Project Risk Management Handbook

Threats and Opportunities

Second Edition

Revision 0

May 2, 2007

Office of Statewide Project Management Improvement (OSPMI)

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Project Risk Management Handbook
May 2, 2007
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Preface

This handbook provides an overview of risk management (both threats and opportunities) at the California Department of Transportation (Department).

This version is effective as of May 2, 2007.

The project team thanks all individuals within and outside the Department for their support and contributions to the production of the *Project Risk Management Handbook*.

Purpose

This document describes the basic concepts and processes that guide risk management planning and implementation during project development.

Audience

Department project managers, functional managers, and other staff engaged in the delivery of capital projects.

Background

The purpose of this handbook is to provide the districts with a complete and uniform approach to project risk management and to make the present policy/subject matter more useful and easier to understand.

Revisions

The 2nd edition represents the first major update to the 1st edition.

Conventions

Titles of books and other documents appear in *italics*. Website URLs appear in ***bold italics.***

Like this example.

Additional information, notes, and tips appear in the left margin.

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State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: DISTRICT DIRECTORS
DEPUTY DISTRICT DIRECTORS
for PROGRAM PROJECT MANAGEMENT

Date: May 2, 2007

From: RICHARD D. LAND
Chief Engineer

Subject: Project Risk Management in Project Delivery

The Project Risk Management Handbook has been updated to further assist project teams in identifying, analyzing, and managing risks on projects delivered by the California Department of Transportation (Caltrans).

The incorporation of risk management practices is one of the targeted strategies in the latest Strategic Planning effort. In the Department's continuing efforts to efficiently deliver quality transportation projects and services on schedule and within budget, the Project Delivery Divisions continue to be focused on improving the processes of project delivery and project quality. As one of these processes, risk management enables a project team to identify, analyze, develop appropriate responses for, monitor, and manage project risks as they arise and change through the life of a project. Risk management helps potential obstacles to be identified and contained early through proper response strategies, thereby minimizing negative impacts on project cost, scope, schedule, and quality. Managing potential risks also helps identify opportunities that may enhance the project and have a positive impact on project objectives. Appropriately identifying and managing project risks will help the department meet its project delivery commitments and provide project stakeholders better information on which to base informed project decisions.

The application of risk management to the delivery of projects was formally implemented in March 2004. Training and related tools, including online reference materials, have been made available to the districts. You are encouraged to continue actively applying risk management principles in Project Delivery. Headquarters Project Delivery Divisions are available to work with districts and regions to support full implementation of the process and to answer any questions. The Division of Project Management will continue providing districts and regions with additional guidance in support of this effort.

c: Will Kempton
Project Delivery Division Chiefs
Joan Sollenberger, Division of Planning
Robert Copp, Division of Traffic Operations
Rachel Falsetti, Division of Transportation Programming

"Caltrans improves mobility across California"

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Overview

This chapter defines:

- Project risk and risk management
- The objective of risk management within the Department

Why Risk Management?

The Capital Project Risk Management Process, described in this handbook, is intended to aid in the effective management of project risks, both threats and opportunities. The project manager (PM), project sponsor (Sponsor), and project team members (Project Development Team, PDT) jointly develop a written plan that enables them to identify, assess, quantify, prepare a response to, monitor, and control capital project risks.

Risk management goes further than planning, and the risk response actions planned and incorporated in a risk management plan need to be executed effectively and monitored for their effectiveness. The project manager should conduct frequent reviews of project risks and the progress made in addressing them, indicating where risks are being effectively handled and where additional actions and resources may be needed.

Definition

Project risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective. A risk may have one or more causes and, if it occurs, one or more impacts.[1]

Risk management is the systematic process of planning for, identifying, analyzing, responding to, and monitoring project risks. It involves processes, tools, and techniques that will help the project manager maximize the probability and results of positive events and minimize the probability and consequences of adverse events as indicated and appropriate within the context of risk to the *overall* project objectives of cost, time, scope and quality. Project risk management is most effective when first performed early in the life of the project and is a continuing responsibility throughout the project's life cycle.

Objective

The project risk management process helps project sponsors and project teams make informed decisions regarding alternative approaches to achieving their objectives and the relative risk involved in each, in order to increase the likelihood of success in meeting or exceeding the most important objectives (e.g. time) sometimes at the expense of other objectives (e.g. cost). Risk management encourages the project team to take appropriate measures to:

- Minimize adverse impacts to project scope, cost, and schedule (and quality, as a result).
- Maximize opportunities to improve the project's objectives with lower cost, shorter schedules, enhanced scope and higher quality.
- Minimize management by crisis.

[1] A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Third Edition, Chapter 11.

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Process Overview

This chapter describes key success factors, important documents of the process, associated tasks, outputs, and key responsibilities of project participants.

Key Success Factors for Project Risk Management

A key success factor is a corporate culture that:

- Supports the honest, realistic and open recognition of project risks even if they indicate problems with the project.
- Encourages talking about risks realistically with no penalty for people who do so openly within the risk management process.
- Promotes discussion in an atmosphere where there are no risks that are out-of-bounds for discussion and no enforcement of bureaucratic hierarchy in meetings where risk identification and assessment is discussed.

Another key success factor is the commitment to collecting realistic and high-quality data about risks. Risk data are often based on the judgment and expertise of informed individuals. It takes effort and organizational support to spend the time and resources needed to collect accurate data about project risk.

A final key success factor is the participation of Caltrans management in policy-making activities such as in developing the threshold definitions of risk impact on main objectives, in identifying the combinations of probability and impact that lead to ranking risks as low, moderate and high, and in determining the relative importance of different objectives for the project.

Project Risk Management Process Flow Diagram

The project team completes the risk management plan and the risk register (defined later in this Handbook) before the project initiation document (PID) component ends. The team updates the register regularly in each subsequent lifecycle component and continues to monitor and control risks throughout the life of the project.

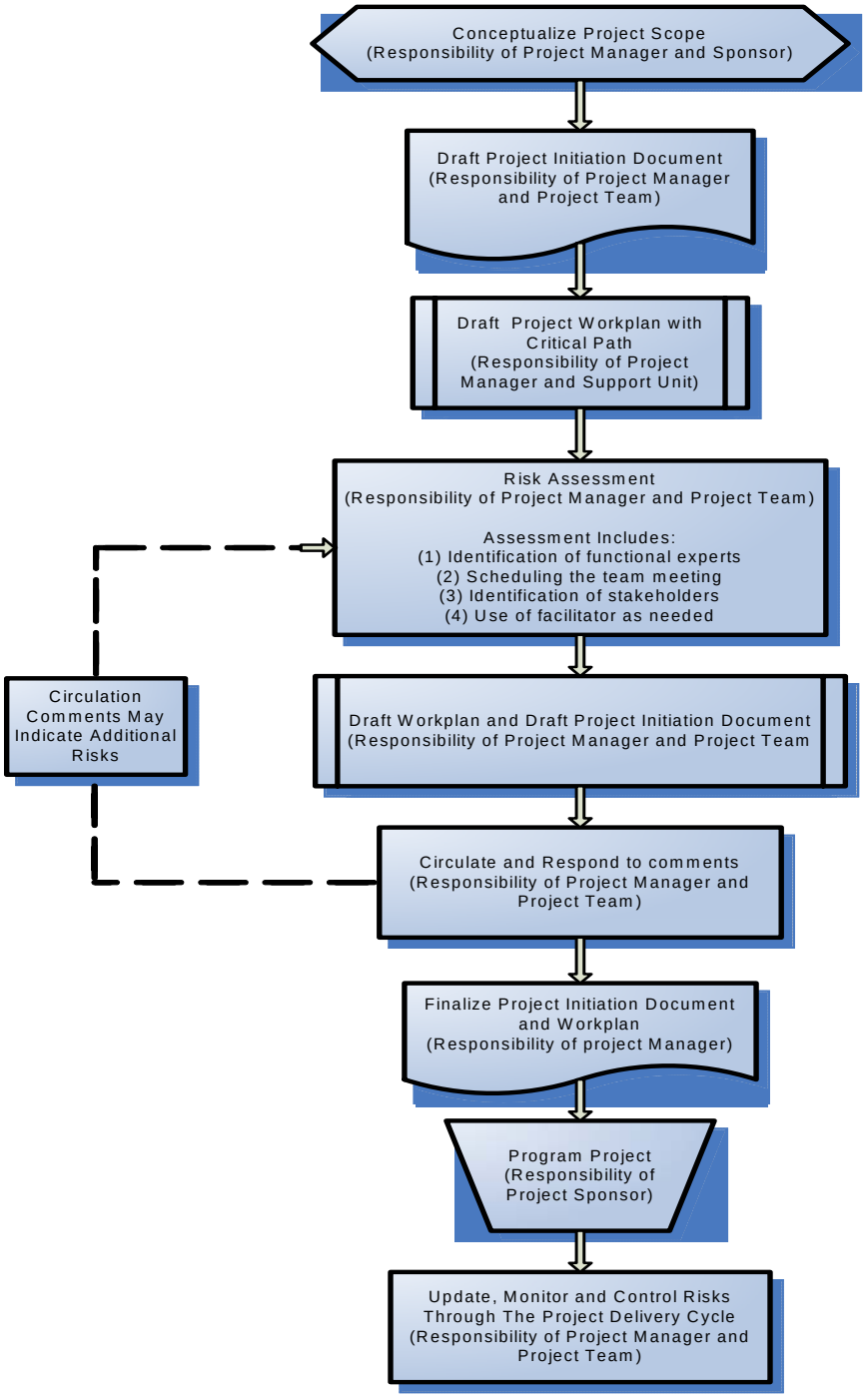

Figure 1. Risk management process flow diagram

Processes and Outputs

This matrix shows the six main processes and all of the deliverables associated with project risk management.

Process	Output(s) (deliverables)
Risk management planning	Risk Management Plan (RMP)
Risk identification	Risk Register (Register)
Qualitative risk analysis	Risk Register (updates) Prioritized list of risks classified as high, moderate, or low.
Quantitative risk analysis	Quantitative Risk Analysis Reports Numerical analysis of the project's likelihood of achieving its overall objectives (Risk Register updates)
Risk response planning	1- Risk Register (updates) 2- Project Management Plan (updates) 3- Project Risk Management Plan (updates) 4- Risk-related contractual agreements The outcome may result in one or more of the following: residual risks, secondary risks, change control, contingency reserve (amounts of time or budget needed).
Risk monitoring and control	Risk Register (updates) The outcome may result in workaround plans, corrective actions, programming change request (PCR), and updates to risk identification checklists for future projects

Key Responsibilities

This matrix shows the six processes and the responsibilities of the project manager and stakeholders.

Process Tasks	Role					
	Sponsor	**Deputy District Director, Program and Project Management**	**Project Manager**	**Project Manager Support/ Risk Officer**	**Project Team**	**Risk Owner**
Risk management planning	C	C	R, A	S	S	
Risk identification	C	C	R	S	S	
Qualitative risk analysis			R	S	S	
Quantitative risk analysis (As applicable)			R	S	S	
Risk response planning	C	C	R, A	S	S	R
Risk monitoring and control			R	S	S	R

Legend:

- R = responsible
- S = support
- A = approve
- C = concur

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Process Steps

This chapter identifies and explains the six risk management processes:

1. Risk Management Planning
2. Risk Identification
3. Qualitative Risk Analysis
4. Quantitative Risk Analysis
5. Risk Response Planning
6. Risk Monitoring and Control

Risk Management Planning

Before starting project studies, the project manager establishes a PDT in accordance with Department policy. For details, see the "PDT Formation" sub-section of the Project Development Procedures Manual.

Careful and explicit planning enhances the possibility of success of the five other risk management processes. Risk Management Planning is the process of deciding how to approach and conduct the risk management activities for a project. Planning of risk management processes is important to ensure that the level, type, and visibility of risk management are commensurate with both the risk and importance of the project to the organization, to provide sufficient resources and time for risk management activities, and to establish an agreed-upon basis for evaluating risks. The Risk Management Planning process should be completed early during project planning, since it is crucial to successfully performing the other processes described in this handbook.[1]

The result of Risk Management Planning is a Risk Management Plan. The risk management plan identifies and establishes the activities of risk management for the project in the project plan (RMP).

For a copy of Standard RMP template, see Appendix A. An electronic version of the template is also available on the Project Risk Management webpage. Please see project management guidance website at ***http://www.dot.ca.gov/hq/projmgmt/guidance.htm***

Risk Identification

Risk identification involves identifying potential project risks. Risk Identification produces a deliverable — the project Risk Register – where risks are identified that may affect the project's ability to achieve its objectives. Risk Identification documents which risks might affect the project and documents their characteristics. The Risk Register is subsequently amended with the results from qualitative risk analysis and risk response planning, and is reviewed and updated throughout the project.

Participants in risk identification activities can include the following, where appropriate: project manager, project team members, risk management team (if assigned), subject matter experts both from the project and from outside the project team, customers, end users, other project managers, stakeholders, and risk management experts. While these personnel are often key participants for risk identification, all project personnel should be encouraged to identify risks.

Risk identification is an iterative process because new risks may become known as the project progresses through its life cycle and previously-identified risks may drop out. The frequency of iteration and who participates in each cycle will vary from case to case. The project team should be involved in the process so that they can develop and maintain a sense of ownership of, and responsibility for, the risks and associated risk response actions. Stakeholders outside the project team may provide additional objective information. The Risk Identification process is a requirement for the Qualitative Risk Analysis process.[1]

The assigned team members identify the potential risks (threats and opportunities), using:

- The risk breakdown structure, suitably tailored to the project. An example of a risk breakdown structure is in Appendix B.
- The sample risk list provided in Appendix C.
- Their own knowledge of the project or similar projects.
- Consultation with others who have significant knowledge of the project or its environment.
- Consultation with others who have significant knowledge of similar projects.
- Other tools and techniques such as those provided in Chapter 11, PMBOK.

It is important to specify the risk correctly. For instance, a risk has a cause and, if it occurs, an impact on a project objective. The risk statement structure that should be followed in specifying identified risks is: Because of the (cause, condition that is true), (a risk) may occur, leading to an impact (at this stage unanalyzed) on XX objective where XX is cost, time, scope and or quality.

This structure helps specify the risk correctly.

As an example of the use of the risk statement structure, the fact that the bridge is built over water is not a risk, it is a cause. The risk may be unknown sub-surface conditions, which if they occur may lead to re-design of the supports. Mitigation could involve coring at the support location and engineering analysis based on the findings, to reduce the probability of unknown conditions.

In risk identification, sometimes there is a temptation to dismiss a risk because "we cannot do anything about it anyway". This argument does not change the risk into a non-risk, simply because there is no viable mitigation strategy. The risk that cannot be mitigated may have an effect on the project and can be calibrated in qualitative and quantitative analysis. It is just not possible to handle this risk, but it is still a risk. Also, some of these risks may be affected by risk handling if people think carefully about it, for instance, political risk may be influenced by public outreach and information campaigns.

Techniques for identifying risks and opportunities are also taught in the Department's Value Analysis courses.

The team considers:

- **Threats** — a risk that 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** — a risk that 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)
- **Triggers** — symptoms and warning signs that indicate whether a risk is becoming a near-certain event and a contingency plan/response plan should be implemented.

The updated Risk Advertisement/Risk Vote guidance memo is posted on the project delivery intranet site. The new guidance requires use of the risk management register as part of the submittal.

The team should also consider:

- **Residual risks** - Risks that remain even after developing responses to the project's original risks. Example: You identify delays caused by hazardous waste issues as one of your primary risks. If you are able to develop a response that mitigates only problems caused by underground fuel tanks, you may still have other hazardous waste risks. Your goal is to reduce residual risks to an acceptable level.
- **Secondary risks** – Secondary risks are caused by responses to the project's original risks. For example, if you decide to hire outside help as a way of mitigating a project risk, you now have additional concerns that arise as a result of using the external vendor. The timeliness of their work and potential contractual disputes are risks you did not have before you decided to use their services.
- **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. For instance, Federal budget cuts may increase delays in Federal Highway Administration permits at the same time federal programming dollars become scarcer.

Qualitative Risk Analysis

Qualitative Risk Analysis includes methods for prioritizing the identified risks for further action, such as Quantitative Risk Analysis or Risk Response Planning. Organizations can improve the project's performance effectively by focusing on high-priority risks.

Qualitative Risk Analysis assesses the priority of identified risks using their probability of occurring, the corresponding impact on project objectives if the risks do occur, as well as other factors such as the time frame and risk tolerance of the project constraints of cost, schedule, scope, and quality.[1]

Sometimes experts or functional units assess the risks in their respective fields and share these assessments with the team. Across the same project the definitions that will be used for levels of probability and impact should be the same.

The organization's management, project customer or sponsor has an important role in the Qualitative Risk Analysis process.

- The project sponsor defines for the risk analysis lead and team the levels of impact on time, cost, scope and quality that would qualify a risk as having a very low, low, moderate, high or very high impact on each objective.
- The project sponsor determines the combinations of probability and impact that make a risk low, moderate and high priority for each objective in light of the definitions just mentioned.

Once the definitions are in place, team members assess the identified risks' probability and impact and then put them into high, moderate, and low risk categories for each project objective (time, cost, scope, quality). They rank risks by degrees of probability and impact, using the definitions in place, and include their assessment rationale. For more information and a sample, see Appendix E: Risk Ranking.

Team members revisit qualitative risk analysis during the project's lifecycle. When the team repeats qualitative analysis for individual risks, trends may emerge in the results. These trends can indicate the need for more or less risk management action on particular risks, or whether a risk mitigation plan is working.

Quantitative Risk Analysis

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks. The result is a probability distribution of the project's cost and completion date based on the identified risks in the project.

Quantitative risk analysis involves statistical techniques, primarily Monte Carlo simulation, that are most widely and easily used with specialized software.

Quantitative risk analysis starts with the model of the project, either its project schedule or its cost estimate depending on the objective. The degree of uncertainty in each schedule activity and each line-item cost element is represented by a probability distribution. The probability distribution is usually specified by determining the optimistic, the most likely and the pessimistic values for the activity or cost element – this is typically called the "3-point estimate." The three points are estimated during an interview with subject matter experts who usually focus on the schedule or cost elements one at a time. The risks that lead to the three points are recorded for the quantitative risk analysis report and for risk response planning. For each activity or cost element a probability distribution type is chosen that best represents the risks discussed in the interview. Typical distributions usually include the triangular, beta, normal and uniform.

A specialized Monte Carlo simulation software program runs (iterates) the project schedule or cost estimate many times, drawing duration or cost values for each iteration at random from the probability distribution derived from the 3-point estimates and probability distribution types selected for each element. The Monte Carlo software develops from the results of the simulation a probability distribution of possible completion dates and project costs. From this distribution it is possible to answer such questions as:

- How likely is the current plan to come in on schedule or on budget?
- How much contingency reserve of time or money is needed to provide the agency with a sufficient degree of certainty?
- Using sensitivity analysis, which activities or line-item cost elements contribute the most to the possibility of overrunning schedule or cost targets?

Additional information on quantitative schedule and cost risk analysis are also available on the project management guidance website at ***http://www.dot.ca.gov/hq/projmgmt/guidance.htm***

When to Use Quantitative Analysis

The Department does not require quantitative analysis for projects; however, the PDT or the District may determine that a project will need to undergo an in-depth quantitative risk analysis based on the cost, complexity or high profile of the project.

Risk Response Planning

Risk Response Planning is the process of developing options, and determining actions to enhance opportunities and reduce threats to the project's objectives. It focuses on the high-risk items evaluated in the qualitative and/or quantitative risk analysis. In Risk Response Planning parties are identified and assigned to take responsibility for each risk response. This process ensures that each risk requiring a response has an owner monitoring the responses, although a different party may be responsible for implementing the risk handling action itself.

The project manager and the PDT identify which strategy is best for each risk, and then design specific action(s) to implement that strategy.

Strategies for Negative Risks or Threats include:

- **Avoid**. Risk avoidance involves changing the project plan to eliminate the risk or to protect the project objectives (time, cost, scope, quality) from its impact. The team might achieve this by changing scope, adding time, or adding resources (thus relaxing the so-called "triple constraint").

  These changes may require a Programming Change Request (PCR). Some negative risks (threats) that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.

- **Transfer**. Risk transference requires shifting the negative impact of a threat, along with ownership of the response, to a third party. An example would be the team transfers the financial impact of risk by contracting out some aspect of the work.

  Transference reduces the risk only if the contractor is more capable of taking steps to reduce the risk and does so. Risk transference nearly always involves payment of a risk premium to the party taking on the risk.

  Transference tools can be quite diverse and include, but are not limited to the use of: insurance, performance bonds, warranties, guarantees, incentive/disincentive clauses, A+B Contracts, etc.

- **Mitigate**. Risk mitigation implies a reduction in the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective than trying to repair the damage after the risk has occurred.

  Risk mitigation may take resources or time and hence may represent a tradeoff of one objective for another. However, it may still be preferable to going forward with an unmitigated risk.

Monitoring the deliverables closely, increasing the number of parallel activities in the schedule, early involvement of regulatory agencies in the project, early and continuous outreach to communities/advocacy groups, implementing value engineering, performing corridor studies, adopting less complex processes, conducting more tests, or choosing a more stable supplier are examples of mitigation actions.

Strategies for Positive Risks or Opportunities include:

- **Exploit.** The organization wishes to ensure that the opportunity is realized. This strategy seeks to eliminate the uncertainty associated with a particular upside risk by making the opportunity definitely happen. Examples include securing talented resources that may become available for the project.
- **Share.** Allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project. Examples include: forming risk-sharing partnerships, teams, working with elected officials, special-purpose companies, joint ventures, etc.
- **Enhance.** This strategy modifies the size of an opportunity by increasing probability and/or positive impacts, and by identifying and maximizing key drivers of these positive-impact risks. Seeking to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions, might increase probability. Impact drivers can also be targeted, seeking to increase the project's susceptibility to the opportunity.

Strategy for both Threats and Opportunities:

- **Acceptance**. A strategy that is adopted because it is either not possible to eliminate that risk from a project or the cost in time or money of the response is not warranted by the importance of the risk. When the project manager and the project team decide to accept a certain risk(s), they do not need to change the project plan to deal with that certain risk, or identify any response strategy other than agreeing to address the risk if and when it occurs. A workaround plan may be developed for that eventuality.

  There are two types of acceptance strategy:

  1- **Active acceptance.** The most common active acceptance strategy is to establish a contingency reserve, including amounts of time, money, or resources to handle the threat or opportunity.

  i. ***Contingency Plan***:

  Some responses are designed for use only if certain events occur. In this case, a response plan, also known as "Contingency Plan", is developed by the project team that will only be executed under certain predefined conditions commonly called "triggers."

2- **Passive acceptance.** Requires no action leaving the project team to deal with the threats or opportunities as they occur.

   i. ***Workaround***:

   Workaround is distinguished from contingency plan in that a workaround is a recovery plan that is implemented if the event occurs, whereas a contingency plan is to be implemented if a trigger event indicates that the risk is very likely to occur.

As with risk identification process, the team should also consider residual risks, secondary risks, and risk interaction in the risk response planning process. See page 10 for details.

Risk Monitoring and Control

Risk monitoring and control keeps track of the identified risks, residual risks, and new risks. It also monitors the execution of planned strategies on the identified risks and evaluates their effectiveness.

Risk monitoring and control continues for the life of the project. The list of project risks changes as the project matures, new risks develop, or anticipated risks disappear.

Typically during project execution there should be regularly held risk meetings during which all or a part of the Risk Register is reviewed for the effectiveness of their handling and new risks are discussed and assigned owners. Periodic project risk reviews repeat the process of identification, analysis, and response planning. The project manager ensures that project risk is an agenda item at all PDT meetings. Risk ratings and prioritization commonly change during the project lifecycle.

If an unanticipated risk emerges, or a risk's impact is greater than expected, the planned response may not be adequate. The project manager and the PDT must perform additional response planning to control the risk.

Risk control involves:

- Choosing alternative response strategies
- Implementing a contingency plan
- Taking corrective actions
- Re-planning the project, as applicable

The individual or a group assigned to each risk (risk owner) reports periodically to the project manager and the risk team leader on the status of the risk and the effectiveness of the response plan. The risk owner also reports on any unanticipated effects, and any mid-course correction that the PDT must consider in order to mitigate the risk.

A

Appendices

This chapter provides the documents referenced in the text.

Appendix A: Sample Risk Management Plan Template

Risk Management Plan

District____EA_____

County_____Route:_____PM_____

Purpose

This document describes how Risk Management will be structured and performed on this project. The risk management plan includes methodology, roles and responsibilities, budgeting, timing, risk categories, definitions of risk probability and impact, probability and impact matrix, reporting formats, and tracking. The Caltrans Project Risk Management Handbook will be utilized as primary reference and guideline.

Approved By:

_____ _____

Project Manager Date

Roles and Responsibilities

Project Manager responsibilities include:

- Incorporate the resources and time required to execute the Risk Management Plan in the project budget and schedule
- Develop, distribute and implement this Risk Management Plan
- Develop and update the Risk Register with the support of the Project Team and incorporate it into the workplan
- Coordinate with the risk owners to monitor risks and implement risk response strategies

Project Manager Support or Risk Officer responsibilities include:

- Support the Project Manager in developing and updating the Risk Management Plan and the Risk Register
- Maintain updates to the Risk Management Plan and the Risk Register
- Maintain a list of risk and response strategies of all the projects in the district
- Update the Sample Risk List and the lessons learned database (http://pd.dot.ca.gov/pm/PMPI/LessonsLearned/index.asp).

Project Team responsibilities include:

- Identify the risk and describe it
- Assess the probability that a risk will occur and specify the criteria used to assess the probability
- Assess the impact of risks on project cost, time, scope, and quality objectives, and specify the criteria used to assess the impact
- Help identify the risk owners and assist in developing the risk response strategies (Project Team members may be assigned as “Risk Owner”)
- Perform the risk response steps assigned
- Assist the PM in activities associated with Risk Monitoring and Control

Risk Owner responsibilities include:

- Develop and/or update the assigned risk response strategy
- Monitor the risk assigned and inform PM of any threats or opportunities to the project. This includes monitoring the risk trigger and informing the PM, if the risk becomes a real event.

Risk Register

The Risk Register documents the identified risks, the assessment of their root causes, areas of the project affected (WBS elements), the analysis of their likelihood of occurring and impact if they occur and the criteria used to make those assessments and the overall risk rating of each identified risk by objective (e.g. cost, time, scope and quality). (Appendix D, Project Risk Management Handbook).

Importantly, it includes the risk triggers, response strategies for high priority risks, and the assigned risk owner who will monitor the risk.

Risk Identification Methods Used

The risk breakdown structure (Appendix B, Project Risk Management Handbook) and Sample Risk List. (Appendix C, Project Risk Management Handbook) will be used as reference tools to help identify and categorize risks.

Risk Analysis Methods Used

Qualitative Risk Analysis attempts to rank the risks into high, medium and low risk categories based on their probability of occurring and impact on an objective. (The objective with the most impact, at a minimum).

This project will _____ will not _____ use qualitative risk analysis

This project will _____ will not _____ use District RM Web tool

Quantitative Risk Analysis attempts to estimate the risk that the project and its phases will finish within objectives taking into account all identified and quantified risks, estimates the contingency needed for cost and schedule and identifies the best decisions using decision tree analysis. (See *Project Risk Management Handbook* for additional information and when to use Quantitative Risk Analysis).

This project will _____ will not _____ use quantitative cost risk analysis

This project will _____ will not _____ use quantitative schedule risk analysis

This project will _____ will not _____ use decision tree analysis

This project will _____ will not _____ use other quantitative methods

Period of Risk Management Meetings and Full Review of Project Risk

Meetings for the purpose of discussing and making decisions on Project risk will be held:

Weekly _____ Bi-Weekly _____ Monthly _____Other_____

The risk management identification, analysis and response planning process shall occur during project initiation document (PID). A full review and update of risk register will occur at the beginning of each subsequent phase of the project.

Budget Allocated for Risk Management

Staff allocated and assigned for risk management activities include:

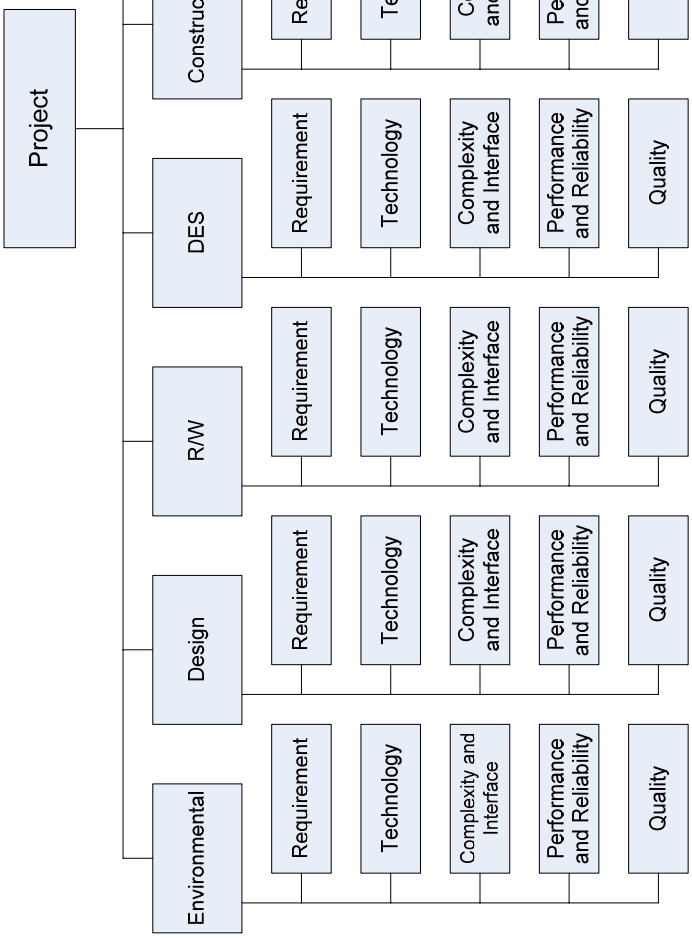
PMSU Chief	@	_____	Hrs
Risk Officer	@	_____	Hrs
PM	@	_____	Hrs
Environmental	@	_____	Hrs
Design	@	_____	Hrs
R/W	@	_____	Hrs
DES/Structure	@	_____	Hrs
Const.	@	_____	Hrs
Traffic Operations	@	_____	Hrs
Maintenance	@	_____	Hrs
	@	_____	Hrs
Total:		_____	Hrs

___Hrs. × $ __ /Hr =

A total of $ is allocated for Risk Management on this project.

Appendix B: Risk breakdown structure

Appendix B
Risk breakdown structure



Note: Risks to the project are categorized by sources of the risk in the above risk breakdown structure.

Appendix C: Sample Risk List

The process of risk identification produces a project risk list. The project team then puts the risks into categories and assigns each risk to a team member.

The project team members may use this sample risk checklist to help in developing a project specific risk list. This list is not meant to be all-inclusive; it is just a guide. Care should be taken to explore items that do not appear on this checklist. Team members add other risk areas from previous project results and as they arise during the project. Such sources might include:

- Final project reports
- Risk response plans
- Organized lessons learned
- The experience of project stakeholders or others in the organization
- Published information such as commercial databases or academic studies

Design Risks

- Design incomplete
- Unexpected geotechnical or groundwater issues
- Inaccurate assumptions on technical issues in planning stage
- Surveys incomplete
- Changes to materials/geotechnical/foundation
- Bridge site data incomplete to DES
- Hazardous waste site analysis incomplete
- Unforeseen design exceptions required
- Consultant design not up to Department standards
- Unresolved constructability items
- Complex hydraulic features
- Unable to meet Americans with Disabilities Act requirements
- Project in a critical water shortage area and a water source agreement required
- Incomplete quantity estimates
- Unforeseen construction window and/or rainy season requirements
- New or revised design standard
- Construction staging more complex than anticipated

External Risks

- Landowners unwilling to sell
- Local communities pose objections
- Unreasonably high expectations from stakeholders
- Political factors or support for project changes
- Stakeholders request late changes
- New stakeholders emerge and request changes
- Threat of lawsuits
- Increase in material cost due to market forces
- Water quality regulations change
- New permits or additional information required

- Reviewing agency requires longer than expected review time
- Changes to storm-water requirements
- Permits or agency actions delayed or take longer than expected
- New information required for permits
- Environmental regulations change
- Controversy on environmental grounds expected
- Pressure to deliver project on an accelerated schedule
- Labor shortage or strike
- Construction or pile driving noise and vibration impacting adjacent businesses or residents

Environmental Risks

- Environmental analysis incomplete
- Availability of project data and mapping at the beginning of the environmental study is insufficient
- New information after Environmental Document is completed may require re-evaluation or a new document (i.e. utility relocation beyond document coverage)
- New alternatives required to avoid, mitigate or minimize impact
- Acquisition, creation or restoration of on or off-site mitigation
- Environmental clearance for staging or borrow sites required
- Historic site, endangered species, riparian areas, wetlands and/or public park present
- Design changes require additional Environmental analysis
- Unforeseen formal NEPA/404 consultation is required
- Unforeseen formal Section 7 consultation is required
- Unexpected Section 106 issues expected
- Unexpected Native American concerns
- Unforeseen Section 4(f) resources affected
- Project may encroach into the Coastal Zone
- Project may encroach onto a Scenic Highway
- Project may encroach to a Wild and Scenic River
- Unanticipated noise impacts
- Project causes an unanticipated barrier to wildlife
- Project may encroach into a floodplain or a regulatory floodway
- Project does not conform to the state implementation plan for air quality at the program and plan level

- Unanticipated cumulative impact issues

Organizational Risks

- Inexperienced staff assigned
- Losing critical staff at crucial point of the project
- Insufficient time to plan
- Unanticipated project manager workload
- Internal "red tape" causes delay getting approvals, decisions
- Functional units not available, overloaded
- Lack of understanding of complex internal funding procedures
- Priorities change on existing program
- Inconsistent cost, time, scope and quality objectives
- Overlapping of one or more project limits, scope of work or schedule
- Funding changes for fiscal year
- Lack of specialized staff (biology, anthropology, geotechnical, archeology, etc.)
- Capital funding unavailable for right of way or construction

Project Management Risks

- Project purpose and need is not well-defined
- Project scope definition is incomplete
- Project scope, schedule, objectives, cost, and deliverables are not clearly defined or understood
- No control over staff priorities
- Consultant or contractor delays
- Estimating and/or scheduling errors
- Unplanned work that must be accommodated
- Lack of coordination/communication
- Underestimated support resources or overly optimistic delivery schedule
- Scope creep
- Unresolved project conflicts not escalated in a timely manner
- Unanticipated escalation in right of way values or construction cost
- Delay in earlier project phases jeopardizes ability to meet programmed delivery commitment
- Added workload or time requirements because of new direction, policy, or statute

- Local agency support not attained
- Public awareness/campaign not planned
- Unforeseen agreements required
- Priorities change on existing program
- Inconsistent cost, time, scope, and quality objectives

Right of Way Risks

- Utility relocation requires more time than planned
- Unforeseen railroad involvement
- Resolving objections to Right of Way appraisal takes more time and/or money
- Right of Way datasheet incomplete or underestimated
- Need for "Permits to Enter" not considered in project schedule development
- Condemnation process takes longer than anticipated
- Acquisition of parcels controlled by a State or Federal Agency may take longer than anticipated
- Discovery of hazardous waste in the right of way phase
- Seasonal requirements during utility relocation
- Utility company workload, financial condition or timeline
- Expired temporary construction easements
- Inadequate pool of expert witnesses or qualified appraisers

Construction Risks

- Inaccurate contract time estimates
- Permit work window time is insufficient
- Change requests due to differing site conditions
- Temporary excavation and shoring system design is not adequate
- Falsework design is not adequate
- Unidentified utilities
- Buried man-made objects/unidentified hazardous waste
- Dewatering is required due to change in water table
- Temporary construction easements expire
- Electrical power lines not seen and in conflict with construction
- Street or ramp closures not coordinated with local community

- Insufficient or limited construction or staging areas
- Changes during construction require additional coordination with resource agencies
- Late discovery of aerially deposited lead
- Experimental or research features incorporated
- Unexpected paleontology findings
- Delay in demolition due to sensitive habitat requirements or other reasons
- Long lead time for utilities caused by design and manufacture of special components (steel towers or special pipe)

Engineering Services Risks

- Foundations utilizing Cast-In-Drilled-Hole or Cast-In-Steel-Shell pile 30" in diameter or greater may require tunneling and mining provisions within the contract documents and early notification of Cal-OSHA
- Bridges constructed at grade and then excavated underneath may require tunneling and mining provisions within the contract documents and early notification of Cal-OSHA
- Hazardous materials in existing structure or surrounding soil; lead paint, contaminated soil, asbestos pipe, asbestos bearings and shims
- Piles driven into fish habitat may require special noise attenuation to protect marine species
- Special railroad requirements are necessary including an extensive geotechnical report for temporary shoring system adjacent to tracks
- Access to adjacent properties is necessary to resolve constructability requirements
- Existing structures planned for modification not evaluated for seismic retrofit, scour potential and structural capacity
- Foundation and geotechnical tasks (foundation drilling and material testing) not identified and included in project workplan
- Bridge is a habitat to bats or other species requiring mitigation or seasonal construction
- Condition of the bridge deck unknown
- For projects involving bridge removal, bridge carries traffic during staging
- Verify that all seasonal constraints and permitting requirements are identified and incorporated in the project schedule
- Complex structures hydraulic design requiring investigation and planning
- Assumptions upon which the Advance Planning Study is based on are realistic and verification of these assumptions prior to completion of the Project Report
- Design changes to alignment, profile, typical cross section, stage construction between Advance Planning Study and the Bridge Site Submittal
- Unexpected environmental constraints that impact bridge construction

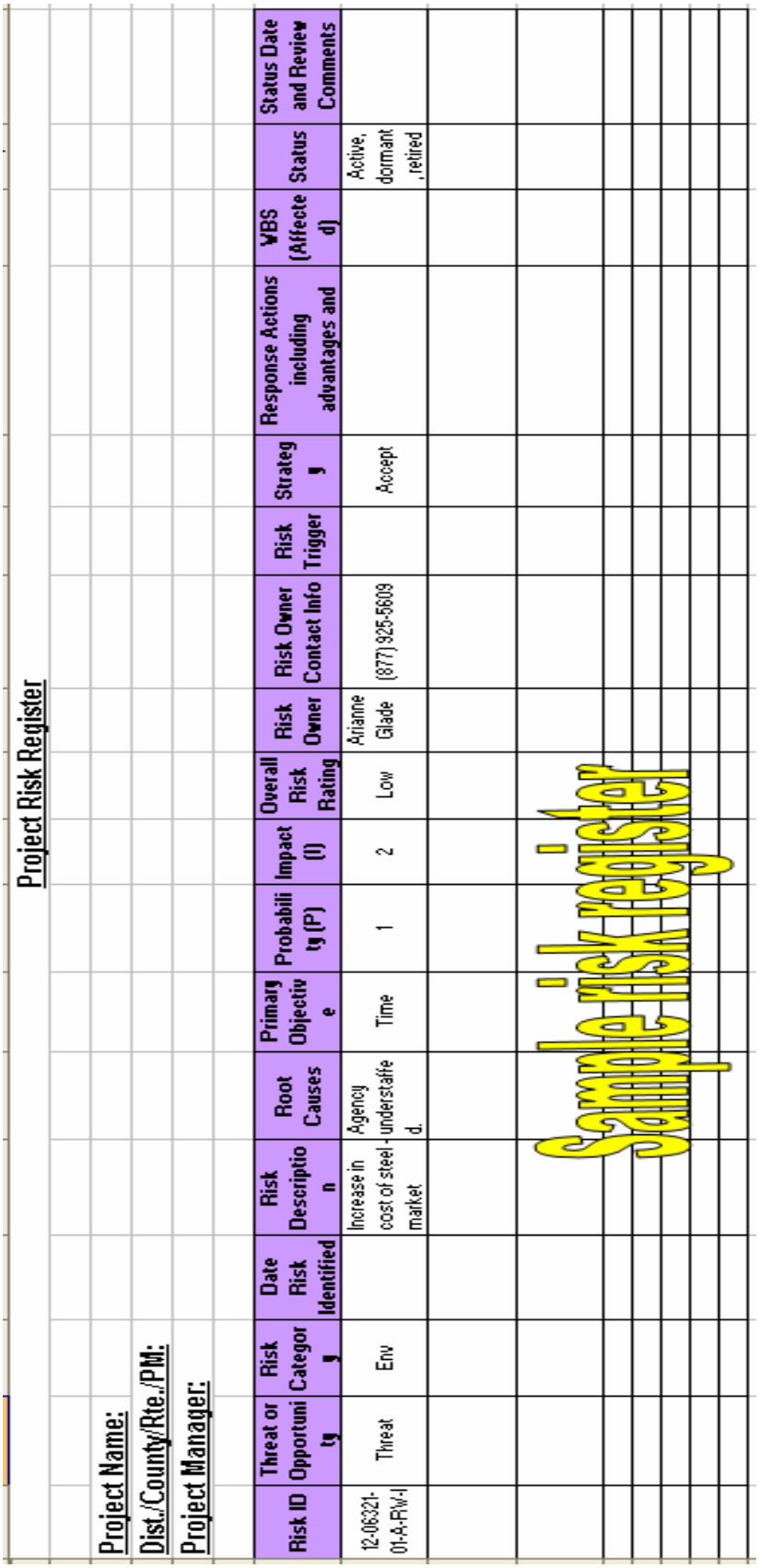
- Unforeseen aesthetic requirements
- Delay due to permits or agreements, from Federal, State, or local agencies for geotechnical subsurface exploration
- Delay due to Right-of-Entry agreements for geotechnical subsurface exploration
- Delay due to traffic management and lane closure for geotechnical subsurface exploration

Appendix D: Sample Risk Register

Using the sample risk list (Appendix C), the assigned project team members add their specific information to the risk register.

The following illustration shows a sample Excel spreadsheet that represents one possibility for what a risk register might include.

For a copy of the most recent electronic version of the risk register please visit the project management guidance Website at:
http://www.dot.ca.gov/hq/projmgmt/guidance.htm



Project Risk Register

Project Name:

Dist./County/Rte./PM:

Project Manager:

Risk ID	Threat or Opportunity	Risk Category	Date Risk Identified	Risk Description	Root Causes	Primary Objective	Probability (P)	Impact (I)	Overall Risk Rating	Risk Owner	Risk Owner Contact Info	Risk Trigger	Strategy	Response Actions including advantages and	WBS (Affected)	Status	Status Date and Review Comments
12-06321-01-A-RW-1	Threat	Env		Increase in cost of steel - market	Agency understaffed.	Time	1	2	Low	Arianne Glade	(877) 925-5609		Accept			Active, dormant, retired	

Sample risk register

Figure 2. Risk management plan spreadsheet sample

Appendix E: Risk Ranking

Using established methods and tools, qualitative risk analysis assesses the probability and the consequences (impact) of each identified risk to determine its overall importance. Using these tools helps to correct biases that are often presented in a project plan. In particular, careful and objective definitions of different levels of probability and impact are the keys to the credibility of the results.

▸ To rank risks by probability and impact:

For more information about risk ranking, see chapter 11 of the PMBOK.

Step 1: Set up a matrix to match a percentage (probability of risk) to a ranking number. Department project managers often use the matrix shown below, but they can set up a different matrix if it would better suit the project.

Risk Probability Ranking	
Ranking	**Probability of Risk Event**
5	60–99%
4	40–59%
3	20–39%
2	10–19%
1	1–9%

Step 2: Set up a matrix to match the objective (time, cost, scope, quality) to a defined impact. Department project managers may use the impact ratings shown in the following matrices for risks, but they can choose values other than those shown below if the Sponsor and the PM think it would better suit the project.

Impact matrices for threats and for opportunities follow:

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

Legend: C – Constructability, O – Operability, M – Maintainability

Evaluating Impact of an OPPORTUNITY on Major Project Objectives						
Impact		**Very Low**	**Low**	**Moderate**	**High**	**Very High**
OBJECTIVE	**Time**	Insignificant Schedule Improvement	Delivery Plan milestone does not improve but float is added	Delivery Plan milestone improves but still within the quarter	Delivery Plan milestone improves by 1 quarter.	Delivery Plan milestone improved by more than one quarter
	Cost	Insignificant Cost reduction	<1% Cost Decrease	1% - 3% Cost Decrease	3%-5% Cost Decrease	>5% Cost Decrease
	Scope	Scope effect is not noticeable	Improves chances to achieve project limits or features with cost increases of 10% or more	Improves chances to achieve project limits or features with cost increases of 5%-10%	Improves chances to achieve project limits or features with cost increases of 2%-5%	Improves chances to achieve project limits or features with cost increases of < 2%
	Quality	No quality improvement noticeable	C, O, M improvement noticeable by project team	C, O, M improvement can be seen and measured	Quality improvement can be claimed for the project	Quality improvement is "best in class"

Legend: C – Constructability, O – Operability, M – Maintainability

Step 3: Each identified risk is assessed based on its:

- Probability of occurring, rated 1 to 5 based on the Risk Probability Ranking table. The probability remains the same for all four objectives (cost, time, scope and quality) of a risk.

- Impact if it does occur, and is rated separately for each objective (cost, time, scope and quality) based on the Evaluating Impact of a Risk (threat or opportunity) on Major Project Objectives.

The output of this exercise is, for each risk, a probability and up to four (4) impacts corresponding to the objectives that the risk would impact.

Step 4: Create the Probability and Impact Matrix and choose which matrix layout is appropriate for each objective.

The output from Step 3 is combined to determine whether the activity is high risk (RED), moderate risk (YELLOW) or low risk (GREEN) for each objective. Establish a PxI Matrix for each main objective that reflects project stakeholders' views of what combination of probability and impact makes a risk to each objective low, moderate or high.

Organizations and sponsors often choose to put a large emphasis on mitigating risks with high or very high impacts. For this purpose they give a greater-than-linear weight to impact levels as they go up (from left to right in the Evaluating Impact of a Risk (threat or opportunity) on Major Project Objectives from very low to very high impact. The greater-than-linear scores higher impacts may apply to any or all objectives – hence it is likely that different objectives may have different scoring systems applied to them.

Impact Scoring		
	Degree of Focus on Risks with High and Very High Impacts	
	Significant (Non-linear)	Moderate (Linear)
Very High	16	5
High	8	4
Moderate	4	3
Low	2	2
Very Low	1	1

The PDT uses a PxI matrix to combine each risk's probability and impact. These matrices establish whether a risk with a certain combination of probability and impact is of high, moderate, or low priority for that objective, based on combinations of probability and impact as established by project management and other stakeholders. There are potentially 4 such matrices, one for each objective, although in practice the patterns of red, yellow and green may be the same for some or all of the objectives. Two candidate matrices for threats and two for opportunities, using the non-linear and linear impact scoring, are shown as follow:

Option 1: PxI Matrix for Significant Focus on High and Very High Impacts (Non-linear Impact Scoring)					
Probability	Threats				
5	5	10	20	40	80
4	4	8	16	32	64
3	3	6	12	24	48
2	2	4	8	16	32
1	1	2	4	8	16
	1	2	4	8	16
	Impact on Selected Objective				

Option 2: PxI Matrix for Moderate Focus on High and Very High Impacts (Linear Impact Scoring)					
Probability	Threats				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	Impact on Selected Objective				

Option 1: PxI Matrix for Significant Focus on High and Very High Impacts (Non-linear Impact Scoring)					
Probability	Opportunities				
5	5	10	20	40	80
4	4	8	16	32	64
3	3	6	12	24	48
2	2	4	8	16	32
1	1	2	4	8	16
	1	2	4	8	16
	Impact on Selected Objective				

Option 2: PxI Matrix for Moderate Focus on High and Very High Impacts (Linear Impact Scoring)					
Probability	Opportunities				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	Impact on Selected Objective				

Translate Score to Risk Rank

Score	Risk
1 – 6	Low
7 – 14	Moderate
15 – ++	High

Figure 3. Sample PxImatrices

The risk scores shown in the Risk Register for each objective reflect the PxI matrix chosen for impact on that particular objective. In the Risk Register the risks can then be displayed by high, moderate, and low groupings for each of the four objectives (time, cost, scope, quality) and for threats as well as opportunities. Department project managers often use the PxI matrices shown above, but they can set up a different matrix and assign different scores if it would better suit the project.

Some Department project managers use a PxI matrix based on narrative probabilities and impacts (very low, low, moderate, high, very high) rather than numerical ones.

Appendix F: References

For more information about risk and risk management, see:

- Chapter 11 of *A Guide to Project Management Body of Knowledge* (PMBOK® Guide), Third Edition, or later
- Chapter 11 of the *Government Extension to a Guide to the Project Management Body of Knowledge*, 2000 Edition or later
- Department *Guide to Capital Project Work Breakdown Structure*, Release 8.0 or later
- project management guidance website at ***http://www.dot.ca.gov/hq/projmgmt/guidance.htm***

G

Glossary

Contingency plan — A set of predefined actions to be taken when a negative risk occurs.

Contingency Reserve — The amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organization.

Decision Tree — A diagram used to select the best course of action in uncertain situations.

Environmental Document — The National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) require certain environmental documentation for transportation projects. Types of documents include a negative declaration (ND) finding of no significant impact (FONSI), or an environmental impact study (EIS)/environmental impact report (EIR).

Impact — Effect or consequence.

Milestone — A significant event in the project, usually completion of a major deliverable.

Mitigation — The act of alleviating a harmful circumstance. Risk mitigation seeks to reduce the probability and/or impact of a risk to below an acceptable threshold.

Opportunity — A risk that will have a positive impact on a project objective if it occurs.

Probability Likelihood of the occurrence of any event.

Program Change Request Any significant changes to the scope, cost, or schedule of a programmed project (STIP, SHOPP, or TCRP) or special program project (toll seismic retrofit, soundwall) require a revision to the delivery commitment.[2]

Project Development Team An interdisciplinary team composed of key members of the project team as well as external stakeholders, that acts as a steering committee in directing the course of studies required to evaluate the various project alternatives during the early components of the project lifecycle.

Project Initiation Document Concept approval document for candidate projects that contains:

- A defined project scope
- A reliable capital and support cost estimate for each alternative solution
- A project schedule (workplan) for the alternative recommended for programming the project

Project Objective A particular goal of a project. All projects have these four objectives:

- Scope
- Schedule
- Cost
- Quality

Project Risk An uncertain event or condition that, if it occurs, has a positive or negative impact on at least one project objective.

Residual Risk Risks that remain even after developing responses to the project's original risks

Risk Interaction The combined effect of two or more risks occurring simultaneously greater than the sum of the individual effects of each free standing risk.

Risk Officer A person assigned to monitor and maintain the project risk management activities/risk registers for all the projects in the district (District specific).

[2] Project Change Requests, memo dated September 21, 2002, Number 006
http://pd.dot.ca.gov/pm/ProjectOffice/ProcessGuidance_Directives/Guidance_DirectivesHome.asp
(Project Change Request is now referred to as Program Change Request).

Risk Owner	A person assigned to monitor the risk(s) and inform the project manager of any changes in the status of the risk.
Secondary Risks	Secondary risks are caused by responses to the project's original risks.
Scope	Encompasses the work that must be done to deliver a product with the specified features and functions.
Threat	A risk that will have a negative impact on a project objective if it occurs.
Trigger	Symptoms and warning signs that indicate whether a risk is becoming a near-certain event and a contingency plan/response plan should be implemented.
Value Analysis	A multi-disciplined team systematically applies recognized techniques to: ▸ Identify the function of a product or service ▸ Establish a worth for that function ▸ Generate alternatives through the use of creative thinking ▸ Reliably provide the needed functions at the lowest overall cost The term is often interchanged with Value Engineering.
Value Analysis Team	A team that performs value engineering.
Workplan	A resourced schedule. The workplan identifies the project-specific WBS elements and defines the cost, timeline, and requirements for each. The current workplan guides the day-to-day operations of project execution and project control.

A

Acronyms

CEQA	California Environmental Quality Act
EIR	Environmental Impact Report
EIS	Environmental Impact Study
FONSI	Finding of No Significant Impact
ND	Negative Declaration
NEPA	National Environmental Policy Act
PCR	Programming Change Request (Formerly Project Change Request)
PDT	Project Development Team
PID	Project Initiation Document
PMBOK	Project Management Body of Knowledge
PSR	Project Study Report
PxI	Probability and Impact
Rbs	Risk breakdown structure

RBS	Resource Breakdown Structure (Caltrans)
RMP	Risk Management Plan
SHOPP	State Highway Operation & Protection Program
SME	Subject Matter Expert
STIP	State Transportation Improvement Program
TCRP	Traffic Congestion Relief Program
VA	Value Analysis
WBS	Work Breakdown Structure

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