional management attention may be needed

- **Low (Green)**
  - Minimum impact. Minimum oversight needed to ensure risk remains low
<table>
<thead>
<tr>
<th>Risk</th>
<th>Status</th>
<th>Phase</th>
<th>Scenario</th>
<th>Date Risk Identified</th>
<th>Risk Description</th>
<th>Root Cause(s)</th>
<th>Primary Object(s)</th>
<th>Overall Risk Rating</th>
<th>Time/Impact/Probability</th>
<th>Risk Owner</th>
<th>Risk Trigger(s)</th>
<th>Risk Source</th>
<th>Strategies</th>
<th>Response Actions</th>
<th>Advanced Time/Impact/Probability</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Active</td>
<td>Test</td>
<td>Event 1</td>
<td>02/01/2023</td>
<td>Risk Event</td>
<td>High</td>
<td></td>
<td>Time</td>
<td>High</td>
<td>(001)</td>
<td></td>
<td>Risk Owner</td>
<td>Action Plan</td>
<td>Additional Support</td>
<td>Additional Comments</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>Active</td>
<td>Test</td>
<td>Event 2</td>
<td>02/02/2023</td>
<td>Risk Event</td>
<td>Medium</td>
<td></td>
<td>Impact</td>
<td>Medium</td>
<td>(002)</td>
<td></td>
<td>Risk Owner</td>
<td>Action Plan</td>
<td>Additional Support</td>
<td>Additional Comments</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>Active</td>
<td>Test</td>
<td>Event 3</td>
<td>02/03/2023</td>
<td>Risk Event</td>
<td>Low</td>
<td></td>
<td>Impact</td>
<td>Low</td>
<td>(003)</td>
<td></td>
<td>Risk Owner</td>
<td>Action Plan</td>
<td>Additional Support</td>
<td>Additional Comments</td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>Active</td>
<td>Test</td>
<td>Event 4</td>
<td>02/04/2023</td>
<td>Risk Event</td>
<td>Very Low</td>
<td></td>
<td>Impact</td>
<td>Very Low</td>
<td>(004)</td>
<td></td>
<td>Risk Owner</td>
<td>Action Plan</td>
<td>Additional Support</td>
<td>Additional Comments</td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td>Active</td>
<td>Test</td>
<td>Event 5</td>
<td>02/05/2023</td>
<td>Risk Event</td>
<td>Very High</td>
<td></td>
<td>Impact</td>
<td>Very High</td>
<td>(005)</td>
<td></td>
<td>Risk Owner</td>
<td>Action Plan</td>
<td>Additional Support</td>
<td>Additional Comments</td>
<td></td>
</tr>
</tbody>
</table>

Approved by: ___________________

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Step 3 – Analysis of Potential Risks

Some agencies and firms have established procedures to analyze risks.

- **CEVP® - Cost Estimate Validation Process** – A workshop process where projects are examined by engineers and risk managers from local and national firms and public agencies to review project details with WSDOT engineers.

- **CRA - Cost Risk Assessment** uses a simpler model and is designed for projects under $100 million (WSDOT).

- **RAP© - Risk Analysis Process** - RAP is HDR’s proprietary risk assessment methodology. It uses a team approach similar to WSDOT’s CEVP® process and utilizes proprietary software (built on the most advanced risk analysis tools available).
Qualitative or Quantitative Risk Analysis

- **Qualitative Analysis** – An assessment of risk relating to the qualities and subjective elements of the risk – those that cannot be quantified accurately in a direct fashion. Qualitative techniques include the definition of risk, the recording of risk details and relationships, and the categorization and prioritization of risks relative to each other. Methods of indexing for ranking purposes are often incorporated.

- **Quantitative** – Modeling of numerical outcomes by combining actual or estimated values with an assumed or known relationship between values, using arithmetic or statistical techniques, to determine a range of likely outcomes of a variable or to understand how variance in one or more values is likely to affect others.

<table>
<thead>
<tr>
<th>Status</th>
<th>ID #</th>
<th>Threat/Opportunity Event</th>
<th>Qualitative Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>1</td>
<td>Threat - Utility relocation</td>
<td>The extent of the prescriptive roadway ownership is great. This requires Caltrans to absorb all cost to relocate the utilities. This will increase the project cost.</td>
</tr>
</tbody>
</table>

**Qualitative Analysis**

<table>
<thead>
<tr>
<th>Type</th>
<th>Probability</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>High</td>
<td>Medium</td>
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</tbody>
</table>
## Quantitative Risk

<table>
<thead>
<tr>
<th>Cost</th>
<th>75%</th>
<th>MIN</th>
<th>5.00$M</th>
<th>8$M</th>
<th>20L</th>
<th>High</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX</td>
<td>25.00$M</td>
<td>10.00$M</td>
<td>48.0Mo</td>
<td>27.0Mo</td>
<td>Very High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEST GUESS</td>
<td>10.00$M</td>
<td>12.0Mo</td>
<td>VL</td>
<td>H</td>
<td>VH</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Schedule</td>
<td>2</td>
<td>0</td>
<td>48.0Mo</td>
<td>VL</td>
<td>VH</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>MIN</td>
<td>12.0Mo</td>
<td></td>
<td>VL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAX</td>
<td>48.0Mo</td>
<td></td>
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</tr>
<tr>
<td>BEST GUESS</td>
<td>36.0Mo</td>
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</table>
# Evaluating Impact of a Threat on Major Project Objectives

<table>
<thead>
<tr>
<th>Impact</th>
<th>Very Low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td>Insignificant Schedule Slippage</td>
<td>Delivery Plan milestone delay within quarter</td>
<td>Delivery Plan milestone delay of one quarter</td>
<td>Delivery Plan milestone delay of more than 1 quarter</td>
<td>Delivery Plan milestone delay outside fiscal year</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Insignificant Cost Increase</td>
<td>&lt;5% Cost Increase</td>
<td>5-10% Cost Increase</td>
<td>10-20% Cost Increase</td>
<td>&gt;20% Cost Increase</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Scope decrease is barely noticeable</td>
<td>Changes in project limits or features with &lt;5% Cost Increase</td>
<td>Changes in project limits or features with 5-10% Cost Increase</td>
<td>Sponsor does not agree that Scope meets the purpose and need</td>
<td>Scope does not meet purpose and need</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>Quality degradation barely noticeable</td>
<td>No safety issues, C, O, M deficiencies approved by project team</td>
<td>No safety issues, C, O, M deficiencies require District management approval</td>
<td>Quality may be made acceptable through mitigation or agreement (i.e. Fact Sheet)</td>
<td>Quality does not meet one or all of the following Safety, C, O, &amp; M</td>
</tr>
</tbody>
</table>

**Legend:** C – Constructability, O – Operability, M – Maintainability
<table>
<thead>
<tr>
<th>Impact</th>
<th>Very Low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td>Insignificant Schedule</td>
<td>Delivery Plan milestone does not improve but</td>
<td>Delivery Plan milestone improves but still</td>
<td>Delivery Plan milestone improved by more than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement</td>
<td>float is added</td>
<td>within the quarter</td>
<td>more than one quarter</td>
<td></td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Insignificant Cost</td>
<td>&lt;1% Cost Decrease</td>
<td>1%-3% Cost Decrease</td>
<td>3%-5% Cost Decrease</td>
<td>&gt;5% Cost Decrease</td>
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<tr>
<td></td>
<td>reduction</td>
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<td></td>
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</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Scope effect is not</td>
<td>Improves chances to achieve project</td>
<td>Improves chances to achieve project</td>
<td>Improves chances to achieve project</td>
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</tr>
<tr>
<td></td>
<td>noticeable</td>
<td>limits or features with cost increases of 10%</td>
<td>limits or features with cost increases of 5%-10%</td>
<td>limits or features with cost increases of 2%-5%</td>
<td></td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>No quality improvement</td>
<td>C, O, M improvement by project team</td>
<td>C, O, M improvement can be seen and measured</td>
<td>Quality improvement can be claimed for the</td>
<td></td>
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<tr>
<td></td>
<td>noticeable</td>
<td></td>
<td></td>
<td>project</td>
<td></td>
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</tbody>
</table>

**Legend:** C – Constructability, O – Operability, M – Maintainability
Step 4 – Developing mitigation plans

Response Planning

- **Risk Response Plan** – A plan of action designed to reduce the impact once a risk event has occurred

  - **Planning** – Prior to the risk event occurring as though it will occur
  
  - **Trigger** – Identifies that the risk event has occurred and notifies the team to implement the risk response plan

  - **Implementation** – Actions to take after the risk event has occurred
Triggers and Response Plans

- **Response Plans**
  - What will you do if the risk event happens, and what plans can you put in place prior to the risk event to minimize the impact once it occurs?

- **Triggers**
  - How will you know when the risk event happens? This is the signal to put your response plan into action.
Step 5 – Allocation of Risk

- Identify how you will allocate risk on the project
- Allocate risk to the best party able to manage them

Strategies:
- Avoid
- Mitigate
- Transfer
- Accept
**Risk Strategies - Avoid**

- Change the project plan to avoid the risk;
  - Change project scope
  - Change project budget
  - Change project schedule
  - Add resources

- Avoidance could disappoint a critical stakeholder or degrade the business reason for performing the project.
Risk Strategies - Mitigate

- Taking positive actions to reduce the impact of a threat or the probability of it occurring.

- Mitigation usually requires positive action and has a cost.

- Mitigation actions should be reflected in your work packages and controlled like any other part of your normal project.

- Mitigation actions will affect your budget and schedule.

- Mitigation can be a very effective strategy; it’s often better than a ‘do nothing’ approach.
Risk Strategies - Transfer

- This involves transferring the risk to another party

- Transference comes at a cost
  - Alternative contracting methods
  - Bonds
  - Insurance

- Some risk cannot be transferred
  - e.g. schedule risk; you can contract the schedule responsibility to third parties, if they are late, your project is still late.

“Contractors do not take risk, they price it”
Risk Strategies - Accept

- After trying to avoid, transfer, or mitigate the threats to your project, you will be left with a residual risk - threats you can’t reduce further.

- In active acceptance, you take the residual expected value of the remaining risk.

- The passive form of acceptance involves just acknowledging the risk and moving forward on the project without reserves.

- The third form of risk acceptance is called denial; professional risk management seeks to reduce the use of denial as a strategy.
Step 6 – Risk Monitoring and Updating

I-405 Congestion Relief and Bus Rapid Transit Projects
Revised July 2003

Scenario
Tukwila to Bothell (Option C)

Project Descriptions:
- Continuous multi-modal corridor improvement projects from I-5 in Tukwila to SR 522 in Bothell.
- Adds one lane each direction from I-5 to SR 181 in Tukwila.
- Adds two lanes each direction from SR 181 in Tukwila to I-90 in Bellevue.
- Adds one lane each direction from I-90 in Bellevue to SR 522 in Bothell.
- On SR 167, adds one lane between I-405 and S. 184th St.
- Constructs Bus Rapid Transit system with stations, HOV direct access ramps and Park & Ride lots and coaches.
- Expands the ramp program.

Schedule:
- End Construction Range: 2013-2014

CEVP Result:
- Total Project Cost (Future SM)

Project Benefits:
- Reduces congestion and improves freight movement.
- Provides bus rapid transit system from SeaTac to Lynnwood.
- Constructs 2300 new Park & Ride spaces.
- Adds 600 new ramps and increases commute reduction programs.
- Improves water resources.

Project Risks:
- Changing environmental requirements for project mitigation (stormwater, wetlands, fish resources and streams) may increase project costs—primarily for added right-of-way purchases.
- Delays in right-of-way purchases may result in construction delays and project cost increases.
- Early stage of project development leads to scope uncertainty.
- Legal challenges and delays in obtaining environmental permits may result in project delay.
- Utility relocations may require extra time to negotiate and complete.

Project Cost Range:
- 10% chance the cost < $4.2 Billion
- 50% chance the cost < $4.7 Billion
- 90% chance the cost < $5.1 Billion

What’s Changed Since 2002:
- Scope: Project limits are smaller.
- Schedule: Begin construction range has been delayed up to one year. End construction range has been accelerated two years.
- Costs: Costs have gone down approximately $1 billion due to scope revisions.
- Risk Management: Identifying new strategies for improved environmental clearances and right-of-way processes. Coordinating decision strategies with FHWA.

Financial Fine Print (Key Assumptions):
- Full project funding becomes available in July 2005. State I-405 Nickel funds will roll-over into this package.
- Inflation escalation is to 2010, the approximate midpoint of construction.
- Additional federal, state, regional and local money may be needed.
- Project cost range includes $18.5 million in past expenses, beginning in 1999.
- Assumes funding decisions do not interrupt or cause construction delays.

Level of Project Design:
- Low
- Medium
- High

July 16, 2003

Washington State Department of Transportation

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Risk Identification and Management is an Important Part of a Successful Project

- Helps to quantify real expected project costs and project expectations
- Recognizes events that could impact the project outcome, schedule and budget
- Develops proactive approaches to deal with risk events before they occur
- Risk mitigation and response helps keep project on schedule and on budget
References

- FHWA – Risk Assessment and Allocation for Highway Construction Management
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