Transportation Risk Management:
International Practices for Program Development and Project Delivery

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U.S. Department of Transportation
Federal Highway Administration

In cooperation with:

American Association of State Highway and Transportation Officials

National Cooperative Highway Research Program

August 2012

International Technology Scanning Program

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-PL-12-029		

4. Title and Subtitle	5. Report Date
Transportation Risk Management: International Practices for Program Development and Project Delivery	August 2012
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Joyce A. Curtis, Joseph S. Dailey, Daniel D'Angelo, Steven D. DeWitt, Michael J. Graf, Timothy A. Henkel, Dr. John B. Miller, Dr. John C. Milton, Dr. Keith R. Molenaar, Darrell M. Richardson, Robert E. Rocco	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
American Trade Initiatives 3 Fairfield Court Stafford, VA 22554-1716	11. Contract or Grant No. DTFH61-10-C-00027

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Office of International Programs Federal Highway Administration U.S. Department of Transportation American Association of State Highway and Transportation Officials	14. Sponsoring Agency Code

15. Supplementary Notes

FHWA COTR: Hana Maier, Office of International Programs

16. Abstract

Studies show that U.S. highway agencies have only recently begun to develop formal risk management policies and procedures at the enterprise, program, and project levels. The Federal Highway Administration, American Association of State Highway and Transportation Officials, and National Cooperative Highway Research Program sponsored a scanning study of Australia and Europe to document risk management policies, practices, and strategies for potential application in the United States.

The scan team found that the leading international transportation agencies have mature risk management practices. The team observed that risk management supports strategic organizational alignment, helps apportion risks to the parties best able to manage them, and facilitates good decisionmaking and accountability at all levels of the organizations.

Team recommendations for U.S. implementation include developing executive-level support for risk management at transportation agencies, defining risk management leadership and organizational responsibilities, and using risk management to make the business case for transportation and build trust with transportation stakeholders.

17. Key Words	18. Distribution Statement
Asset management, enterprise, performance management, program development, project delivery, risk management	No restrictions. This document is available to the public from the: Office of International Programs, FHWA-HPIP, Room 3325, U.S. Department of Transportation, Washington, DC 20590 *international@fhwa.dot.gov, www.international.fhwa.dot.gov*

19. Security Classify. (of this report)	20. Security Classify. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	80	Free

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National Cooperative Highway Research Program

International Technology Scanning Program

The International Technology Scanning Program, sponsored by the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP), evaluates innovative foreign technologies and practices that could significantly benefit U.S. highway transportation systems. This approach allows for advanced technology to be adapted and put into practice much more efficiently without spending scarce research funds to re-create advances already developed by other countries.

FHWA and AASHTO, with recommendations from NCHRP, jointly determine priority topics for teams of U.S. experts to study. Teams in the specific areas being investigated are formed and sent to countries where significant advances and innovations have been made in technology, management practices, organizational structure, program delivery, and financing. Scan teams usually include representatives from FHWA, State departments of transportation, local governments, transportation trade and research groups, the private sector, and academia.

After a scan is completed, team members evaluate findings and develop comprehensive reports, including recommendations for further research and pilot projects to verify the value of adapting innovations for U.S. use. Scan reports, as well as the results of pilot programs and research, are circulated throughout the country to State and local transportation officials and the private sector. Since 1990, more than 85 international scans have been organized on topics such as pavements, bridge construction and maintenance, contracting, intermodal transport, organizational management, winter road maintenance, safety, intelligent transportation systems, planning, and policy.

The International Technology Scanning Program has resulted in significant improvements and savings in road program technologies and practices throughout the United States. In some cases, scan studies have facilitated joint research and technology-sharing projects with international counterparts, further conserving resources and advancing the state of the art. Scan studies have also exposed transportation professionals to remarkable advancements and inspired implementation of hundreds of innovations. The result: large savings of research dollars and time, as well as significant improvements in the Nation's transportation system.

Scan reports can be obtained through FHWA free of charge by e-mailing international@dot.gov. Scan reports are also available electronically and can be accessed on the FHWA Office of International Programs Web site at www.international.fhwa.dot.gov.

International Technology Scan Reports

International Technology Scanning Program: *Bringing Global Innovations to U.S. Highways*

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Assuring Bridge Safety and Serviceability in Europe (2010)

Pedestrian and Bicyclist Safety and Mobility in Europe (2010)

Improving Safety and Mobility for Older Road Users in Australia and Japan (2008)

Safety Applications of Intelligent Transportation Systems in Europe and Japan (2006)

Traffic Incident Response Practices in Europe (2006)

Underground Transportation Systems in Europe: Safety, Operations, and Emergency Response (2006)

Roadway Human Factors and Behavioral Safety in Europe (2005)

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European Road Lighting Technologies (2001)

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Asian Bridge Structures (1997)

Bridge Maintenance Coatings (1997)

Northumberland Strait Crossing Project (1996)

European Bridge Structures (1995)

All publications are available on the Internet at www.international.fhwa.dot.gov.

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Executive Summary

Background

Managing transportation networks, including agency management, program development, and project delivery, is extremely complex and fraught with uncertainty. Administrators, planners, and engineers coordinate a multitude of organizational and technical resources to manage transportation network performance. While most transportation agency personnel would say they inherently identify and manage risk in their day-to-day activities, a recent study found that only 13 State departments of transportation (DOT) have formal enterprise risk management programs and even fewer have a comprehensive approach to risk management at the agency, program, and project levels.[1]

Risk management is implicit in transportation business practices (see figure 1). Transportation agencies set strategic goals and objectives (e.g., the reliable and efficient movement of people and goods), but success is uncertain. Internal and external risk events can impact the achievement of these objectives. Likewise, agencies set performance measures and develop asset management systems to optimize investment decisions. Again, risks can impact the achievement of performance and assets. Risk is pervasive in transportation. It is incumbent on transportation agencies to develop explicit enterprise risk management strategies, methods, and tools.

Figure 1. *Relationship of risk management to transportation agency management.*

What is Risk Management?

The international standard ISO 31000 defines risk as "the effects of uncertainty on objectives."[2] In its broadest terms, risk is anything that could be an obstacle to achieving goals and objectives. Risk management is a process of analytical and management activities that focus on identifying and responding to the inherent uncertainties of managing a complex organization and its assets.

Risk can be managed at multiple levels (see figure 2). Enterprise risk management is a term that executives use when discussing risk. For this purpose, enterprise risk management involves three levels—agency, program, and project risk management. Agency risk management is the responsibility of highway agency executives. Executives benefit from the process, but they are also responsible for defining and championing the process. Agency risks are the uncertainties that can affect the achievement of the agency's strategic objectives (e.g., agency reputation, data integrity, funding, safety, leadership). Agency risk management is the consistent application of techniques to manage the uncertainties in achieving agency strategic objectives. Therefore, agency risk management is not a task to complete or a box to check, but a process to consistently apply and improve. As we move down a layer, risk management at the program level involves managing risk across a network or multiple projects (e.g., risks inherent in city or regional transportation

[1] National Cooperative Highway Research Program (2011). *Executive Strategies for Risk Management by State Departments of Transportation.* NCHRP Project 20-24(74), National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC.

[2] International Organization for Standardization (ISO) (2009). *ISO 31000 Risk Management—Principles and Guidelines.* International Organization for Standardization, Geneva, Switzerland.

planning, risk of material price escalation, design standard changes, environment, structures). Finally, risks may be unique to a specific project. Project risk management occurs with staff familiar with the specifics of that project and other technical experts and stakeholders (e.g., utility relocation coordination, right-of-way purchase delays, geotechnical issues, community issues). Figure 2 summarizes the responsibility, type of risk, and risk management strategies at these three levels.

Figure 2 describes many risk management strategies highway agencies already practice in the United States. Agency personnel manage risk daily. However, comprehensive risk management, from the agency to the project level, is not common in the United States.[3] This report describes the best practices of international organizations with the most mature risk management programs. Adopting these best practices will lead to improving agency governance structures, better aligning stakeholder functions with facility user needs, saving short- and long-term funds, reducing fatalities, and improving other agency functions that have uncertainty.

[3] National Cooperative Highway Research Program (2011). *Executive Strategies for Risk Management by State Departments of Transportation.* NCHRP Project 20-24(74), National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC.

Purpose and Scope

From May 26 to June 12, 2011, a U.S. panel traveled to Australia and Europe to learn from their significant experience by conducting a scan of risk management practices for program development and project delivery. The purpose of the scan was to review and document international policies, practices, and strategies for potential application in the Unites States. The team conducted meetings with government agencies, academic researchers, and private sector organizations that actively participate in risk management efforts. The scan team also visited project sites and personnel who were applying these practices. The scan team visited with international organizations from the following:

- New South Wales, Australia
- Victoria, Australia
- Queensland, Australia
- London, England
- Cologne, Germany
- Rotterdam, Netherlands
- Glasgow, Scotland

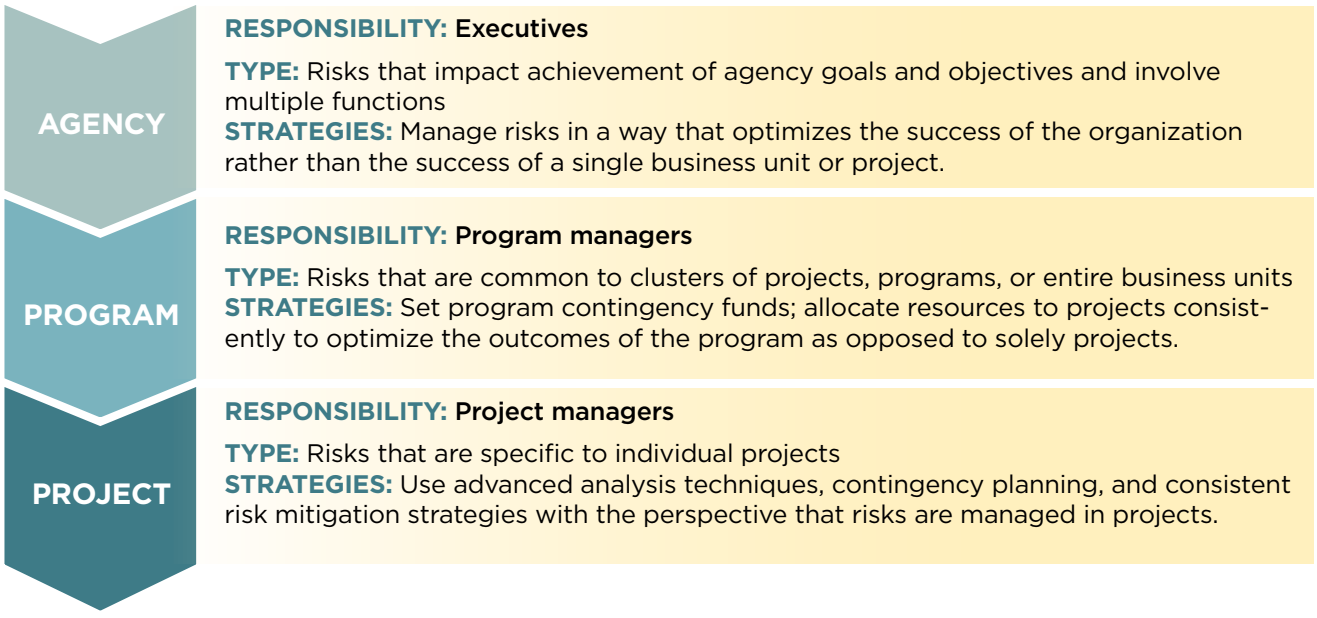


Figure 2. *Levels of enterprise risk management (agency, program, and project).*

Observations and Key Findings

The leading international transportation agencies have mature risk management practices. They have developed policies and procedures to identify, assess, manage, and monitor risks. A brief summary of the team's observations includes the following:

- Risk management supports **strategic organizational alignment.**
- Mature organizations have an **explicit risk management structure.**
- Successful organizations have a **culture of risk management.**
- A wide range of **risk management tools** are in use.
- Risk management tools are key for **programmatic investment decisions.**
- A variety of **risk management methods** are available.
- Active **risk communication strategies** improve decisionmaking.
- Risk management enhances **knowledge management and workforce development.**

A fully functioning and mature risk management program supports performance management and asset management. It integrates strategic planning with performance and asset management by focusing on risks that could negatively impact overall agency performance.

Benefits and Challenges of Formal Risk Management

For agencies that do not currently conduct enterprise risk management, there is an investment to begin. Developing an organizational structure and investing in the development of methods and tools are not trivial tasks. An understanding of the benefits and challenges is helpful in developing an enterprise risk management program.

Benefits

- Helps with making the business case for transportation and building public trust
- Avoids or minimizes managing-by-crisis and promotes proactive management strategies
- Explicitly recognizes risks in multiple investment options with uncertain outcomes
- Provides a broader set of viable solution options earlier in the process
- Communicates uncertainty and helps focus on key strategic issues
- Improves organizational alignment
- Promotes an understanding of the repercussions of failure
- Helps apportion risks to the party best able to manage them
- Facilitates good decisionmaking and accountability at all levels of the organization

Challenges

- Gaining organizational support for risk management at all levels
- Evolving existing organizational culture, which can be risk averse
- Developing and funding organizational expertise for risk management
- Implementing and embedding a new process for risk management
- Difficulty in applying risk allocation alternatives within organizational constraints
- Lack of willingness to accept and address issues that risk management will identify

Recommendations

The risk management scan team included Federal, State, and private sector members with well over 100 years of combined experience in the operation,

design, and construction of U.S. transportation systems. Through this focused research study, the team has gained a fresh perspective on how the U.S. transportation industry can use risk management practices to better meet its strategic objectives, improve performance, and manage assets. The following scan team recommendations offer a path forward for the transportation community and will help develop a culture of risk awareness and management in the United States:

1. Develop executive support for risk management.
2. Define risk management leadership and organizational responsibilities.
3. Formalize enterprise risk management approaches using a holistic approach to support decisionmaking and improve successful achievement of strategic goals and objectives.
4. Use risk management to reexamine existing policies, processes, and standards.
5. Embed risk management in existing business processes so that when asset, performance, and risk management are combined, successful decisionmaking ensues.
6. Identify risk owners and manage risks at the appropriate level.
7. Use the risk management process to support risk allocation in agency, program, and project delivery decisions.
8. Use risk management to make the business case for transportation and build trust with transportation stakeholders.
9. Employ sophisticated risk analysis tools, but communicate results in a simple fashion.

Implementation

The risk management scan findings confirm that an efficient and effective enterprise risk management program is a powerful tool for the international transportation agencies the team visited. The demonstrated benefits for the agencies are both quantitative, such as better controls over costs and delivery schedules, and qualitative, such as less likelihood of negative public relations issues. Risk management provides information that allows agencies to improve programs and projects by making them more efficient. By identifying and mitigating risks, agencies can avoid policies and standards that are not practical for all cases. The findings further confirm that risk management programs can be a powerful tool and unifying systems approach for State agencies. While today each U.S. highway agency differs in its level of risk management maturity, it seems reasonable that the implementation activities associated with this scan should advance enterprise risk management in State agencies throughout the country. That is, agencies need to do risk management at the agency, program, and project levels to be fully successful.

The scan findings confirm the need for additional implementation activities that fall into the categories of research, training, governance, and communication and marketing for knowledge transfer. The following are some preliminary short- and long-term implementation suggestions to evolve and advance enterprise risk management in U.S. highway agencies:

- Conduct an executive-level risk management workshop.
- Host an international enterprise risk management workshop.
- Develop a guidebook on enterprise risk management strategies, methods, and tools.
- Develop and deploy risk management tools.
- Develop risk management performance measures.
- Develop and implement risk management assessment tools and a maturity model.
- Introduce risk management case studies.
- Activate an American Association of State Highway and Transportation Officials risk management subcommittee (elevate from a technical committee).
- Update risk management training to incorporate lessons learned from the scan.

Most agencies would agree that they already do some form of risk management, but few agencies have reached the level of maturity found in the host countries visited on this scan. The implementation strategies will serve as a means to transfer the practices from Australia and Europe that could significantly improve highways and highway transportation services in the United States. This technology transfer enables innovations to be adapted and put into practice much more efficiently without spending scarce research funds to re-create advances already developed by other countries. Successful implementation in the United States of the world's best practices is the goal of the effort.

Reader's Guide to the Report

The report combines a discussion of common practices and illustrative case studies of risk management in Australia and Europe with critical analysis of the applicability of these techniques to U.S. agencies and culture. Whenever possible, parallel U.S. examples are provided to amplify techniques that are directly applicable. This report begins with a discussion of risk management strategies and tools that are common to the agencies on the scan. It then discusses applications of risk management at the agency, program, and project levels. The document concludes with recommendations for developing risk management practices in the U.S. transportation sector.

The report is designed to provide information to various users in a number of ways. Chapter 3 on agency risk management focuses on providing information to transportation executives and inspiring them to lead change in their agencies. It is rich with examples of how transportation agencies can benefit from a holistic approach to risk management. Chapter 4 on program risk management is geared to program managers and leaders of discipline groups. It provides more comprehensive approaches to aligning various risk management efforts across highway agencies. Chapter 5 on project risk management provides project managers with examples and tools to improve their project performance. Chapter 6 provides a framework for enterprise risk managers in highway agencies to implement risk management in their organizations and support growth of risk management in the U.S. transportation community.

CHAPTER 1:

Introduction

Background and Purpose

National Cooperative Highway Research Program (NCHRP) studies have found that U.S. highway agencies have only recently begun to develop formal risk management policies and procedures at the enterprise, program, and project levels.[4] Formal enterprise risk management has the potential to help highway agencies communicate uncertainty, gain trust from the public, make the business case for more public funding, provide a broader set of viable solution options earlier in the process, and apportion risks to the party best able to manage them. The public highway sector trails public sector counterparts such as the U.S. Department of Energy and the Federal Transit Administration in risk management application at the project level. Adding urgency is the current Federal highway reauthorization plan, which is based on performance measures that will necessitate an integrated risk management approach to succeed.

Planners, engineers, and project and administrative managers must coordinate a multitude of human, organizational, technical, and natural resources. Quite often, the engineering and construction complexities are overshadowed by societal, economic, and political challenges. Financial uncertainties are pervasive and create cascading impacts throughout transportation organizations because of the length of the planning, design, and construction process. Clearly, the tools of risk management belong in the broad set management tools required for successful delivery of national and State highway facilities.

[4] National Cooperative Highway Research Program (2011). *Executive Strategies for Risk Management by State Departments of Transportation.* NCHRP Project 20-24(74), National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC, May 2011.

National Cooperative Highway Research Program (2010). *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs.* NCHRP Report 658, ISBN 978-0-309-15476-5, National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC, June 2010, 120 pp.

✓ ***Formal risk management improves decisionmaking and accountability at all levels of the organization.***

The purpose of this scan was to examine risk management programs and practices in other countries that actively assess transportation system performance risks and manage them through a risk management process. The scan objectives were to document lessons learned from public agencies that are administering mature risk management programs under a variety of programmatic strategies and project delivery methods. The scan focused on risk identification, analysis, and management techniques that result in successful program delivery and enhanced stakeholder communications. The scope of this scan was limited to an exploration of risk management processes, tools, documentation, and communication. Risk management strategies, methods, and tools used by international agencies are the key information obtained by this scan.

Methodology

The Federal Highway Administration (FHWA) and the American Association of State and Highway Transportation Officials (AASHTO) jointly sponsored this scan with the cooperation of NCHRP. The scan topic was selected by the Transportation Research Board's (TRB) NCHRP Panel 20-36 from a number of competing proposals for the 2011 funding cycle. After the proposal was accepted, Daniel D'Angelo, deputy chief engineer and director of design for the New York State Department of Transportation (DOT), and Joyce Curtis, associate administrator of FHWA's Office of Federal Lands Highway, were appointed scan cochairs. They joined representatives from the public and private sectors to represent a cross-section of the industry. The team members are shown in figure 3 (see next page) and their affiliations are listed below. Contact information and biographical sketches for the scan team members are in Appendix A.

- **Joyce Curtis** (FHWA cochair), associate administrator, FHWA Office of Federal Lands Highway
- **Daniel D'Angelo, P.E.** (AASHTO cochair), deputy chief engineer and director of design, New York State DOT
- **Keith R. Molenaar, Ph.D.** (report facilitator), professor and chair, University of Colorado Boulder
- **Joseph S. Dailey,** Wyoming Division administrator, FHWA
- **Steven D. DeWitt, P.E.,** chief engineer, North Carolina Turnpike Authority
- **Michael J. Graf,** program management improvement team leader, FHWA
- **Timothy A. Henkel,** assistant commissioner, Minnesota DOT
- **John B. Miller, Ph.D.,** president, Barchan Foundation, Inc.
- **John C. Milton, Ph.D., P.E.,** director of enterprise risk and safety management, Washington State DOT
- **Darrell M. Richardson, P.E.,** assistant State roadway design engineer, Georgia DOT
- **Robert E. Rocco,** associate vice president and risk manager, AECOM Transportation

The next step was to conduct a desk scan to select the most appropriate countries for the scan team to visit. The objective was to maximize the time the panel spent reviewing its topics of interest. The desk scan employed a two-tier methodology of literature review and synthesis. The methodology provided for data collection from government agencies, professional organizations, and experts who are most advanced in the scan topics. Given the wide variety of scan topics and the relatively short time in which to collect information, the desk scan did not act as an all-inclusive study of global activities, but it provided concrete quantitative information to select the most appropriate scanning partners.

The literature review focused on gathering documents that describe risk management organizational structures, practices, and published guidance. Document types, in order of importance, included government reports, journal articles, conference proceedings, periodical articles, and Web documents. Government reports are the most difficult to locate. These documents were found through previous scans and on governmental Web sites. The main search engine for the journals and conference proceedings is the Ei Compendex database. Ei CompendexWeb is a comprehensive bibliographic database of engineering research literature, containing references to more than 5,000 engineering journals and conferences. Also useful was TRB's database of papers and conference proceedings. World Wide Web searches yielded perhaps the most useful results for this report. The scan employed Google Scholar as the main Web search engine.

Figure 3. *U.S. scan team.*

Three primary selection criteria were analyzed for this desk scan: (1) risk management organizational structure, (2) transferability of practices to the United States, and (3) adoption of ISO 31000 Risk Management standards. Each agency's organizational structure was analyzed to see if it defined risk management as a specific organizational function. The applicability of an organization's risk management practices to the United States was also examined. This was done by comparing the planning, design, and operations functions to the United States. The government's political and economic structures were also considered. The number of times each agency was visited on past scans

was used as an indicator of transferability of practices. Finally, countries were selected on the basis of their adoption of the ISO 31000 standard. This standard is important because it provides the framework around which an international community of risk managers can be established. A country that has officially adopted this standard would be more accessible to an investigation.

The results of the desk scan were presented to the U.S. scan team at a Washington, DC, meeting to select the host countries. The team also used the meeting to finalize a panel overview document, which was sent to the host countries to prepare them for the U.S. delegation. The panel overview explained the background and scope of the scan, sponsorship, team composition, topics of interest, and tentative itinerary.

Before conducting the scan, the team prepared a comprehensive list of amplifying questions to further define the panel overview and sent it to the countries it planned to visit. Some of the host countries responded to the questions in writing before the scan, while others used them to organize their presentations. The team attempted to craft questions that were precise enough to elicit the information that it anticipated, yet open-ended enough that the host countries could bring new ideas—not envisioned by the U.S. scan team—to light. The team was successful in its assembly of the questions, as documented throughout this report. The amplifying questions are in Appendix B.

The delegation traveled to Australia and Europe from May 26 to June 12, 2011. The team visit consisted of a combination of meetings with highway agencies and practitioners and site visits. The scan team met with representatives of the following organizations:

- Roads and Traffic Authority, Sydney, Australia
- VicRoads, Melbourne, Australia
- Transport and Main Roads, Brisbane, Australia
- Federal Highway Research Institute (BASt), Cologne, Germany
- Ministry of Transport, Public Works, and Water Management, Rotterdam, Netherlands
- Transport Scotland, Glasgow, Scotland
- Highways Agency, London, England

The team met with these agencies in a series of day-long interviews. The team followed the amplifying questions to ensure consistency in data collection. The team also collected documentation of risk management policies and procedures from the agencies. The results of this report are based on the desk scan, the interviews and documents collected in the interviews, and the synthesis of the scan team members during and after the visits.

CHAPTER 2:

Common Definitions, Strategies, and Tools for Risk Management

Introduction

Leading transportation agencies use common strategies and tools for risk management. These strategies and tools were found to be consistent throughout Australia and the European countries the scan team visited. While risk analysis techniques can be mathematically complex and rigorous, the resulting strategies and application tools are simple. They communicate risk information simply to decisionmakers. This chapter presents risk management definitions and the most common strategies and tools. It provides a foundation for the discussion of agency, program, and project risks in the chapters that follow.

Risk Management Definitions

While the vocabulary of risk management terms varies slightly from agency to agency, the fundamental definitions are consistent throughout the globe. Multiple industry organizations define risk terms in an attempt to provide standardization. The scan team found that all the agencies in Australia and the majority of agencies in Europe visited on this scan refer to the definitions from the *ISO 31000 Risk Management—Principles and Guidelines.*[5] The most pertinent definitions for this report are in table 1.

In addition to the ISO 31000 definitions, a number of organizations have created risk management definitions to clarify

Table 1. *Risk management definitions (from ISO 31000).*

Term	ISO 31000 Definition
Risk	Effect of uncertainty on objectives
Risk Management	Coordinated activities to direct and control an organization with regard to risk
Risk Management Framework	Set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing, and continually improving risk management throughout the organization
Risk Management Policy	Statement of the overall intentions and direction of an organization related to risk management
Risk Management Plan	Scheme within the risk management framework specifying the approach, management components, and resources to be applied to risk management
Risk Attitude	Organization's approach to assess and eventually pursue, retain, take, or turn away from risk
Risk Identification	Process of finding, recognizing, and describing risks
Risk Assessment	Overall process of risk identification, risk analysis, and risk evaluation
Risk Analysis	Process to comprehend the nature of risk and determine the level of risk
Risk Evaluation	Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable
Event	Occurrence or change of a particular set of circumstances
Likelihood	Chance of something happening
Consequence	Outcome of an event affecting objectives
Level of Risk	Magnitude of a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood
Risk Treatment	Process to modify risk
Control	Measure that is modifying risk
Residual Risk	Risk remaining after risk treatment
Monitoring	Continual checking, supervising, critically observing, or determining the status to identify change from the performance level required or expected

[5] International Organization for Standardization (ISO) (2009). *ISO 31000 Risk Management—Principles and Guidelines.* International Organization for Standardization, Geneva, Switzerland.

the process. Appendix D compares the primary definitions and summarizes the terminology used in this report. Appendix D cites some of the more prominent national and international documents, including the FHWA *Guide to Risk Assessment and Allocation for Highway Construction Management,*[6] the NCHRP *Guide for Managing NEPA-Related and Other Risks in Project Delivery,*[7] the NCHRP *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Costs,*[8] the Project Management Institute's *Project Management Body of Knowledge,*[9] the Project Management Institute's *Standard for Program Management,*[10] and the Committee of Sponsoring Organizations of the Treadway Commission's Enterprise Risk Management—Integrated Framework.[11]

Figure 4. *Cyclical nature of the risk management process (adapted from PMI and ISO 31000).*

Risk Management Process

Several risk management steps (i.e., the risk management process) apply to all levels of transportation organizations. The guides from the Project Management Institute, ISO, NCHRP, and FHWA each have similar steps. Figure 4 outlines five steps that have proven to be effective in managing risk: (1) identification, (2) analysis, (3) evaluation, (4) treatment, and (5) monitoring and review. Also, as shown in figure 4, the risk management process should be iterative. This means the steps must be repeated over time. As risk treatment efforts are implemented, some risks no longer apply, some residual risk may remain, and some new risks may be identified. The nature of transportation development, design, construction, and operations requires an iterative and active risk management process.

Brief descriptions of each step follow. More detailed explanations with descriptions and examples of these steps are provided throughout this report.

1. **Risk identification** is the process of determining which risks might affect objectives and documenting their characteristics. Risk identification uses simple tools such as brainstorming and checklists. Risks can affect objectives at the agency level (e.g., achievement of strategic goals), the program level (e.g., management of critical assets), and the project level (e.g., attainment of budget or schedule commitments). Risk identification should occur continuously throughout the risk management process.

2. **Risk analysis** involves defining, quantitatively or qualitatively, the consequence (i.e., impact) and likelihood (i.e., probability) of a risk. Risk analysis can use simple methods to describe risks, such as probability and impact matrices, or more sophisticated probabilistic methods, such as three-point estimates or probability functions and Monte Carlo simulations. More qualitative methods typically apply when analyzing strategic goals and related items.

[6] Federal Highway Administration (2006). *Guide to Risk Assessment for Highway Construction Management.* Report FHWA-PL-06-032, U.S. Department of Transportation, Washington, D.C.

[7] National Cooperative Highway Research Program (2011). *Guide for Managing NEPA-Related and Other Risks in Project Delivery.* NCHRP Web-Only Document 183, National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC.

[8] National Cooperative Highway Research Program (2010). *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs.* NCHRP Report 658, ISBN 978-0-309-15476-5, National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC.

[9] Project Management Institute (2004). *A Guide to Project Management Body of Knowledge* (PMBOK Guide). Project Management Institute, Newton Square, PA.

[10] Project Management Institute (2006). *Standard for Program Management.* Project Management Institute, Newton Square, PA.

[11] Committee of Sponsoring Organizations of the Treadway Commission (2004). *Enterprise Risk Management—Integrated Framework.* Committee of Sponsoring Organizations of the Treadway Commission, www.coso.org.

More quantitative methods apply when analyzing cost and schedule estimates or complex design decisions.

3. **Risk evaluation** involves the process of comparing the results of risk analyses with an agency's level of risk tolerance. If risks are too great, action (i.e., risk treatment) will need to be taken. Risk evaluation presupposes that an agency has defined its risk tolerance and is prepared to take action if a risk's consequence and likelihood are too great.

4. **Risk treatment** involves a risk response and risk modification. Common options involve avoidance, mitigation, or transference of the risk. Risk avoidance is the best option if the agency's goals can still be achieved when the risk is avoided. Mitigation typically involves making an investment to reduce the consequence or likelihood of a risk. Transference involves allocating the consequence of the risk to another party (e.g., a contractor), but there is typically a price to transferring the risk because the other party must mitigate the risk. The fundamental tenets of risk transference include allocating risks to the party best able to manage them, allocating risks in alignment with agency goals, and allocating risks to promote team alignment with customer-oriented performance goals.

5. **Risk monitoring** and review are the capture, analysis, and reporting of risk status in relation to performance. Risk monitoring and review typically employ a risk management plan to monitor risk status and identify changes from the performance level required or expected. Risk monitoring and review assist in contingency tracking and resolution.

Structures for Successful Risk Management

The scan team found structures for successful risk management. Explicit structures can be shown with organization charts and defined risk manager roles and responsibilities, as described in Chapter 3. The risk management policies described in Chapter 3 are also a key to success. However, explicit structures and policies are only part of a successful strategy. The risk workshops and risk registers described in this chapter are key tools found in each agency visited on the scan. The outcome of these structures, policies, and tools must be comprehensive risk management plans and risk management communication. The most mature risk management organizations have structures that encompass the strategies and tools described at the agency, program, and project levels, explained in Chapters 2 through 5 of this report.

Risk Workshops

Risk workshops are formal meetings at which agency staff, subject matter experts, and risk analysis facilitators work together to identify and analyze risks. Stakeholders from outside the agency can also participate, if appropriate. The workshops can focus on qualitative or quantitative risk analysis techniques. Qualitative analyses typically identify and rank risks. Quantitative analyses typically identify risks, quantify uncertainty in performance (e.g., for generating ranges of total cost and schedule), and quantify the significance of each risk (e.g., for subsequent risk management cost-benefit analysis).

Figure 5 provides an example of a workshop agenda and attendees. Risk workshops can vary in length from a few hours to an entire week, depending on the outcomes desired. Workshops dealing only with risk identification can typically be completed in a matter of hours. Workshops that result in sophisticated financial or schedule simulation models can last multiple days. A commonly cited key to risk workshop success is finding the right

Risk Identification Agenda

1. Provide brief risk identification training.
2. Define scope and goals of risk identification workshop.
3. Discuss assumptions and issues of risk.
4. Brainstorm risks.
5. Review historic checklists for any brainstorming oversights.
6. Summarize results.

Roll Call

- Risk Facilitator
- Project or Program Manager
- Internal Subject Matter Experts
- External Subject Matter Experts
- Appropriate Internal and External Stakeholders

Figure 5. *Generic risk workshop agenda and attendees.*

people to attend. Risk identification needs to come from a variety of sources to be comprehensive, and risk assessment should have a consensus input to be accurate.

The products of risk workshops vary depending on the complexity of the issues and time available for the workshop. Common products from the least to most complex are as follows:

- A list of risks with complete descriptions
- A quantification of risk for both consequence and likelihood
- A range of project costs and schedules to support contingency estimates
- Initial risk mitigation plans
- Preliminary risk register and risk management plan

In addition to these products, risk workshops generally help align team members' understanding of objectives and risks and focus resources on the areas that are most affected.

All agencies visited on this scan used risk workshops. Transport and Main Roads in Queensland, Australia, used half-day risk workshops with its board of directors to manage strategic risks. The Highways Agency in England used risk workshops to identify risks and rely on the experience and knowledge of team members (and internal and external stakeholders where appropriate).[12]

Transport Scotland used risk workshops to identify and quantify risks (see figure 6). Its workshops, which use a proprietary system called GroupSystems, were the most structured of all the examples found on the scan. All workshop participants are provided with a laptop computer to identify and quantify risks anonymously. The agency has found that the benefits include better brainstorming because participants can debate and vote anonymously. The voting draws on the experience and expertise of all participants, and the system helps achieve consensus more rapidly and captures all information automatically.

[12] Highways Agency (2010). *Highways Agency Risk Management Policy and Guidance.* Highways Agency, London, England.

Risk workshops are a key tool in the risk management process. Whether it be at the agency, program, or project level, the use of workshops to gain input is essential to the risk management process.

Risk Registers

A risk register is a tool that agencies use to address and document risks. They are often the product of a risk workshop. The scan team found that the risk register was the most common risk management tool at all agencies. Figure 7 shows how Transport and Main Roads in Queensland, Australia, applied risk registers throughout the agency. The risk register is a living document that describes risk characteristics. For identified risks, the register typically provides an assessment of the root causes, the objectives affected (e.g., agency goals, program performance measures, project cost and/or schedule), an analysis of their likelihood of occurring, their impact if they occurred, the criteria used to make those assessments, and the overall risk rating of each risk by objective. It can include risk triggers, the response strategies for high-priority risks, and the risk owner who will monitor the risk. It is a comprehensive list of risks and how they are being addressed as part of the holistic risk management process. Although sophisticated risk register software is commercially available, the scan team found that risk registers are generally kept on a spreadsheet that can be easily categorized, updated, and maintained throughout the agency.

A risk register is a living document. Transportation executives update risk registers relating to their strategic objectives in monthly or quarterly meetings. Program managers update risk registers in coordination with their asset management and investment decisions. Project managers update their risk registers as they progress through project development and manage the cost, schedule, and contingency budgets. There is no prescription for how extensive a risk register should be. Based on the scan team's findings, the agency should determine the most beneficial use of the risk register, with the objective of minimizing the impact of risks.

Figure 8 (see pages 16 and 17) provides an example of a risk register template from VicRoads in Victoria, Australia. The risk register covers the entire risk management process. Risks are described in the first column. The remaining columns describe important

information about the risks relating to the management process, including the following:

- Key risk area
  - Reputation
  - Environment
  - Security of assets
  - Management effort
  - Legal and compliance
  - Health and safety of VicRoads project activities
  - Business performance, scope, time, and capability
  - Financial
  - Stakeholder management
  - Quality
  - Traffic management
- Risk reference
- Potential cause (and assessment of uncontrolled risk)
- Existing risk controls, management actions, and management tools
- Risk assessment with existing controls
  - Consequence
  - Likelihood
  - Risk rating
- Proposed further risk treatment actions
  - Action
  - Responsibility
  - Target completion
- Risk assessment after treatment actions
  - Consequence
  - Likelihood
  - Risk rating
- Progress report
  - Comment on progress
  - Responsible officer
  - Revised forecast completion

The Highways Agency in England provided the scan team with a copy of its risk register template (see figure 9, page 18). The template contains fewer details than the template from VicRoads, but it provides similar information for each identified risk, including the following:

Figure 6. *Transport Scotland's risk workshop.*

Figure 7. *Aligned risk management approach (Transport and Main Roads, Australia).*

- Risk category
- Risk reference
- Gross risk status
- Risk treatment
- Controls in place
  - Control description
  - Lead for control action
- Residual risk status
- Planned further action
- Lead for planned further action
- Target risk level

MPD Risk Profile—Risk Register and Risk Management Plan

Risk Description	MPD Key Risk Area (Key Success Factor)	Ref.	Potential Cause (and assessment of Uncontrolled Risk)	Existing Risk Controls, Management Actions and Management Tools	Risk Assessment with existing controls		
					Consequence	Likelihood	Risk Rating
Identify and describe credible events or situations that would impact on the achievement of goals and objectives.			Identify credible reasons that the risk event might occur. Consider credible scenarios or potential failures. Make an informed judgement of the likely inherent risk without the operation of existing controls. By considering the inherent risk we are able to prioritise and monitor that the controls that have been put in place are working as intended.	Identify key policies, management systems, procedures, actions etc that have been put in place that will eliminate or reduce the potential consequences and/or likelihood of the risk event occurring. Key controls should be prioritised, monitored and assessed to ensure effectiveness in reducing the uncontrolled risk level (e.g. by audit or performance monitoring)	Consider with existing controls in place.	Consider with existing controls in place.	Assess risk level with existing controls in place.
Extreme	**Division/Project**—Consequences threaten the continuation of the Business Area/Project and possibly major impact to the reputation of VicRoads Major Projects Division requiring intervention from VicRoads executive management—requires prompt action by Director Major Projects to implement stringent new controls to treat the risk.				**Key Risk Areas (Key Success Factors) from MPD Project Risk Management Assessment Guide** • Reputation • Environment • Security of Assets • Management Effort • Legal & Compliance • Health & Safety of VicRoads Projects activities* • Business Performance, Scope, Time & Capability • Financial • Stakeholder Management • Quality • Traffic Management		
High	**Division/Project**—Consequences threaten the effective completion of the Business Area/Project—existing controls must be effective and requires additional treatment action to be managed by Project Director level.						
Medium	**Project**—Consequences threaten completion of a Business Area/Project section or activity—existing controls must be effective and possibly additional treatment action effectively implemented—action to be managed at Project Delivery Manager level.						
Low	**Project**—Risk is managed by current practices and procedures—consequences are dealt with by routine operations at Team Leader level—monitor routine practices and procedures for effectiveness.						
				Documentation is required to demonstrate that the typical elements of risks in Attachment A have been considered. The Corporate Risk Management Assessment Guide or MPD Project Risk Management Assessment Guide should be used to determine the risk level and to determine if additional treatment action is required.			

Figure 8. *Risk register template from VicRoads Major Projects Division in Victoria, Australia.*

Proposed further Risk Treatment Actions			Risk Assessment after Treatment Actions			Progress Report		
Action	**Responsibility**	**Target Completion**	**Consequence**	**Likelihood**	**Risk Rating**	**Comment on Progress**	**Responsible Officer**	**Revised Forecast Completion**
Decide if the existing risk level is acceptable or whether it should be reduced further. Risk treatment actions may be developed to further reduce the potential consequences and/or the likelihood of the event occurring to reduce the level of risk.	Assign to accountable manager to ensure that the treatment action is implemented effectively (e.g. CMG for corporate risks and relevant manager for BA or project risks)	Determine target completion date taking into account priorities and resourcing.	Consider with existing controls and further risk treatment actions completed.	Consider with existing controls and further risk treatment actions completed.	Assess Risk level with existing controls and further risk treatment actions completed.			

Highways Agency Standard Format Risk Register: Format Version dated 26th August 2010
Organisation Name: Date of Risk Register

Category	Ref	Risk		Gross Risk Status	Treat/ Tolerate/ Terminate	Controls in Place		Residual Risk Status	Planned Further Action	Lead	Target Risk
		Description	Board Lead			Brief Description	Action Lead				
Escalate to (Org)	1	Example: A terrorist incident on the network results in serious congestion.	[Name]	High	Treat	Contingency planning and regular scenario exercises to be undertaken.	[Name]	High	[including planned completion date]	[Name]	High
	2			High				Medium			Medium
	3			High				High			High
Own	4			Medium				Low			Low
	5			Medium				Low			Low
	6			Medium				Low			Low
	7			Medium				Low			Low
	8			High				Medium			Medium
	9			High				Medium			Medium
	10			High				Low			Low
	11			Medium				Low			Low
	12			High				Medium			Medium
	13			Critical				Low			Low
Relegate	14			Medium				Medium			Medium
Retired	15			Low				Low			Medium

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	High	High	Critical
Almost Certain	Medium	Medium	High	Critical	Critical

Scoring	
Low	3
Medium	5
High	7
Critical	10

Figure 9. *Risk register template from the Highways Agency in England.*

Although each agency created unique risk registers for different levels and different objectives, all registers were similar in format to figure 8. Other examples of risk registers at the agency, program, and project levels are provided throughout this document.

Risk Quantification

Risk quantification is a core task in the risk management process. Because risk events, by nature, may or may not occur, the concept of risk quantification stems from probability theory. However, the use of risk management tools does not require a comprehensive knowledge of probability theory. The most common tool is the **expected value method** of risk quantification, which all of the agencies the team met with used:

Expected Value of Risk = Probability of Occurrence X Magnitude of Impact

or

Risk Rating = Likelihood X Consequence

The expected value of risk can be used by decision-makers to rank risks (see figures 12 and 13 in this chapter and the risk tolerance discussion in Chapter 3). The application of this concept ranges from very subjective judgments to quantitative definitions of risk that are well grounded in statistical theory and lead to rigorous estimates. However, all agencies visited on this scan apply the expected value method to quantifying risk, as seen in the examples provided throughout this report.

Ideally, highway agencies would have historic data available to quantify all risk. However, the use of historic data is the exception rather than the norm and agencies must rely on subjective assessments from agency personnel. Risk quantification is fundamentally a management activity supported by people familiar with risk management activities. Managers and analysts approach risk using different but complementary viewpoints. Managers tend toward qualitative assessment of risks. They evaluate risks on their worst-case effects and their likelihood of occurrence. Managers also tend to focus on strategies and tactics for avoiding risks or reducing a risk's negative impacts. Analysts, on the other hand, tend toward quantitative assessment of risks. They evaluate risk impacts in terms of a range of tangible results, and they evaluate risk of occurrence in terms of probabilities. The analyst's focus is on the combined tangible effect of all the risks on project scope, cost, and schedule. A comprehensive risk assessment combines both qualitative and quantitative assessments.

Heat Maps

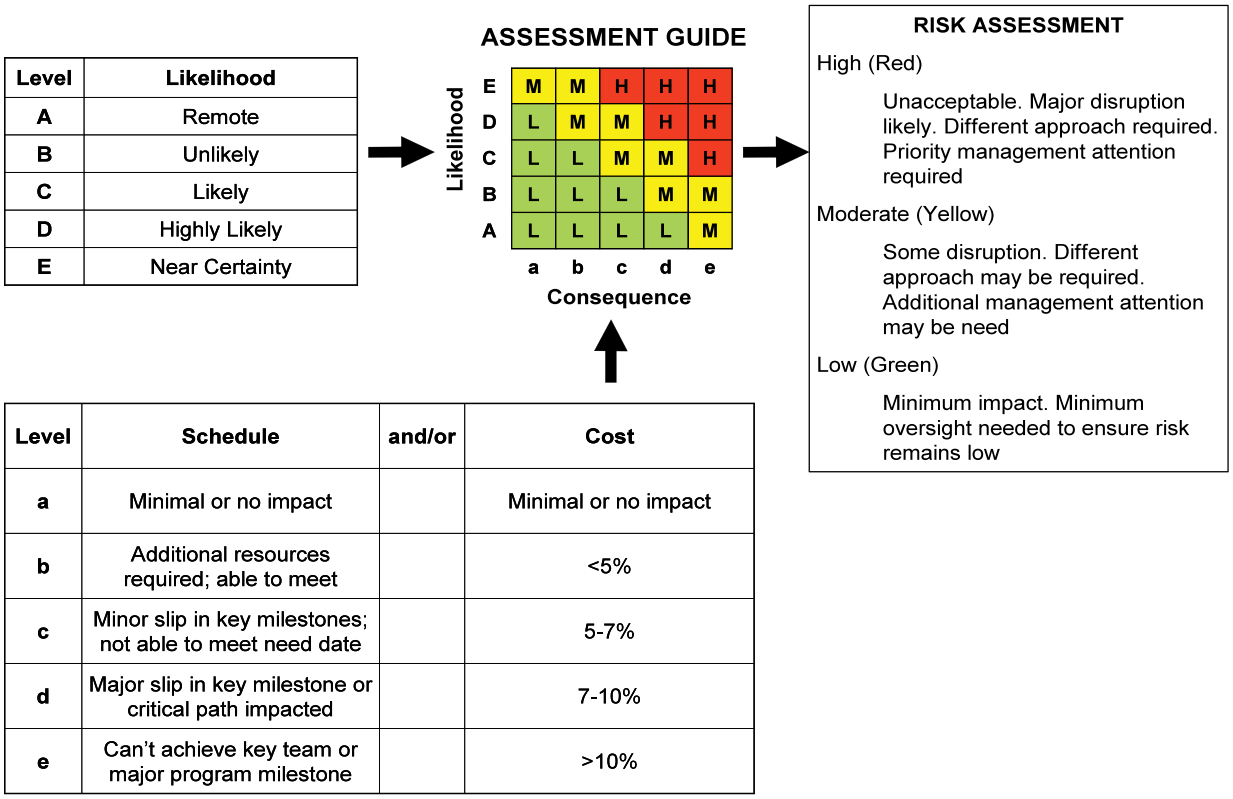
Heat maps are visual tools to communicate the expected value of identified risks. Likelihood and consequence are the two primary characteristics used to screen risks and separate them into risks that are minor (i.e., do not require further management attention) and significant (i.e., require management attention and possibly detailed quantitative analysis). Various methods have been developed to classify risks according to their seriousness. One common method is to develop a two-dimensioned matrix that classifies risks in three categories based on the combined effect of their likelihood and consequence—the heat map.

A heat map, or consequence X likelihood, is used for qualitative analysis of risks on a project. It is formed by combining each risk's probability of occurrence (likelihood) with its impact (consequence) on objectives to rank risks or determine the level of priority to assign to that risk (e.g., high, medium, low). These assessments can be used to make risk treatment decisions (see figures 12 and 13 later in this chapter and the risk tolerance discussion in Chapter 3) or as a first step in a more quantitative probabilistic analysis.

A heat map displays each risk's rating through its likelihood and corresponding consequence. These matrices can take many forms, but a simple illustration is shown in figure 10 (see next page).

The agencies the team met with on the scan used heat maps at all levels of the agency. The heat map in figure 10 is from a project-based risk management process and measures impacts on cost and schedule. However, heat maps can be used to show the relationship of risks to any variety of objectives.

Figures 11 and 12 (see pages 20 and 21) provide the Highways Agency's policy guidance on risk quantification and heat maps, respectively. This guidance is intended more for project and program risk. The principles described in the previous paragraphs can all be seen in these examples.



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

	a	b	c	d	e
E	M	M	H	H	H
D	L	M	M	H	H
C	L	L	M	M	H
B	L	L	L	M	M
A	L	L	L	L	M

Level	Schedule	and/or	Cost
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%

Figure 10. *Heat map example.*

Likelihood Assessment

This concerns the likelihood of a key risk event occurring over a given period. In view of the focus on high-level risk events with substantial policy implications, it was agreed to adopt a 5-year time horizon as per the Corporate Risk Register. The agreed likelihood scale is presented below.

Level	Descriptor	Likelihood Over 5 Years
1	Rare	>0.02% (less than 1 in 5,000 chance)
2	Unlikely	0.02% to <2% (1 in 5,000 to 1 in 50 chance)
3	Possible	2% to <20% (1 in 50 to 1 in 5 chance)
4	Likely	20% to <75% (1 in 5 to 1 in 2 chance)
5	Almost Certain	>75% (more than 7 in 10 chance)

Figure 11. *Risk assessment guidance from the Highways Agency in England.*[13]

[13]Highways Agency (2010). *Highways Agency Risk Management Policy and Guidance.* Highways Agency, London, England.

(Figure 11 continued)

Impact Assessment

This concerns the impact of a key risk event, which can be broken down into the following categories.

Level	Impact	Description
1	Insignificant	Almost no impact
2	Minor	A noticeable impact, but not a significant one
3	Moderate	Now the impact is noticeable and has a material effect on the relevant area
4	Major	The impact threatens to seriously damage the affected area
5	Catastrophic	The impact is almost all-encompassing

Impacts can be considered in a number of different ways:

- **Time impact—**When is the risk likely to occur?
- **Cost impact—**Consideration of the cost of the risk occurring against the cost of preventing its occurrence.
- **Delivery impact—**How badly would this risk disrupt what we're trying to deliver?
- **Reputation impact—**How much damage would this event do to the reputations of the Highways Agency, Department for Transport, or government if it occurred?

Prioritization Matrix (Heat Map)

After likelihood and impact assessments have been made, a risk matrix allows the severity of the risk of an event occurring to be determined, using a black-red-amber-green (BRAG) scoring system.

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	High	High	Critical
Almost Certain	Medium	Medium	High	Critical	Critical

Green	***Low Overall Gross Risk—****Good; might need some refinement*
Amber	***Medium Overall Gross Risk—****Cause for concern; needs attention*
Red	***High Overall Gross Risk—****Highly problematic; requires urgent and decisive action*
Black (Critical)	***Critical Overall Gross Risk—****Focused senior management attention is required. HA Board may need to be made aware.*

Figure 12. *Risk management assessment guide from the Highways Agency in England.*[14]

[14] Highways Agency (2010). *Highways Agency Risk Management Policy and Guidance.* Highways Agency, London, England.

Note that the heat map in figure 12 displays low risk in the upper left quadrant and high risks in the lower right. The examples from the Netherlands and England display the low-risk factors on the upper left and the high-risk factors on the bottom right. The majority of heat maps in the United States show the high-risk factors in the upper right, similar to figure 10. While the visual presentation may be slightly different, the calculation and meaning are the same on all three heat maps.

Use of Risk Communication Strategies to Improve Decisionmaking

One of the greatest benefits of the risk management process is the ability to communicate information simply to decisionmakers throughout the organization and externally to stakeholders. While the analysis may be supported by complex, rigorous, and probabilistically sophisticated models, it is of little value if its outputs are obscured in jargon or overly complicated in their representation. A theme throughout the agencies was to keep it simple. Enterprise risk matrices are discussed at executive or board meetings as a standard agenda item. Risk communication improves alignment within the organization to achieve its strategic goals and objectives.

Figure 13 shows an output of the Performance Audit Group at Transport Scotland. The Performance Audit Group uses a rigorous risk-based analysis for its performance reviews, but its output uses a simple color-coding scheme. The use of the red, amber, and green to show the status of risks was common throughout the agencies visited.

This report shows numerous other examples of best practices in risk communication. The following is a summary of the examples:

- Figure 10. Heat map example for a generic project.
- Figure 12. Risk management assessment guide from the Highways Agency.
- Figure 15. Risk management assessment guide from VicRoads.
- Figure 26. Geotechnical asset risk profile from the Highways Agency.

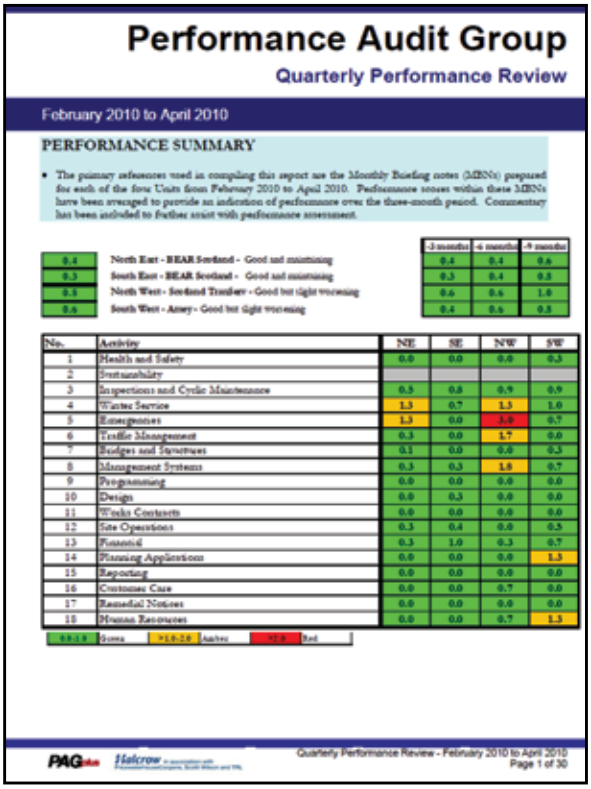


Figure 13. *Risk management output (Performance Audit Group, Transport Scotland).*

- Figure 27. Heat map example for a program of investments.
- Figure 29. Key risk sources bookmark from Transport and Main Roads.
- Figure 31. Project risk assessment bookmark from Transport and Main Roads.

Risk Management Plan

A formal risk management plan is a detailed plan of action for managing risk. Risk planning involves the 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 use to execute a risk management strategy; and plan for adequate resources.

The formal risk management plan is a document that summarizes the project and outlines the steps

of the risk management process and how the agency is approaching them. The risk management plan will vary based on the complexity of the project, but most projects should include an outline similar to the following:

1. Introduction
2. Summary
3. Definitions
4. Organization and roles
5. Risk management strategy and approach
6. Risk identification
7. Risk assessment and analysis
8. Risk evaluation
9. Risk treatment
10. Risk monitoring and control

A risk management plan is a formal document that explains how an agency manages risk. It provides guidance and requirements and serves as a communication tool on the risk management approach. The plan formalizes the ideas presented during the risk management process and may clarify some of the team's assumptions on the process. The Project Management Institute provides a good framework for a risk management plan in its *Project Management Body of Knowledge.*[15]

Risk management plans vary with the objectives of the risk management application. Figure 14 provides an example of a program risk management plan from the *Program Risk Management Practice Guide* of Transport and Main Roads in Queensland, Australia.[16]

Conclusion

Strategies and tools for risk management are surprisingly similar around the globe. Using the ISO 31000 definitions and risk management process as a context, this chapter presented risk management strategies and tools such as risk workshops, risk registers, risk quantification, heat maps, and risk management plans. These strategies and tools provide the foundation for the discussion of risk management applications at the agency, program, and project levels in the chapters that follow.

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[15] Project Management Institute (2004). *A Guide to Project Management Body of Knowledge (PMBOK Guide).* Project Management Institute, Newton Square, PA.

[16] Transport and Main Roads (2011). *Transport and Main Roads Guide to Risk Management: Section 4 Program Risk Management Practice Guide.* Transport and Main Roads, Queensland, Australia.

Program Risk Management Process

- Plan for program risk management (including establishing the context)
  - Inputs—plan for program risk
  - Tools and techniques—plan for program risk management
  - Outputs—plan for program risk
- Risk identification—program risk management
  - Inputs—risk identification—program risk
  - Tools and techniques—risk identification—program risk
  - Outputs—risk identification—program risk
- Risk analysis and evaluation—program risk
  - Inputs—analyze and evaluate program risk
  - Tools and techniques—analyze and evaluate program risk
- Treatment of program risk
  - Inputs—treatment of program risk
  - Tools and techniques—treatment of program risk
  - Outputs—program risk treatment
- Monitor and review program risks
  - Inputs—monitor and review program risks
  - Tools and techniques—monitor and review program risks
  - Outputs—monitor and review program risks
- Closing program risk management
  - Inputs—closing program risk management
  - Tools and techniques—closing program risk management
  - Outputs—closing program risk management

Figure 14. *Program risk management plan example (Transport and Main Roads, Queensland, Australia).*

CHAPTER 3:

Agency Risk Management

Introduction

Agency risk management involves strategically considering risks as a system and applying techniques to manage the uncertainties surrounding the achievement of an organization's objectives. By definition, enterprise risk management cannot be viewed as a task to complete, but as a continuous and iterative process within the organization. Several factors have increased the need for enterprise risk management over the past decades. The number, diversity, and complexity of risks have grown because of the acceleration of technological advances and globalization, which has contributed to the need for organizations to manage all risks consistently. Transportation agencies face unique pressures from external risks, such as those associated with public opinion, insufficient financial and staff resources, and closures of transportation facilities because of infrastructure failure, crashes, incidents, or weather-related events. Enterprise risk management is a process that will help manage these uncertainties.

In 2010, NCHRP conducted a survey of State DOTs on enterprise risk management.[17,18] Respondents from 35 of the 43 State DOTs that completed the survey (81 percent) claimed that their DOT has formal, published risk management policies and procedures. However, none believed that their agency was always successful in applying appropriate risk management strategies at the various levels of the enterprise. Twenty-six respondents (62 percent) believed that they **frequently** applied the appropriate strategies, nine (21 percent) believed that they **seldom** applied the appropriate strategies, and seven (17 percent) believed that they **never** applied the appropriate strategies. When asked how agencies developed their enterprise risk management framework, five (14 percent) indicated that they adopted an enterprise risk management framework from outside the agency, 11 (31 percent) developed their framework in-house, one (3 percent) adopted a framework from another State DOT, and one (3 percent) adopted a framework from another industry.

The need for agency-level risk management is apparent and guidance is needed. The results of this scan provide examples of international agency risk management that U.S. agencies can use to develop their own frameworks. After a discussion of assigning risk management roles, responsibilities, and accountability, this chapter describes how risk management relates to an agency's strategic objectives, how transportation agencies organize for risk management, what policies are common to agencies, how organizations define their risk tolerance, how agencies measure risk management maturity, and risk communication strategies.

Assigning Risk Management Roles, Responsibilities, and Authority

Ultimately, executive leadership is accountable for all risks that occur in an agency. Changes in leadership are often a result of stakeholder outcry after a catastrophic risk is realized. All agency employees are responsible for identifying risks at their management level—even if they are not directly responsible for managing the risk. Assigning roles, responsibilities, and authorities for risk management is a hierarchical task. Risks should always be managed at the lowest level possible. Level of authority for managing risk (e.g., spending on mitigation strategies, ability to transfer risk) should be clearly defined in projects and programs. Risk that cannot be managed at a lower level must be escalated to the next higher level of management. Executive risk management is a combination of managing the risks identified by the executive team and the risks that have been escalated through the risk management structure. Risk management roles,

[17] Note that the term "agency risk management" is used synonymously with "enterprise risk management" in this document.

[18] National Cooperative Highway Research Program (2011). *Executive Strategies for Risk Management by State Departments of Transportation.* NCHRP Project 20-24(74), National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC.

responsibilities, and authority are threads that run throughout this chapter.

Relationship of Risk Management to Strategic Objectives

International organizations use risk management to align the strategic objectives within their organizations. The scan team found that organizations use consistent risk assessment rating scales at the agency, program, and project levels. They also align their risk registers to include agency business objectives at the program and project levels. Although program and project managers can assess risks against their own program or project objectives, they must also include an assessment against the corporate risks.

Transportation agencies manage some of the largest and highest valued public assets and budgets in Federal, State, and local governments. These agencies are spending the public's money. It is their corporate responsibility to set clear strategic goals and objectives to manage these assets in a manner that improves the economic growth and livability of their regions and gives the public the best value for their dollar. Risks can affect an agency's ability to meet its goals and objectives. As network and delivery managers, it is incumbent on agencies to identify risks, assess the possible impacts, develop plans to manage the risks, and monitor the effectiveness of their actions. The following summarizes common strategic objectives and related risks found on the scan:

Common Agency Strategic Objectives

- **Operating the system—**Support reliable and efficient movement of people and goods.
- **Maintaining and improving the system—** Provide a transportation system that promotes economic growth and enhances livability.
- **Being responsible—**Deliver sustainable projects and network solutions.

Common Agency Risks

- **Agency reputation—**A negative public opinion could result in the loss of trust, revenues, and the ultimate efficiency of the transportation network.
- **Data availability and integrity—**Insufficient or inaccurate data or the loss of agency data creates a risk of the loss of efficiency or the ability to manage the network.
- **Insufficient or unknown long-term funding—** An inability to fund the current and projected system creates a risk of future safety or asset failures.

These objectives and risks provide agency-level examples. Similar objectives and risks were found at the program and project levels. Mature agencies align their objectives and risks at all three levels and maintain a culture of risk management in their decisionmaking.

The most common tool agencies use to align risks to agency objectives is the risk register. Figure 15 provides an example of how VicRoads assesses strategic risks to include in its corporate risk register. The VicRoads Corporate Assessment Guide provides for consistent measurement of strategic risks at the agency level. Other agencies used similar assessment guides, typically in conjunction with their boards of directors or executive management.

Development of an Explicit Risk Management Structure

Although agencies have different risk management organizational structures, mature risk management organizations define their structures explicitly. In Victoria, Australia; London, England; and Glasgow, Scotland, risk management organizational structures were tied to corporate audit functions. In Brisbane and Sydney, Australia, there was an explicit risk manager position (director, risk management) tied to the highest levels of corporate governance. Australian agencies participated in the development of the ISO 31000 Risk Management standard and apply it to their agency, program, and project risk structures. England applied the ISO process to the major programs. These agencies also follow the processes defined by their government audit functions where applicable.

Transport and Main Roads in Queensland, Australia, provided the structure depicted in figure 16 (see page 28). It clearly defines a corporate risk management organizational policy and the role of a corporate risk manager who reports directly to the

MAJOR PROJECTS DIVISION PROJECT RISK MANAGEMENT ASSESSMENT GUIDE - FEBRUARY 2009

Note: - This guide illustrates the range of potential consequences and likelihood that may be associated with key project risk areas.
- Judgement is required to assess the consequences and likelihood of a risk event (both before and after effective risk treatment action).

STEP 1

Key Risk Areas, Success Factors and Illustration of Potential Impacts

	KRA	CORPORATE						MAJOR PROJECTS DIVISION					
		Reputation (Political & Community)	Environment (Area Wide, Permanent/Temporary, Community Impact)	Security of Assets	Management Effort	Legal and Compliance (Working within the law)	Health & Safety of Projects activities (Community or Staff) OHS Regulations 2007 identified 'High Risk' construction work	Business Performance, Scope, Time & Capability (Works Program, Scope, Delay, Delay Notification & Resources)	Financial ($ impact)	Stakeholder Management (Communication & Responsiveness)	Quality (Immediate/Long Term Performance, Reduced Life, Appearance, Fit For Purpose)	Traffic Management (Levels of Congestion)
Consequence Ratings	Catastrophic (Worst case scenarios)	* Significant adverse community impact and condemnation * Consistent extreme negative media attention (months) * Irreconcilable community loss of confidence in the Major Projects Division's intentions and capabilities and possibly in the government * Public Government intervention	* Permanent damage over a wide area affecting most of Major Projects Division's projects * Permanent impact threatens survival of flora or fauna affecting most of Major Projects Division's projects * Threat to community health	* Significant or critical community infrastructure assets are destroyed * Significant or critical community infrastructure assets are unusable for months	* Impact cannot be managed within the organisation's existing resources and threatens survival of the organisation * Ministerial intervention	* Significant prosecution and fines * Major litigation involving class actions * Major non-compliance with Legislation	* Fatalities or permanent disabilities * Section of the community or workforce harmed	* Total failure to properly deliver the Major Projects Divisional works program and objectives * All major projects expected to miss completion date by > six months * Failure to provide notification of timing issues causing unacceptable impact on major stakeholders/government * Failure to achieve government commitment * Significant loss of capability and expertise within Major Projects Division for 6 months	* Significant adverse impact (Greater than $100m financial budget) on Major Projects Division budget	* Divisional or Project Stakeholder impacts requiring Government intervention * Stakeholder action will prevent achievement of Divisional objectives	* Major Infrastructure Failure. * Extended closure (weeks or months) of major section required * Defect/failure significantly affecting design life * Repeated failure of infrastructure or performance requirements affecting most of Major Project's Division's projects	* During construction continued total failure in traffic management resulting in prolonged congestion on the immediate and extended road network. Becomes a major daily media item calling for Government action the Premier makes a statement. * At openings of Major Project Division's projects continued total failure in traffic management resulting in prolonged congestion. * On Project opening, total failure in traffic management resulting in widespread congestion on the immediate and extended road network.
	Major	* Considerable and prolonged community impact and dissatisfaction publicly expressed * Community loss of confidence in the Major Projects Division or Project's capabilities (weeks) * Consistent negative media attention (weeks) * Ministerial intervention	* Pervasive and severe temporary damage extending over a large area requiring extensive and lengthy remediation and years of recovery * damage to flora or fauna requires significant period of recovery (years)	* Non-critical community infrastructure assets are destroyed * Significant or critical assets are unusable for weeks	* Impact requires long term significant management and organisational resources to respond	* Major breach of regulations * Major litigation	* Injuries requiring hospitalisation * Increase in Major Projects Division workforce absentee rate	* Major elements and objectives of the Major Projects Divisional works program will not be achieved * 50% of major projects expected to miss completion date by > six months * Failure to achieve commitment to a major stakeholder * Significant loss of capability and expertise within Major Projects Division for 2 months * Significant loss of Business Area/Project team capability and expertise for 6 months	* $5m - $100m or greater than 10% adverse financial impact on Major Projects Division budget * Greater than 10% adverse financial impact to Project's budget	* Divisional Stakeholder impacts requiring Chief Executive or Director Major Projects intervention * Stakeholder action will prevent achievement of major elements of the Project	* Serious defect requires closure for a days at or after Project opening * Defect/failure severely affecting design life	* During construction, increased levels of congestion resulting in travel time increase through the worksite by more than 20 minutes. * Widespread congestion on immediate road network. * On Project opening, increased levels of congestion.
	Moderate	* Sectional community impacts and concerns publicly expressed (days) * Negative media attention (days) * Loss of confidence by the community in the Project's processes * Ministerial concern	* Severe temporary damage over limited area requiring extensive remediation * Impact on flora or fauna is recoverable	* A range of assets, including some significant assets, are unusable for weeks	* Impact requires management and resources from a key area of the organisation to respond	* Serious incident requires investigation and legal representation to determine legal liability * non-compliance with regulation	* Injuries requiring medical treatment * Increase in projects workforce absentee rate * Lack of Project staff resulting in a stressful working environment	* Major elements and objectives of the Project's works program will not be achieved * Failure to achieve project delivery impacting on dependent works * Project expected to miss completion date by 1 to 3 months * Significant loss of Business Area/Project team capability and expertise	* $1M - $5M or 5% to 10% adverse financial impact and financial performance to Project's budget	* Project Stakeholder impacts requiring Project Manager intervention * Stakeholder action will significantly delay major elements of the Project	* Serious defect (without closure) at or soon after Project opening * Design life threatened, some defects issues causing inconvenience and high financial loss	* During construction , slight increase in levels of congestion resulting in a travel time increase through the worksite between 10 minutes to 20 minutes. * Slight increase of congestion on immediate road network. * On Project opening, slight increase in levels of congestion.
	Minor	* Local community impacts and concerns * Occasional once off negative media attention.	* Temporary damage affecting local area * No threat to fauna or flora	* A number of assets unusable but can be replaced within acceptable timeframes	* Impact requires additional local management effort or redirection of resources to respond	* Complex legal issue to be addressed	* Injuries requiring first aid treatment * Increase in Project staff absentee rate * Lack of Project staff resulting in overtime	* Requires rescheduling of elements to achieve the works program * Project expected to miss completion date by 1 to 3 weeks * Short term loss of resource capacity	* < 5% adverse financial impact to Project's budget	* Project Stakeholder impacts requiring Delivery Manager intervention * Stakeholder action will disrupt planned project activities	* Extensive minor defects at opening * Design life not threatened, minor inconvenience, medium financial loss	* During construction, marginal increase in levels of congestion resulting in travel time increase through the worksite between 5 minutes to 10 minutes. * Marginal increase of congestion on immediate road network. * On Project opening, marginal increase in levels of congestion.
	Insignificant	* Isolated local community or individual's issue-based concerns.	* Minor temporary damage that normal practice can rectify	* Assets receive minimal damage or are only temporarily unavailable	* Impact can be managed through routine activities	* Legal issues managed by routine procedures	* Incident with or without minor injury	* Minor changes in scheduling of works program * Minor changes in milestones * Temporary loss of resource capacity	* Negligible impact on Project's budget	* Stakeholder issues managed by routine procedures and consultation	* Localised minor defects at opening * No noticeable impact on quality objectives, low financial loss	* During construction, minor increase in levels of congestion resulting in travel time increase through the worksite of less than 5 minutes. * Minor delays/disruptions affecting immediate road network. * On Project opening, no increase in levels of congestion.

STEP 2

Likelihood Ratings and Risk Levels

	Rare	Unlikely	Possible	Likely	Almost Certain
Recurring events	Less than once in 5 years	About once in 5 years	About once in 3 years	About once a year	Several times a year
Single events	Negligible likelihood	Likelihood low but not negligible	Likelihood less than 50/50	As likely as not to happen (50/50)	More than likely to happen
Catastrophic (Worst case scenarios)	Medium	Medium	High	Extreme	Extreme
Major	Low	Medium	Medium	High	Extreme
Moderate	Low	Medium	Medium	Medium	High
Minor	Low	Low	Low	Medium	Medium
Insignificant	Low	Low	Low	Low	Medium

STEP 3

RISK LEVEL CONTEXT AND TREATMENT ACTION REQUIRED

Extreme	**Division/Project** - Consequences threaten the continuation of the Business Area/Project and possibly major impact to the reputation of VicRoads Major Projects Division requiring intervention from VicRoads executive management - requires prompt action by Director Major Projects to implement stringent new controls to treat the risk.
High	**Division/Project** - Consequences threaten the effective completion of the Business Area/Project - existing controls must be effective and requires additional treatment action to be managed by Project Director level.
Medium	**Project** - Consequences threaten completion of a Business Area/Project section or activity - existing controls must be effective and possibly additional treatment action effectively implemented - action to be managed at Project Delivery Manager level.
Low	**Project** - Risk is managed by current practices and procedures - consequences are dealt with by routine operations at Team Leader level - monitor routine practices and procedures for effectiveness.

Figure 15. *VicRoads Corporate Risk Management Assessment Guide.*

board. Its risk management guidelines include the following key contents:

- Transport and Main Roads Guide to Risk Management
  - Strategic Risk Management Practice Guide
  - Program Risk Management Practice Guide
  - Project Risk Management Practice Guide
  - Risk Management Tools and Techniques
  - Risk Management Specialist Areas

Transport and Main Roads also provided the scan team with its corporate risk manager's job description, shown in figure 17. The role of the assistant director for risk management is to provide the risk management system, leading and supporting the risk management framework. The assistant director is charged with integrating risk management across the enterprise. The individual reports to the director of governance and planning and takes direction from the general manager of corporate governance. The role helps integrate risk management across the agency.

The Highways Agency in England provided the scan team with its *Risk Management Policy and Guidance* document.[19] This document outlines the agency's risk management organizational structure at the enterprise level. As seen in figure 18 (see page 30), the Highways Agency's risk management structure involves the chief executive, board, Audit Committee, Corporate Performance Reporting Team, Directorate Performance Management Teams, and staff at every level in the agency.

As previously stated, each organization the scan team met with had a unique risk management structure. Structures at the program and project levels supported the overall agency risk management structure. However, most structures were explicit and provided a clear communication of risk management roles and responsibilities. Perhaps the most explicit structures were those that were tied to executive management and audit functions at the agency level. Figure 19 (see page 31) shows a high-level graphic for the VicRoads executive risk management structure. The chief executive was ultimately accountable for all risks. The Corporate Management Group developed policies and

Figure 16. *Risk management framework (Transport and Main Roads, Queensland, Australia).*

strategies based on information from the executive directors, directors, and business area managers, which was typically communicated through the risk management reporting cycle. The director of risk management worked with all of these stakeholders. The program had a strong audit function to ensure that the processes were followed and the proper risk responses were put in place. VicRoads conducts audits of its departments and projects to confirm that risk management activities are being planned and enacted. It also monitors the progress of corporate risk management actions to completion.

Risk Management Policy

In addition to clear organizational structures, the majority of agencies the scan team met with had concise risk management policy statements. These statements clarify the role of risk management in the organization and communicate overall risk management objectives. The following statements from Transport and Main Roads and VicRoads in Australia provide examples of agency-level risk management policies. These policy statements are clearly tied to the ISO 31000 risk management approach, which was developed with significant input from Australian organizations.

[19]Highways Agency (2010). *Highways Agency Risk Management Policy and Guidance.* Highways Agency, London, England.

Role Description for Assistant Director (Risk Management)

Branch:	Governance and Planning	Division:	Corporate Governance

Your opportunity

In the role of *Assistant Director (Risk Management)* you will provide a risk management system, for identifying and managing strategic and operational risk within TMR. You will lead and support a risk management framework which includes a model for managing strategic and operational level risk and encompasses an integrated and enterprise wide approach to the management of the department's strategic risk to ensure TMR's long term success.

This role reports to the Director, Governance and Planning and also undertakes direction from the General Manager, Corporate Governance as required.

Accountabilities include:

- Provide expert strategic risk management advice to the Director-General, senior management and other senior members of the department, in the development and implementation of strategies and policies to manage risk-related matters and enable the effective and safe delivery of departmental core business.
- Monitor and coordinate all departmental-wide risk related matters for the Audit and Risk Committee.
- Develop and maintain effective networks and relationships with key stakeholders.
- Establish and maintain effective liaison with the divisions and their communities of practice in the Department of Transport and Main Roads, other departments and in the private sector to maintain consistency across the department's risk management strategy and policies.
- Direct the preparation of strategic risk profiles used to support risk assessment and strategic planning activities on behalf of the department.
- Direct the analysis of the department's performance in regards to risk management and report issues and trends to the General Manager (Corporate Governance).
- Lead state-wise scanning and analysis of risks to identify changes in stakeholder sentiment.
- Monitor the external environment to identify relevant risk management trends and develop strategies to actively communicate the department's priorities to the organisation and stakeholders.
- Facilitate risk training to ensure selected key divisional and decentralised staff have required skills, competence and confidence to deal with operational risk matters.
- Liaise with the secretariat for senior management and present to the Audit and Risk Committee in the ratification of risk management policy.
- Manage the operations of the Risk Advisory Unit, including establishing work programs and planning and setting priorities.
- Provide high level reports to the General Manager (Corporate Governance) on strategies relating to risk management.

Figure 17. *Role description of the assistant director for risk management at Transport and Main Roads, Queensland, Australia.*

Transport and Main Roads, Queensland, Australia

The Department of Transport and Main Roads (TMR) is committed to the responsible management of risk associated with its operations throughout the department. The department requires all employees to have a diligent and conscientious involvement with risk management in relation to their duties that impact on both internal and external operations. Management within the department strongly supports the active pursuit of proactive risk management practices that reasonably reduce the chance and impact of adverse effects, along with making the most of a broad range of opportunities as they arise.

The department is dedicated to establishing an appropriate risk management culture whilst contributing to good corporate governance through a consistent risk management approach. It also provides for the identification of factors that might impact on the department's ability to deliver its services, along with promoting opportunities through a systems thinking process of risk identification, analysis, and responses.

The practice of risk management in the department will be governed by the approach outlined in the Risk Management Framework. The Risk Management Framework provides the components and guidance to embed risk management

Highways Agency Risk Management Roles and Responsibilities

Chief Executive
- Assumes overall responsibility for the agency's system of internal control.
- Ensures clarity of accountability for risk management.

Board
- Defines overall risk appetite and defines the risk management culture.
- Board directors are responsible for overall implementation of the agency's risk management policy and risk management strategy in their directorates.

Audit Committee
- Reviews performance, progress, and compliance with risk management process.
- Supports the chief executive with assurance on a sound system of internal control.

Corporate Performance Reporting Team
- Serves as risk management policy and process owner.
- Maintains the board's risk register.

Directorate Performance Management Teams
- Ensure that risk management policy and processes are complied with.
- Validate risk assessments.
- Agree on assignment of risk responses to risk owners.
- Coordinate the reporting of corporate risks.
- May collectively or individually own directorate-wide risks.
- Identify lessons learned; disseminate risk management guidance and training.
- Develop plans to improve risk management.
- Oversee the collation of risk registers in their directorates.

Program Project and Process Managers
- Coordinate the identification of risks from within their sphere of control.
- Ensure a thorough understanding of risk responsibilities in their teams.
- Act on risk responses delegated to them by risk owners.

Staff at Every Level of the Agency
- Understand how and why risk is managed in the agency.
- Have a clear responsibility for reporting the risks that they perceive or identify promptly to their line manager or the appropriate risk manager so that the risk can be recorded, further assessed, and escalated if pertinent.

Figure 18. *Risk management roles and responsibilities (Highways Agency, England).*

competency into departmental processes and will be monitored and reviewed by the department's Audit and Risk Committee.

VicRoads, Victoria, Australia

1. Overview

Risk is inherent in all day-to-day operations. Risk management is therefore not an "add-on." We need to manage risk to enable us to get on with the job confidently and responsibly, knowing that relevant risks have been identified and dealt with appropriately. All staff need to identify, evaluate, and manage risks during their normal business activities. VicRoads has statutory obligations, under the Financial Management Act 1994 and the Victorian Managed Insurance Authority Act 1996, to ensure that its risk profile is critically reviewed at least annually and that its risk management framework is implemented across the organization at all levels and operates effectively to control risks to a satisfactory level.

2. Policies

In accordance with the Department of Treasury and Finance documented Victorian Government Risk Management Framework VicRoads Chief Executive will attest in VicRoads Annual Report to the implementation of an effective risk management system, consistent with the Risk Management Standard AS/NZS 31000:2009, and the achievement of satisfactory risk management outcomes.

The application of a systematic approach to the management of risk and the contingencies of business continuity and disaster recovery planning will continue to assist VicRoads achieve its organizational objectives and ensure compliance with its statutory obligations.

VicRoads will continue to improve its existing risk management framework and will reinforce a culture of risk management and ensure that risk management principles are adopted in our business procedures. To achieve this we will:

- Ensure staff are familiar with the risk management concepts and procedures used by VicRoads;
- Incorporate systematic approaches to risk management in our management systems; and
- Regularly monitor risk management performance.

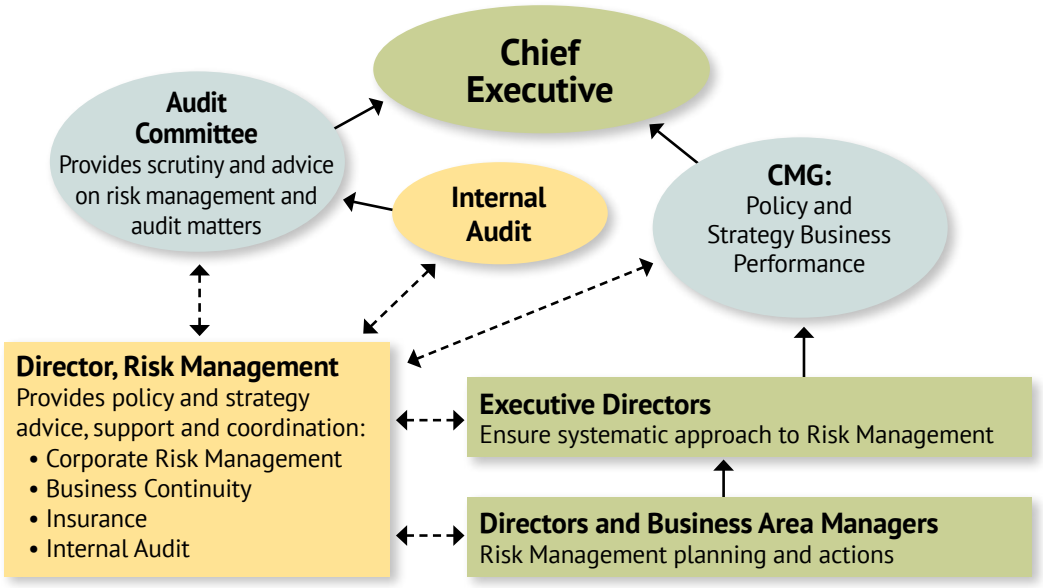


Figure 19. *Risk management organizational structure (VicRoads, Victoria, Australia).*

The *Risk Management Policy and Guidance* document of England's Highways Agency also provides good examples of agency-level policies. The following statements are from this policy and guidance document and address the Highway Agency's philosophical approach to risk taking and risk tolerance.

Highways Agency, England

1. Risk appetite (or Target Risk), at the organizational level, is the amount of risk exposure, or potential adverse impact from an event, that the Agency is willing to accept/retain. Once the risk appetite threshold has been breached, risk mitigation plans and business controls are implemented to bring the exposure level back within the accepted range.

2. The Board welcomes and encourages well-managed risk taking where the potential rewards in terms of improved customer service, savings of time or cost, or improvements in quality make taking the risk worthwhile. No one need fear the consequences for failure if the risks that caused the failure were anticipated, appropriately managed and, where required, escalated to senior management.

3. The Highways Agency Board has no toleration for risks that threaten:
   - Integrity, propriety, and regularity in the use and stewardship of public funds and assets, or
   - Our ability to demonstrate that safety risks have been reduced as low as reasonably practicable.

Clearly written policies on risk tolerance allow for consistent risk assessment. The level of risk tolerance should be set at the executive level and supported by the chief risk officer (or similar position) so that it remains consistent throughout the organization. Risk assessment at the agency level requires that the agency define its risk tolerance in relation to the probability and impact of risks. Figure 20 (see next page) is an example of how VicRoads in Australia has translated its policies on risk tolerance to measures for each individual risk (also see figure 15).

Alignment of Risk Management Throughout the Organization

Gaining alignment of risk management activities throughout an agency is a key to achieving agency risk management success. Perhaps the best example of risk management alignment throughout an agency was seen at VicRoads in Victoria, Australia.

EXTREME	Consequences would threaten VicRoads viability and have serious implications for Government—**requires prompt action** by VicRoads executive management to implement stringent new controls to mitigate risk.
HIGH	Consequences would threaten the effective operation of VicRoads, a key VicRoads area, function or service—existing controls must be effective and **requires additional mitigation action** to be managed by executive management.
MEDIUM	Consequences would threaten a VicRoads activity—existing controls must be effective and **possibly** additional mitigation action implemented—action may be be managed below executive management.
LOW	Risk is managed by current practices and procedures—consequences are dealt with by routine operations—monitor routine practices and procedures for effectiveness—maintain regime of continuous improvement.

Figure 20. *VicRoads corporate risk management assessment scale.*

To support its government insurance procedures, which are managed by the Victorian Managed Insurance Authority (VMIA), Victoria maintains a risk register at the state level. Figure 21 provides a graphic of the State Risk Register. It shows how risks are escalated from various agencies into an integrated risk register.

Figure 21 shows how VicRoads aligns risk up to the State Risk Register. Figure 22, which depicts the risk management approach for the M80 freeway expansion project in Melbourne, shows how VicRoads aligns risk throughout the agency. The project delivery team organized project-specific risks in categories that aligned with agency risks (financial, health and safety, environment, security of assets, management effort, reputation, and legal and compliance) and added project-specific risk categories (traffic management, stakeholder management, and quality) to complete the risk register. The team developed risk management actions and tracked these with a risk register. The result was a project risk management plan that aligned with the corporate risk management plan.

Policies on risk escalation help align risks throughout the agency. Figure 23 shows the process the Highways Agency in England uses to escalate risks, thereby aligning risk activities throughout the agency. The Highways Agency provided the following guidelines on risk escalation:

1. Escalation is required where there is a high residual risk that you cannot manage within your area of responsibility, perhaps because the risk has a wider impact than the immediate work area or requires treatment beyond your level of authority.

2. Risks should be escalated via the Team/Group/Divisional/Directorate Risk Register, advising that the risk cannot be controlled locally or where the residual risk remains red.

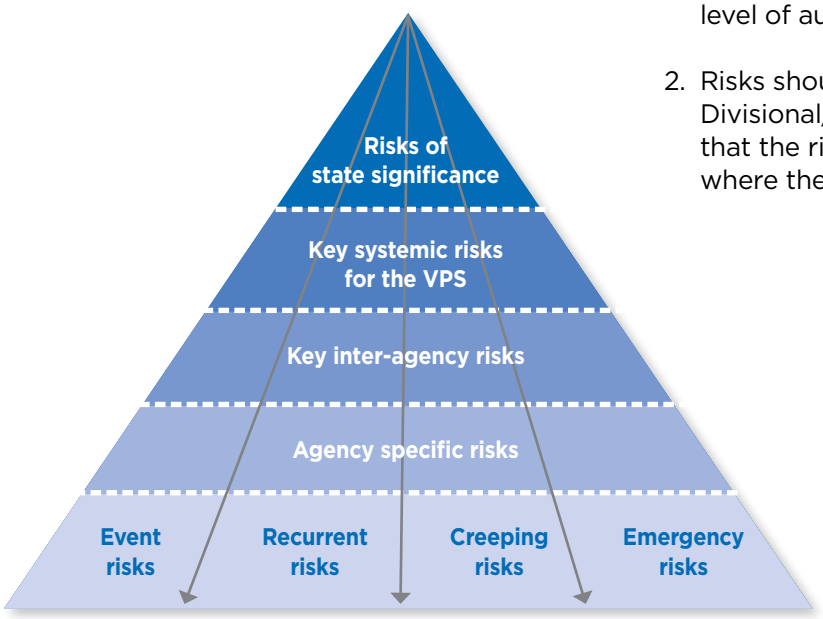


Figure 21. *Victorian Managed Insurance Authority State Risk Register approach.*

Figure 22. *M80 risk management approach (VicRoads, Victoria, Australia).*

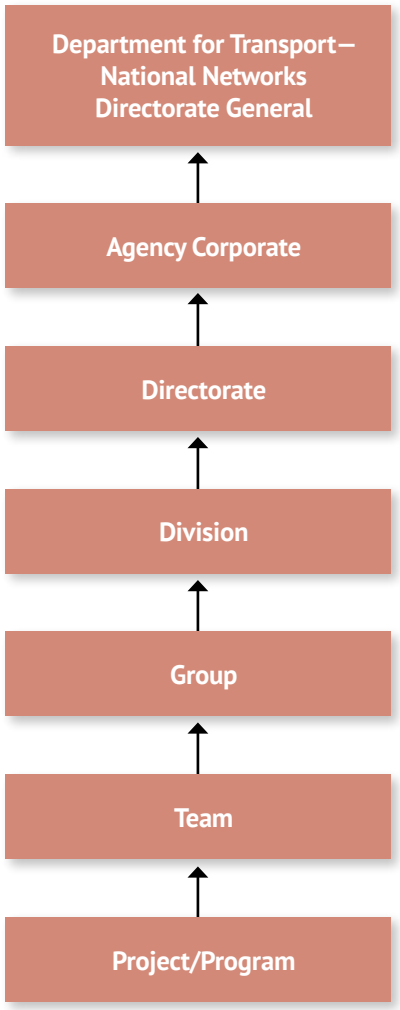


Figure 23. *Highways Agency, England, risk escalation process.*

Use of Risk Analysis to Examine Policies, Processes, and Standards

Highway agency policies, processes, and standards can become conservative. The realization of many low probability risks over a long time period can cause planners, engineers, and project managers to create documents that are too conservative. The use of risk analysis techniques can help agencies reexamine policies, processes, and standards. A transparent understanding of risk likelihood and consequence can reveal where policies, processes, and standards have become outdated. An examination of risk treatment options can provide for alternative methods to mitigate and manage risks.

The Transport Roads and Traffic Authority in New South Wales, Australia, provided numerous examples in which it reviewed standards and guidelines to see if they had become too conservative. The authority formally reviews technical, safety, and environmental standards to separate minimum standards that support reasonable interventions and rights from guidelines of good practice if resources are available. It tries to separate minimum services for access rights and safety from those that reflect customer service needs or supplier desires. These are subjective decisions that can be influenced by low-probability, but high-impact, risk events. The use of risk assessment methods has resulted in a more objective analysis of the expected value of impacts and the risk to agency objectives. Agency officials believe that their standards and guidelines are more appropriate and cost-effective because of this risk analysis.

Achievement of a Risk Management Culture

The scan team found that mature organizations have achieved a clear culture of risk management. A risk management culture is defined by shared norms, values, and actions relating to risk management from the leadership to all levels of agency staff. Staff members talk about risk with a common vocabulary and understanding. When a culture of risk management has been achieved, risk is considered throughout decisionmaking and asset management activities as just part of the process, not an additional level of management.

Both VicRoads in Victoria, Australia, and Transport and Main Roads in Queensland, Australia, use a risk management maturity model. The risk framework maturity model used in Victoria was developed by VMIA to help all government agencies improve their risk management framework through assessment of their current practices and comparison with a best-practice model for risk management, as shown in figure 24. In particular, the risk framework quality review assesses the following areas:

- Policy and plan
- Governance and accountability
- Risk management processes
- Risk management culture
- Resources and capability
- Validation and assurance
- Interorganizational risk management

VMIA conducts risk framework quality reviews of government agencies, using this tool to assess their maturity and identify areas where they may invest and improve their risk management processes. Agencies decide whether suggested enhancements would add value and improve their risk management outcomes.

VicRoads has been assessed favorably against the criteria of the VMIA maturity model and uses the model for internal benchmarking and continuous improvement. In addition, VicRoads conducts an annual program of internal audits of selected departments to review their application of the VicRoads corporate risk framework to ensure compliance with corporate requirements.

Conclusion

The scan team found numerous examples of mature risk management organizations. These organizations align risk management with their strategic goals. They have clear risk management organizational structures and crisp risk management policies. They clearly define their corporate risk tolerance. They also measure their risk management performance and even their maturity. Application of these agency-level risk management strategies in the United States has the potential to improve transportation agency performance.

Figure 24. *Risk framework maturity model (VicRoads, Victoria, Australia).*

CHAPTER 4:

Program Risk Management

Introduction

Program risk management involves risks that are common to programs or entire business units and clusters of projects. For example, operations programs manage a broad array of risks, including emergency and special event response. Safety programs address strategies in response to safety risks for design, construction, and operations. Asset management programs can benefit greatly from risk-based decisionmaking when maintaining assets. State transportation improvement programs (STIP) are an obvious application for program risk management because common risks can occur across projects in a STIP. Managing risks at the program level provides a unique opportunity to address risks across multiple projects or functional units. Program risk management provides opportunities to leverage risk mitigation strategies and optimize investments.

Program and Portfolio Risk

Many U.S. highway program managers rely on project management techniques to manage their program risks. These strategies may be effective for small programs, but they are not sufficient for large-scale programs, especially considering the broad array of highway agency program areas. Highway agencies typically have hundreds of projects in their program. If they view these projects as a portfolio, they will see opportunities for optimal risk management strategies. If an agency has many small resurfacing projects, it may choose to include an asphalt price escalation clause in all contracts and manage the risk of cost escalation itself rather than ask each small contractor to take the risk for increasing prices. The use of risk management at a program level will allow for better project and enterprise risk management.

The Project Management Institute recently published *The Standard for Program Management.*[20]

[20] Project Management Institute (2006). *Standard for Program Management.* Project Management Institute, Newton Square, PA.

The recommendations in this document focus on managing smaller programs consisting of similar projects. The institute identified six activities for managing program risk to consider higher order issues:

1. Identify and analyze interproject risks.
2. Verify project risk response plans that could affect other projects.
3. Determine root causes.
4. Propose specific solutions to risk escalated by project managers.
5. Implement response mechanisms that benefit more than one project.
6. Manage program contingency reserves (in terms of cost and time).

These six activities were observed in the international organizations the team met with on the scan. Program risk management involves the same iterative risk management process used at the enterprise and project levels. The standard risk management process of risk identification, assessment, management, and monitoring is used to make many risk-based decisions, including the following:

- Asset management
- Bridge inspection
- Cost and schedule control
- Performance measures
- Asset management
- Reliability-centered maintenance
- Tunnel safety and general safety planning

Excellent examples of program risk management were found in asset management, operations management, management functional units (e.g., design functions, operations), and management of major projects (which are essentially groups of smaller projects bundled together).

Use of Risk Analysis for Asset Management

International transportation agencies use risk analyses to make programmatic investment decisions. Examples were found in all agencies, but the most explicit examples were observed in the Highways Agency in England. The Highways Agency's overall approach is shown in figure 25. To make an investment decision, the agency must first conduct a risk assessment. Risk assessment processes are developed for each distinct asset area (pavement, bridges, etc.). The assessments are done by the relevant asset specialists. The process depends on quality data, inventory, and condition to assess risk and identify the appropriate response. Risks are identified in each asset silo and qualitatively evaluated against each other to identify the most important risk between asset areas. Highways Agency assets related to risk are primarily managed by specialists in pavements, structures, drainage, geotechnical, and technology.

The Highways Agency provided a compelling example on geotechnical assets. In 2010, the agency developed *A Risk-Based Framework for Geotechnical Asset Management.*[21] The objective of the framework is to allow the allocation of limited resources using a rational basis for prioritization. Figure 26 shows the geotechnical asset risk profile of a corridor. The color coding relates to the risk level of the asset. These risk levels are defined in guidance documents and standards. The report's executive summary provides an excellent overview of the approach:

> The general context for making risk-based renewal and intervention decisions about the Agency's geotechnical assets relates to the ongoing costs incurred repairing slope instabilities of approximately £20 million per annum. The presence of major defects is used as the basis for decisionmaking, based on the premise that these defects are indicative of the onset of loss of performance of the slope. It is proposed that decisions be made in the context of the performance requirements of the geotechnical assets, which are influenced by a number of different consequence components.
>
> The first input to the framework is a definition of general hazards and failure mechanisms for different types of geotechnical assets, which will inform the asset management strategy.

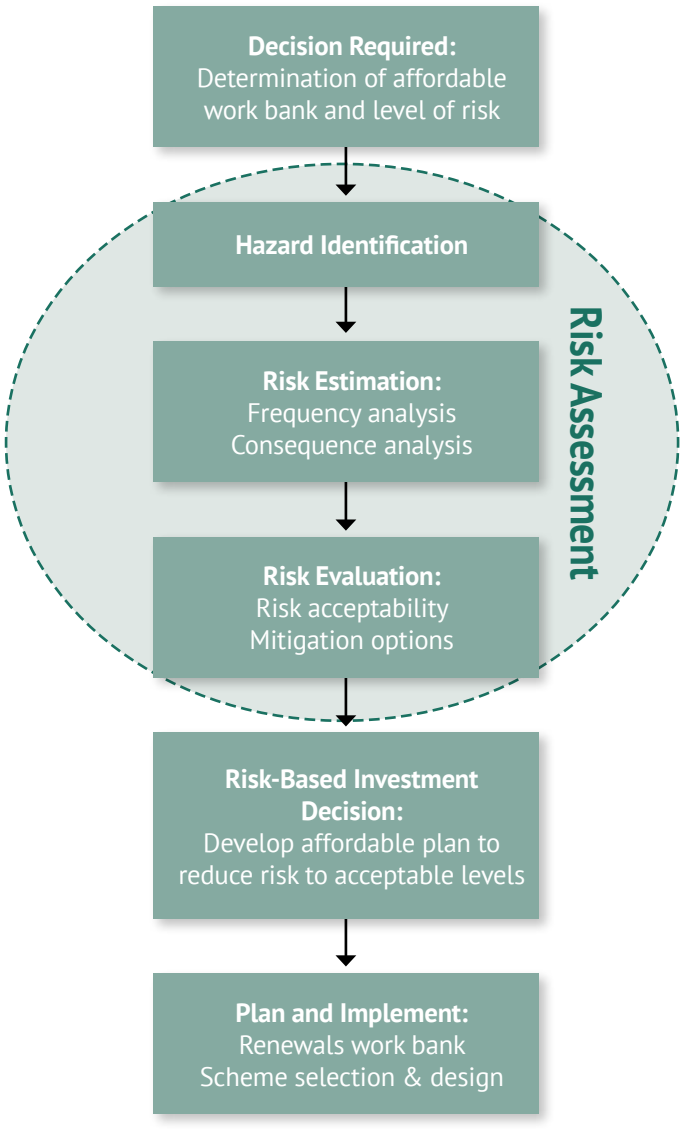


Figure 25. *Asset management risk assessment (Highways Agency, England).*

[21] Highways Agency (2010). *A Risk-Based Framework for Geotechnical Asset Management.* Arup and Partners for Highways Agency, London, England.

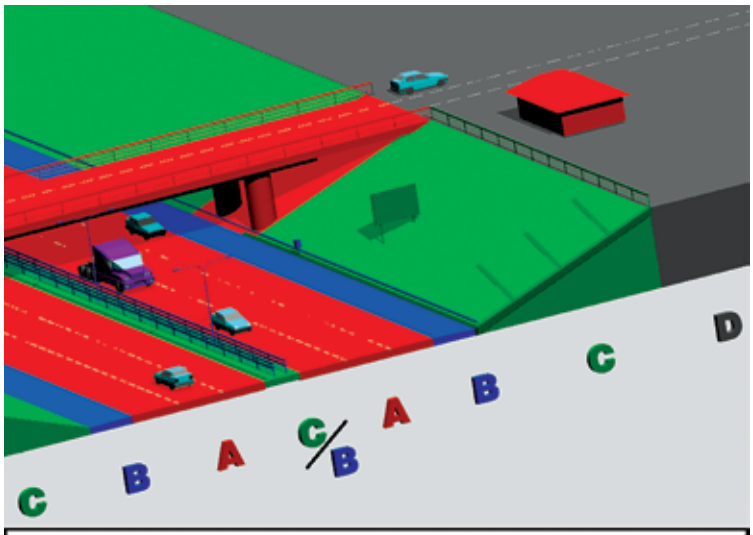
The main step of the framework is the estimation of risk, based on an improved model of the future performance of geotechnical assets, from Task 651(666), to inform likelihood, and a more detailed breakdown of the different consequence components that link in to the performance requirements of the geotechnical assets, other assets, and the network as a system. A simple risk matrix is proposed, based on qualitative assessments of likelihood and consequence.

Consequence may be an aggregated consequence rating based on all components, or individual elements of consequence can be considered if required. Within the decisionmaking framework there is scope to undertake more complex quantitative risk assessments as the decision requires.

Risk evaluation separates assets into three main groups, essential, those that MUST be repaired, high and moderate priority, and low priority where no action is required. For those geotechnical assets in the middle category, which should or could be repaired, the decision should be optimized on the basis of a full understanding and communication of the risk. The output of the risk evaluation stage is an unconstrained work bank (in terms of budget) defined in terms of an indicated risk rating and a definition of the acceptability of that risk.

The decisionmaking stage describes an Optimized Decision Making (ODM) process, based around decision rules and defined intervention and mitigation options. Where sufficient data are available and the decision to be made warrants it, a Quantitative Risk Assessment (QRA) tool can be implemented within the optimization process.

The output from the framework is a clear route to prioritizing decisions about renewals and interventions, with



RISK MATRIX					
Risk Level NOW for observations of Class and Location Index NOW					
Location Index	Class				
	1A/1B/1C	1D	2A/2B	3A/3B	3C
A	Severe	High	Medium	Negligible	Negligible
B	Severe	Medium	Medium	Negligible	Negligible
C	High	Medium	Low	Negligible	Negligible
D	Medium	Low	Negligible	Negligible	Negligible

Figure 26. *Geotechnical asset risk profile (Highways Agency, England).*

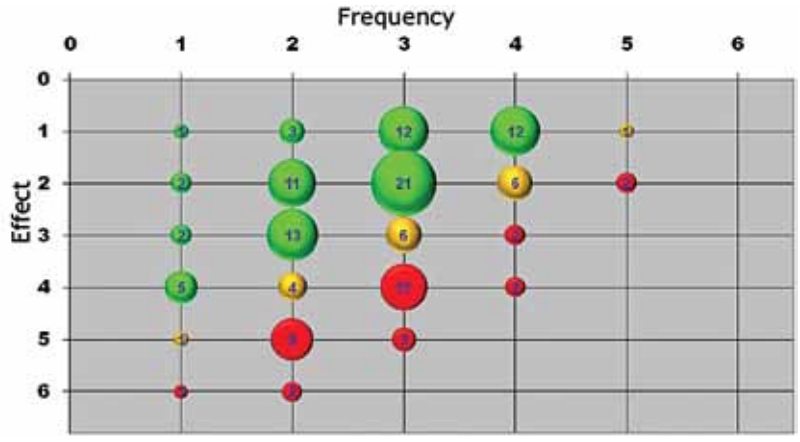


Figure 27. *Program risk analysis for Dutch waterways (Rijkswaterstaat, the Netherlands).*

a clear communication of the risks as the reason for making the decisions, as well as the residual risks where a decision not to intervene is made.

The European highway community sees risk management as a foundation for asset management. PAS-55 Asset Management is a key standard in Europe. PAS-55 explicitly addresses risk management in its approach to asset management and should be a reference for any asset management program in the United States that wishes to include risk management.[22] It should be noted that ISO has now accepted PAS-55 as the basis for development of the new ISO 55000 series of international standards.

Use of Risk Analysis for Operations Management

The Netherlands also provided excellent examples of program risk analysis at the operations level. Figure 27 shows a heat map for a risk-based waterway network management tool in the Netherlands. It communicates the potential for the waterways to be out of service. Risk analysts communicate the results of analyses to decisionmakers. This analysis used failure mode, effects, and criticality analyses to identify failure mechanisms for the waterway network. Operations management can also use Monte Carlo simulations to calculate the expected value of life-cycle cost. Examples were also provided for risk-based bridge inspections and an analysis of rail crossing investments to improve safety.

Risk Management at the Division, Branch, or Functional Unit Levels

The scan team found multiple applications of risk management at the division, branch, and functional unit levels. In this section, functional unit is used to describe all of these applications. The terminology varied slightly from agency to agency, but the application was similar. The use of risk registers at the functional unit level was pervasive. Each unit identifies risks unique to its function. Risk identification at the functional level follows the same process as risk identification at the agency and project levels. However, functional units typically assess their risks against both functional unit goals and overall agency goals.

[22] British Standards Institution (2008). *PAS-55 Asset Management.* The Woodhouse Partnership Ltd, Kingsclere, UK.

The scan team observed examples of risk management on a variety of programs. Some of the interesting applications include the following:

- The Highways Agency applies program risk management to managing agent contracts (MACs). MACs are term contracts (normally 5 years) for maintenance and capital upgrades on sections of the Highways Agency networks. The agency requires MAC operators to perform risk management, paying particular attention to agency-wide risks. It communicates the agency's risk tolerances to MAC operators (see figure 9). The Highways Agency looks collectively at individual MAC risk registers to identify trends and closes the loop by providing MAC operators with risk information from other operators to continuously improve the process.

- Risk management applied to a new license plate program in Queensland, Australia. The agency realized that the new system was one of its most public programs and its failure could have a negative impact on public confidence. The license plate program unit conducted periodic risk analyses and escalated any significant risks to senior management for quick action.

- VicRoads is constructing the M80 corridor through multiple contracts. It requires each contractor to conduct a risk analysis and maintain risk registers. The agency examines these risk registers for trends and seeks to mitigate similar risks from the agency level.

Figure 28 provides an example of a functional unit risk template from Transport and Main Roads in Queensland, Australia. The branch conducts a risk analysis of its own function, but the agency requires the branch to map the risks against the agency's strategic objectives. This communicates the objectives to the branch and allows the agency to collect risks across multiple units so it can identify trends or risks it should manage at the agency level.

Risk Management on Major Programs

Major programs consist of groups of small projects. The scan team saw excellent examples of risk management on major programs in Australia, England, and the Netherlands, and the application was refer-

MIP BRANCH PRIORITIES - ANALYSIS VS RISKS AND STRATEGIC PRIORITIES			RISK PROPOSITIONS										STRATEGIC PRIORITIES						ACTION TYPE What type of action is this?
BRANCH / UNIT PRIORITIES **3** = Significant impact (treating risk / supporting priority) **2** = Some impact (treating risk / supporting priority) **1** = Little impact (treating risk / supporting priority) **0** = This action does not impact on the risk or priority		Sub - Total (RPs)	1 Current processes and systems are often sub-optimised for MIP's needs and lead to waste, churn and reduced outcomes	2 Stakeholder engagement is variable	3 Management of project and business knowledge is inconsistent	4 Mismatch between MIP needs and workforce capability/capacity	5 Difficulty in adapting/changing processes and rules	6 Boundaries and silos limit WoG and whole of TMR decision making	7 MIP is not as professionally disciplined as it could be, especially in work considered to be non-core	8 Some leadership behaviours contribute to (or even drive) MIP risks	9 Ineffective communication within MIP can block its effectiveness	Sub - Total (SPs)	Integrated Governance Framework: a governance framework aligned to the TMR business model	Meet Social Obligations: communities and stakeholders are our advocates in the delivery of our program of projects	Readiness for Transformation: our capability positioned to adapt to the TMR change agenda and the changing external environment	Sustainable Safety Culture: striving for zero harm at our project sites and in our workplaces	Economy and Efficiency: delivery of program / project objectives in a timely and cost effective way	Valued Leaders: leaders who have the knowledge and capability to empower our people to work openly with our customers and our stakeholders	An ongoing action to support MIP's core business A new initiative to improve MIP's performance An action directly treating a risk proposition
Total Scores			66	56	65	34	54	49	54	63	52		57	52	56	32	60	60	Pick one
PSS1 Provide ongoing specialist project support to the MIP program	29	19	3	2	3	2	1	2	2	2	2	10	2	1	1	1	3	2	
PSS2 Develop and undertake a program of business improvement initiatives for project support systems	35	22	3	2	2	3	2	3	3	2	2	13	3	1	3	1	3	2	
R1 Improve understanding across MIP of our culture (values / behaviours)	34	20	2	2	2	2	2	2	3	3	2	14	3	2	3	2	2	2	
R2 Improve MIP approach to program/project management through a holistic approach and better disciplined application of project management methodology	36	22	3	2	3	2	2	2	3	2	3	14	3	2	2	2	3	2	
R3 Embed quality assurance in MIP	38	22	3	2	3	2	3	2	3	2	2	16	3	3	3	2	2	3	
R4 Review MIP governance framework (program/project/corporate)	34	21	2	2	2	2	2	3	3	3	2	13	3	2	3	2	1	2	
R5 Provide a "start-to-finish" procurement system to ensure procurement processes and standards are innovative, compliant with SPP and relevant for MIP	30	18	3	2	2	1	2	1	3	2	2	12	3	2	2	1	2	2	
R6 Develop professional risk PAI program proposal for TMR	17	9	2	3	1			2	1		0	8	2	1	1		2	2	

Figure 28. *Branch risk analysis with relation to agency objectives (Transport and Main Roads, Queensland, Australia).*

enced in the other countries. Risk management on major programs involves the use of cascading risk registers that are mapped against the objectives of the program (e.g., complete a corridor by a fixed date; improve to a defined level of service).

Transport and Main Roads in Queensland, Australia, provided the team with a unique communication tool for major program risk management. Figure 29 is a bookmark that identifies the program's nine top risk sources. The program management team developed the list in a risk analysis workshop:

1. Current processes and systems are often suboptimized, leading to waste, churn, and reduced outcomes.
2. Stakeholder engagement is variable.
3. Management of project and business knowledge is inconsistent.
4. There is a mismatch between needs and workforce capability and capacity.
5. Adapting and changing processes and rules is difficult.
6. Boundaries and silos limit decisionmaking.
7. Program is not as business disciplined as it could be, especially in work considered to be noncore.
8. Some leadership behaviors contribute to (or even drive) risks.
9. Ineffective communication can block effectiveness.

Figure 29. *Major risk bookmark (Transport and Main Roads, Queensland, Australia).*

Optimal management of risks on major projects requires an awareness of risks across projects. Program goals and objectives should cascade down to the individual project risk analysis. Individual project risks should inform the program risk register and allow program managers to mitigate risks across projects.

Conclusion

Program risk management involves risks common to programs, entire business units, or clusters of projects. The U.S. transportation community has much to learn in this area from its international partners. Applying risk analysis to asset management will allow U.S. agencies to make more informed decisions and have the greatest impact with limited investments. Risk analysis across the functional units in a transportation organization will help agencies optimize their mitigation efforts and escalate significant risks to the agency level when they cannot be managed at the program level. Using risk analysis at the major project level is not too far off for U.S. transportation agencies because the use of project risk management is growing, as the next chapter discusses.

CHAPTER 5:

Project Risk Management

Introduction

Project risk management is pervasive in the countries visited on this scan. However, U.S. project risk management practices appear to be on par with international counterparts and perhaps ahead of them on the use of Monte Carlo simulation of costs and schedules. Project risk management, therefore, was not the scan focus. However, project risk management is important in the context of overall agency and program risk management. U.S. agencies do not appear to integrate project risk management in their agencies at the level of those in the countries the team visited—particularly Australia and the United Kingdom. Figure 30, developed by the Highways Agency in England, provides an excellent conceptual graphic of how risk management should integrate at the project, program, and agency levels. As described by the Highways Agency, each level has its own risk register and risk manager. Risks can be escalated to higher levels. Conversely, risks can be cascaded down. Risks can also be raised independently at any level, and the process will ensure they are managed appropriately.

Because project risk management is not the scan focus, this chapter is concise. It provides a project risk management overview and a discussion of cost and schedule risk analysis. It ends with a discussion of how project risk management is used to make project delivery decisions. For more detail on project risk management practices in the United States, see Appendix C.

Risk Management in Project Management

The Project Management Institute includes risk management as part of project management. This was found to be true in the countries visited on the scan. Transport and Main Roads in Queensland, Australia, provided multiple examples of risk management on projects. Figure 31 is a bookmark given to project managers with risk assurance questions they must be able to answer:

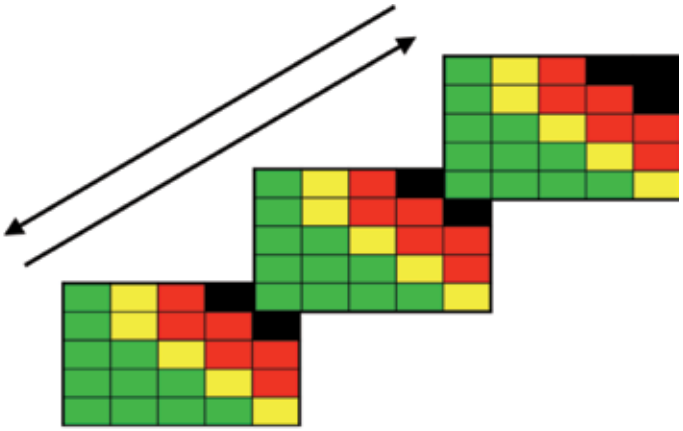


Figure 30. *Cascading risk registers from project to program to agency (Highways Agency, London, England).*

Figure 31. *Project risk bookmark (Transport and Main Roads, Queensland, Australia).*

1. What we are trying to achieve?
2. What could go wrong? And how?
3. What opportunities exist and how they can be realized?
4. What do we need to do to mitigate threats and seize opportunities?
5. How were answers to the above questions tested and validated?
6. Who needs to know or be involved?
7. How quickly do we need to respond?
8. What resources are required?

The questions are simple and straightforward, but embedded in them is the risk management process of providing the context of, identifying, analyzing, evaluating, treating, and monitoring the risks. Transport and Main Roads expects project managers to manage risk on a daily basis. It also provides resources to assist in the process from the risk unit in the main project office.

The Roads and Traffic Authority in New South Wales, Australia, provides its ProjectPack for managing major projects. It is a guideline filled with procedures, templates, forms, checklists, verification records, and samples. The risk management portion of the ProjectPack follows the Australian and New Zealand Standard AS/NZS ISO 31000 and contains the following:

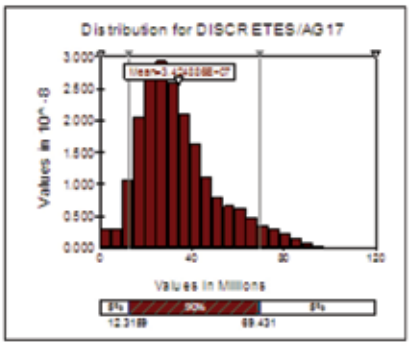
- Risk management procedure
- Risk register (blank template)
- Sample register (containing generic risks)
- Instructions for the risk register
- Samples of project risks

The Roads and Traffic Authority stated that project risk management is required government and agency policy. Officials believe that it results in fewer surprises; better planning, performance, and effectiveness; better estimates and cost control; better stakeholder relationships; and better safety and environmental outcomes.

Project Cost and Schedule Risk Analysis

A clear benefit of project risk management is better cost and schedule analysis. Once risks are identified and assessed, the need for contingencies can be calculated. Contingency calculations can be informed by simple expected value calculations or more sophisticated Monte Carlo analyses of cost and schedule models.

Figure 32 shows the output from a risk-based Monte Carlo analysis for cost on a project in Queensland, Australia. A risk-based Monte Carlo analysis uses ranges of possible impacts for risks and simulates estimates thousands of times over to generate a range of possible outcomes. The graphic at the top



Summary Information	
Workbook Name	uMR 11 03 09V1 - Wo
Number of Simulations	1
Number of Iterations	10000
Number of Inputs	62
Number of Outputs	1
Sampling Type	Latin Hypercube
Simulation Start Time	12/03/2009 6:21
Simulation Stop Time	12/03/2009 6:22
Simulation Duration	00:00:39
Random Seed	1047568171

Summary Statistics			
Statistic	Value	%tile	Value
Minimum	0	5%	12,315,878
Maximum	107,473,744	10%	15,723,058
Mean	34,248,862	15%	18,269,330
Std Dev	17,264,570	20%	20,182,370
Variance	2.9807E+14	25%	21,977,270
Skewness	0.92529107	30%	23,797,556
Kurtosis	3.71486224	35%	25,601,134
Median	30,749,382	40%	27,320,640
Mode	26,473,311	45%	28,985,974
Left X	12,315,878	50%	30,749,382
Left P	5%	55%	32,693,366
Right X	69,430,968	60%	34,877,360
Right P	95%	65%	37,147,196
Diff X	57,115,090	70%	39,711,532
Diff P	90%	75%	42,732,244
#Errors	0	80%	46,748,008
Filter Min		85%	52,068,836
Filter Max		90%	59,772,040
#Filtered	0	95%	69,430,968

Sensitivity			
Rank	Name	Regr	Corr
#1	DISC / AB13	0.631	0.622
#2	DISC / AB6	0.334	0.383
#3	DISC / AB2	0.256	0.265
#4	DISC / AB9	0.236	0.252
#5	DISC / AB12	0.221	0.273
#6	DISC / AG13	0.191	0.109
#7	DISC / AG2	0.160	0.185
#8	DISC / AB3	0.147	0.173
#9	DISC / AB16	0.102	0.124
#10	DISC / AG9	0.068	0.071
#11	DISC / AB10	0.063	0.076
#12	DISC / AB14	0.051	0.050
#13	DISC / AG12	0.044	0.077
#14	DISC / AB15	0.042	0.044
#15	DISC / AB7	0.039	0.032
#16	DISC / AB4	0.035	0.040

Figure 32. *Range cost estimate from a risk-based Monte Carlo analysis (Transport and Main Roads, Queensland, Australia).*

left of figure 32 shows probable project costs across a range of values through a probability mass function. The graph at the center left shows the same values on a cumulative probability function, making quick identification of values at various levels of confidence possible (e.g., P=50, P=80, or P=90). The difference between the P=50 and the P=80 is often used to estimate a project contingency. The graph at the bottom left of figure 32 is a sensitivity analysis, or what is commonly referred to as a tornado diagram. The risks at the top of the tornado diagram correlate most highly with the range in estimate values and deserve the most management attention for risk mitigation efforts.[23]

[23] For a complete explanation of risk-based cost estimating, see NCHRP Report 8-60: *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs.*

Rigorous cost and schedule risk analyses provide insights on how risks impact project outcomes. These analyses allow for more sophisticated risk registers that can be used to manage project contingency. As risks are retired in the risk register, contingency can be released based on an updated cost model with the revised risk inputs. Figure 33 shows a more sophisticated project risk register. Cumulative risk exposure is shown in the heat maps and bar charts on the left. The top-ranked risks are shown in the table on the right. The risks have been removed in this example at the request of the agency.

Selection of Appropriate Project Risk Allocation Methods

Project risk identification and analysis provide transparency in risk allocation. When risks are

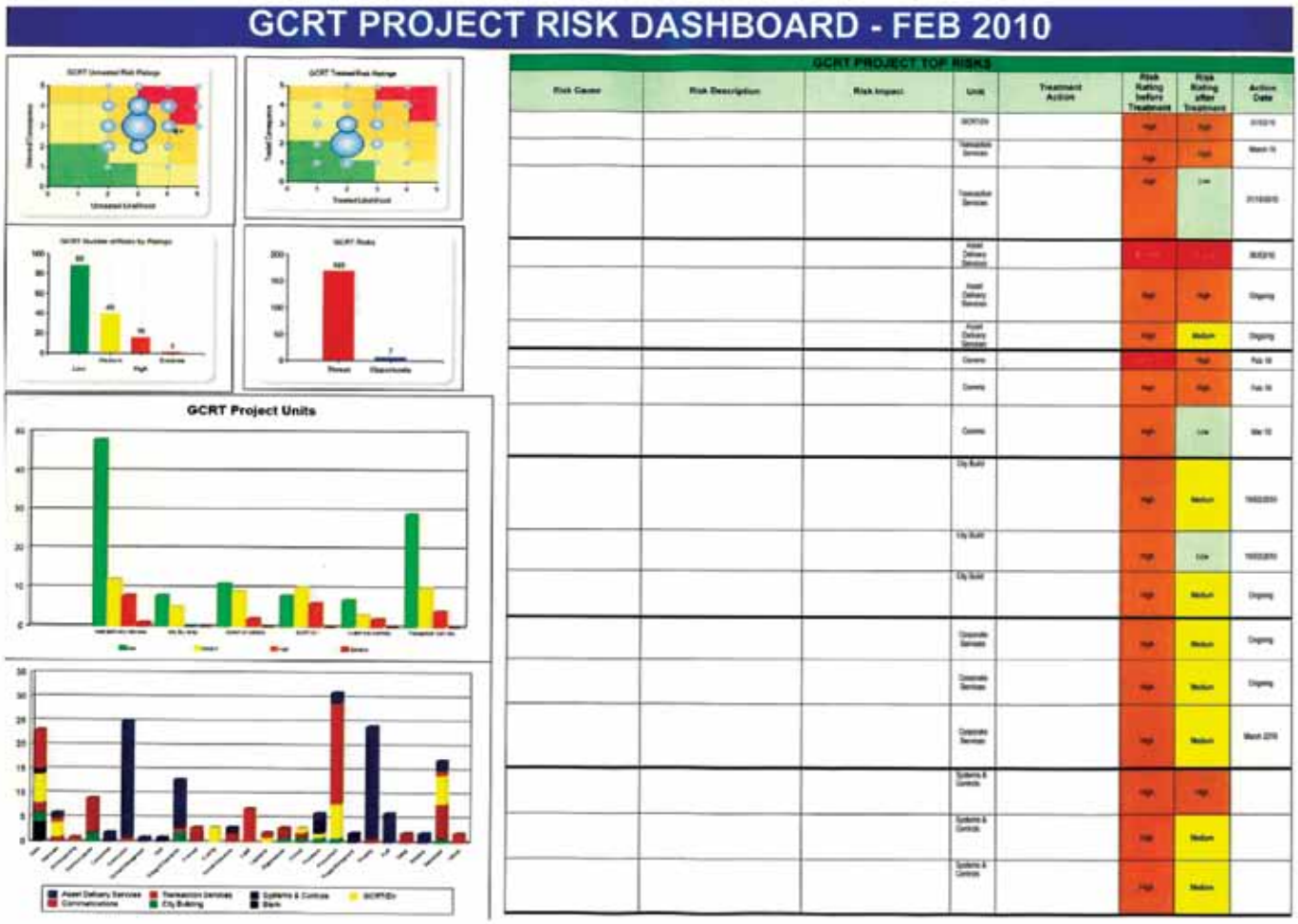


Figure 33. *Project risk dashboard (Transport and Main Roads, Queensland, Australia).*

managed within the project, allocation can be made to an individual risk owner (e.g., a top-level project executive). The risk can also be assigned to a risk manager who takes action on the risk owner's behalf to manage the risk at a level in accordance with the agency's risk tolerance.

Project delivery methods and contracts are the vehicle used to transfer risks from an agency to its industry partners. Figure 34 shows how Transport and Main Roads in Queensland, Australia, applies risk assessment in selecting project delivery methods. The agency has a variety of project delivery methods, as shown in figure 34. These delivery methods include traditional design-bid-build, design-construct (D&C, equivalent to U.S. design-build), design-construct-maintain (DCM), early contractor involvement (ECI, a form of design-build with a target price as opposed to the lump sum price in U.S. design-build), and two forms of alliancing (a relational contracting method not yet used in U.S. transportation construction).

Figure 34 shows traditional project delivery on the left side of the horizontal access and relational contracting on the right. Traditional delivery transfers the majority of risk to the general contractor after the agency completes an independent design. Traditional delivery is used on routine projects on which multiple lump-sum offers can be tendered on a fixed scope. Relational delivery methods establish a cooperative strategy for both design and construction in which the contractor is involved early in delivery. As described in figure 34, relational delivery embraces this cooperative strategy to manage risk. It involves open-book contracting with pain-share and gain-share clauses around a target price. It helps deal with complex projects that have fast-track design and construction, many unknowns, and complex approval processes.

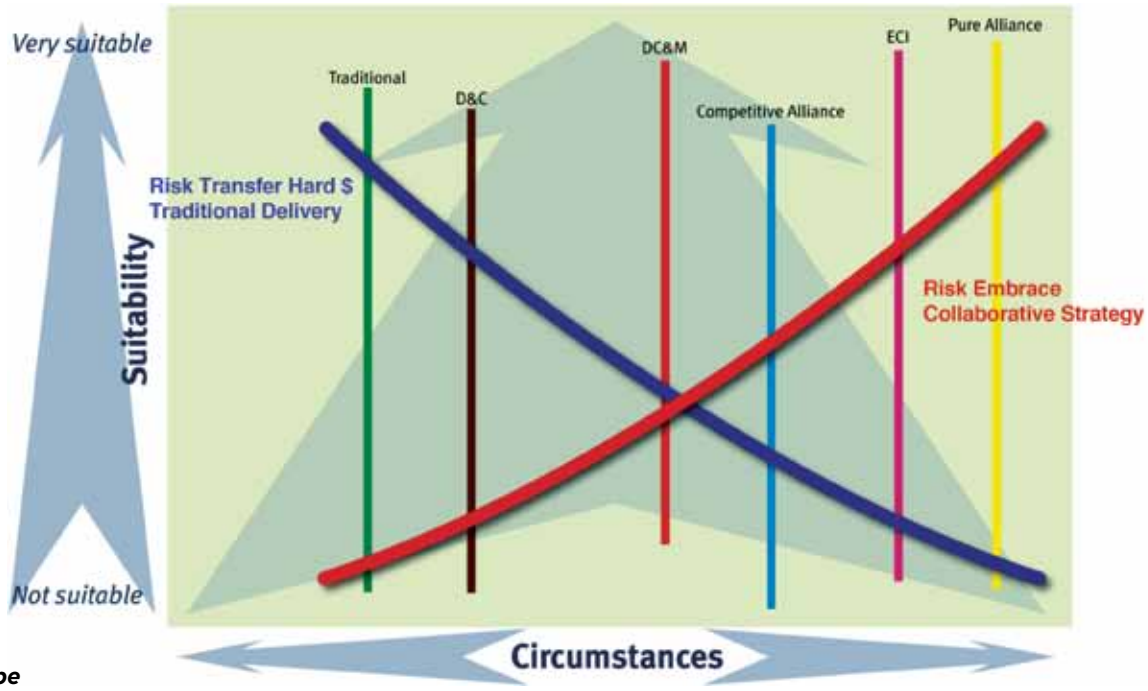


Figure 34. *Risk allocation and project delivery selection (Transport and Main Roads, Queensland, Australia).*

Conclusion

This chapter describes how project risk management supports program and agency management. Project risks cascade up and inform the agency about project problems that can impact overall agency goals. The use of standard risk templates assists in this process. Project risk management can also be used to make better project delivery decisions and more equitable risk allocation. Project risk management is a key element in a holistic agency risk management approach.

CHAPTER 6:

Recommendations and Implementation

Recommendations

The risk management scan team included Federal, State, and private sector members with well over 100 years of combined experience in the operation, design, and construction of U.S. transportation systems. Through this focused research study, the team has gained a fresh perspective on how the U.S. transportation industry can use risk management practices to better meet its strategic objectives, improve performance, and manage its assets. The following scan team recommendations offer a path forward for the transportation community and will help develop a culture of risk awareness and management in the United States.

Develop Executive Support for Risk Management

A mature risk management organization employs risk management at the agency, program, and project levels. A risk management culture must include strong leadership. The lack of management support is perhaps the most frequently cited barrier by agencies embarking on risk management implementation. Efforts of project and program risk managers can be lost without strong executive-level support of and participation in the risk management process.

Define Risk Management Leadership and Organization

Although everyone in a transportation agency should have a role in risk management, agencies should define clear risk management structures and provide leadership with the authority to make risk management decisions. No two agencies visited on this scan had identical risk management organizational structures. However, the mature organizations had clear structures and committed leadership.

Formalize Risk Management Approaches

Transportation agencies should strive to formalize risk management approaches, using a holistic approach to support decisionmaking and improve successful achievement of strategic goals and objectives. The most mature international organizations had clear policies that describe their risk management approach and risk tolerance. These agencies also had concisely published guidance on their risk management process with templates for risk identification, analysis, treatment, monitoring, and updating.

- ✓ *Develop executive support for risk management.*
- ✓ *Define risk management leadership and organization.*
- ✓ *Formalize risk management approaches.*
- ✓ *Use risk management to examine policies, processes, and standards.*
- ✓ *Embed risk management in business practices.*
- ✓ *Identify risk owners and levels.*
- ✓ *Allocate risks appropriately.*
- ✓ *Use risk management to make the business case for transportation.*
- ✓ *Employ sophisticated risk tools, but communicate results simply.*

Use Risk Management to Examine Policies, Processes, and Standards

The use of risk analysis techniques can help agencies reexamine policies, processes, and standards. A transparent understanding of risk likelihood and consequence can reveal policies, processes, and standards that have become too conservative or outdated. An examination of risk treatment options can provide for alternative methods to mitigate and manage risks.

Embed Risk Management in Business Practices

The risk management process should enhance, not supplant, existing business practices. Combining risk management with asset management and performance management will provide for successful decisionmaking. An awareness of what can go wrong and the likeliness of it happening causes business managers to treat risks rather than ignore them. The scan provided sound examples of how business practices were made more efficient through a lens of risk management.

Identify Risk Owners and Levels

Risk identification and treatment planning will not make a difference if treatment options are not implemented. Agency personnel or agency partners must become owners of risks. Most risk registers viewed on this scan documented risk ownership directly on the register. The owners are tasked with implementing risk treatment and assisting with monitoring and updating. If risk treatment is not achievable with the assigned owner, risks should be escalated to the level in the agency where they can be managed. As the Highways Agency states in its risk management policy document, "No one need fear the consequences for failure if the risks that caused the failure were anticipated, appropriately managed and, where required, escalated to senior management."

Allocate Risks Appropriately

The fundamental tenet of risk management is to allocate risks to the party that can best manage them. The international agencies on this scan had a variety of tools to allocate risk, from insurance to concessions, design-build project delivery, and lump-sum contracting. Clarity of who is responsible for managing which risks is essential. Open-book and joint risk register arrangements can also ensure transparency in judging financial risks.

Use Risk Management to Make the Business Case for Transportation

Communication with stakeholders of risks to transportation assets and performance can help make the business case for transportation investment. International transportation organizations have found the public to be good consumers of risk information. Using risk analysis to convey possible disruption to network performance can help make the business case for investments that mitigate risk and improve performance.

Employ Sophisticated Risk Tools but Communicate Results Simply

Quantitative risk management is based on statistical methods, and the models of cost and time impacts can be quite complex. However, these analyses are meaningless if decisionmakers and stakeholders cannot understand the results. Agencies should use sophisticated risk analysis tools to provide the most accurate predictions, but they must communicate results in a simple fashion to obtain the most value from the process.

Implementation and Future Research

The scan findings confirm that an efficient and effective enterprise risk management program is a powerful tool for the international transportation agencies visited. The demonstrated benefits of the programs scanned are both quantitative, such as better controls over costs and delivery schedules, and qualitative, such as less likelihood of negative public relations issues. Risk management provides information that allows agencies to improve programs and projects by making them more efficient. By identifying and mitigating risks, agencies can avoid policies and standards that are not practical for all cases. The findings further confirm that risk management programs can be a powerful tool and unifying systems approach for State agencies in the United States. Although highway agencies differ in their level of risk management maturity, it seems reasonable that the implementation activities associated with this scan be those that evolve and advance enterprise risk management in State agencies throughout the country. That is, agencies need to do risk management at the agency, program, and project level to be fully successful.

After reviewing a variety of options, the scan team prioritized its activities to concentrate on informing senior State transportation officials about risk management and how it can improve organizational decisionmaking. Table 2 outlines the implementation activities and priorities in the categories of communication and marketing, research, training, and governance.

The following amplifies some of the implementation activities in table 2:

Table 2. *Risk management scan implementation.*

ACTIVITY	PRIORITY
Communication and Marketing	
Conduct Webinar—Conduct national Web conference on scan findings.	Short Term
Conduct Outreach—Develop list of venues at which scan team members can present team findings, including professional committees and trade groups.	Short Term
Brief SCOH—Brief AASHTO Standing Committee on Highways.	Short Term
Brief TIG—Brief AASHTO Technology Implementation Group.	Short Term
TRB Session—Seek a risk management session at the 2013 TRB Annual Meeting.	Short Term
Private Sector Outreach—Share, communicate, and market the findings, recommendations, and best practices assimilated from the scan. Priority private sector organizations include the American Consulting Engineering Companies, Associated General Contractors, National Association of State Procurement Officials, National Institute of Governmental Purchasing, National Conference of State Legislatures, American Legislative Exchange Council, and American Bar Association.	Midterm
Marketing Materials—Develop risk management communication and marketing materials to use at various events.	Short Term
Disseminate—Inform appropriate AASHTO committees via e-mail, letter, and presentations about the scan report and its recommendations for U.S. adoption and provide the marketing materials. Key committees and subcommittees include Highways, Structures, Environment, Planning, Finance and Administration, Construction, and various design subcommittees.	Midterm
CEO Workshop—Conduct chief executive-level workshop at the AASHTO Annual Meeting to brief executives on risk management and how to apply it at the enterprise and program levels.	Midterm
Technical Workshop—Sponsor an International Enterprise Risk Management Technical Workshop (in conjunction with TRB) in which representatives from the agencies the scan team met with share best practices and technical advice on implementing risk management.	Midterm
Research	
Guidebook—Propose an NCHRP project to develop a guidebook on enterprise risk management strategies, methods, and tools.	Short Term
Tools—Propose research, if these activities are not addressed by the guidebook, for risk management tool development and deployment. Key risk management tools include heat maps, risk identification, risk categorization, risk assessment, and risk analysis.	Short Term
Maturity Model—Propose research on a risk management maturity model that will help agency executives determine priorities for investing in their evolving risk management programs. This item is highly ranked, but scheduling of projects caused the team to move it to a long-term activity.	Midterm
Case Studies—Propose research on risk management case studies to demonstrate the observed benefits of enterprise risk management programs.	Short Term
Performance Measures—Propose research on the appropriate performance measures that integrate risk management into the business practices and outcomes of transportation agencies.	Midterm

(continued)

(Tab le 2 continued)

ACTIVITY	PRIORITY
Training	
Update NHI Training—Update the National Highway Institute risk management course based on the recommendations of the proposed NCHRP research and the scan findings.	Midterm
Provide Training—In addition to NHI training, provide the findings from the NCHRP research and scan via FHWA workshops and train-the-trainer sessions.	Midterm
Governance	
AASHTO Subcommittee—Elevate the AASHTO Task Force on Risk Management to a joint technical committee at a minimum and empower it to promote the ongoing maturation of risk management.	Long Term

Communication and Marketing

Distribute risk management communication and marketing materials. Develop and distribute executive summaries, marketing brochures, and presentations that provide the business case for risk management and a high-level overview of risk management strategies, methods, and tools. This is a short-term priority that will support other implementation activities.

Disseminate the scan report to committees, subcommittees, and transportation Interests. Share, communicate, and market the findings, recommendations, and best practices assimilated from the scan. Priority should be given to AASHTO and TRB committees. Communication venues include a TRB risk management workshop or session (January 2013) and the AASHTO fall meeting. The scan report should be presented to chief executive officers and to breakout sessions. Dissemination should not be limited to these AASHTO and TRB committees. AASHTO and TRB subcommittees and task forces should be informed as well. A risk management scan Web conference should be scheduled. These are short-term priorities.

Disseminate risk management scan information to private sector interests. Share, communicate, and market the findings, recommendations, and best practices assimilated from the scan. Priority private sector organizations include the American Consulting Engineering Companies, Associated General Contractors, National Association of State Procurement Officials, National Institute of Governmental Purchasing, National Conference of State Legislatures, American Legislative Exchange Council, and American Bar Association. This is a midterm priority.

Organize chief executive and risk management practitioner workshop. Bring together chief executive officers and risk managers responsible for implementing or coordinating risk programs from agencies to share risk management strategies, methods, and tools to promote a culture of risk management in the United States. The first conference could showcase the NCHRP risk management report and the international scan findings. This is a short-term priority.

Hold international enterprise risk management technical workshop. Bring together risk managers responsible for implementing or coordinating risk programs from around the world to share risk management strategies, methods, and tools to promote a culture of risk management in the United States. The first conference could showcase the Roads and Traffic Authority (Sydney, Australia) model for enterprise risk management. This is a short-term priority.

Research

Develop guidebook on enterprise risk management strategies, methods, and tools. A comprehensive guidebook on risk management strategies, methods, and tools will have perhaps the greatest impact on the propagation of consistent and effective enterprise risk management across the country. NCHRP guidebooks are comprehensive and can speak to multiple levels of agency personnel. A guidebook

on enterprise risk management should (1) provide agency executives with an explanation of implementation strategies, (2) guide chief risk executives and program managers on methods for developing programs and measuring their effectiveness, and (3) provide staff with tools to implement these programs. This would be the most significant research activity and could encompass some of the following research topics.

Develop and deploy risk management tools. The risk management international scan identified a number of risk management tools in the literature and in practice. One is the use of heat maps as a decisionmaking tool. Common tool areas include risk identification, categorization, assessment, analysis, and communication. Highway agencies would benefit from standard formats and training for these and other common tools. If these tools cannot be developed comprehensively through the previously described guidebook, they could be developed through individual research efforts. This is a short-term priority.

Develop risk management maturity model. The development of a risk management maturity model will help agency executives determine priorities for investing in their evolving risk management programs. A maturity model could also be tied to performance measures and national standards to help propagate consistency of programs across the country. The research would likely need to consider maturity models from other industries as a knowledge source to support what exists in the highway sector. This is a short-term priority.

Research risk management case studies. Case studies may be the best research tool to demonstrate the observed benefits of enterprise risk management programs. Clear demonstration of these benefits could entice more agencies to formally adopt such programs. Detailed case studies of how enterprise risk management has helped agencies deal with significant uncertainties such as a decrease in available resources, changing regulations or design standards, or failure of a major artery would provide transportation executives with a demonstration of tangible benefits. Investing in a research effort to develop risk management case studies is a logical next step. This is a short-term priority.

Identify risk management performance measures. The mature risk management agencies consistently advised that the practice of risk measurement is best integrated into the business practice and business outcomes of organizations. The identification, development, and testing of performance measures that help agencies understand their risk management maturity level could be a task included with the development of risk management maturity models. Ideally, this research could identify performance measures at the enterprise level that support the evolution and integration of risk management practices in agencies across the country. This is a midterm priority.

Training

Provide training via the National Highway Institute and other avenues. Provide training via FHWA workshops and other methods. Request that FHWA update the National Highway Institute risk management course based on recommendations contained in the NCHRP studies and the international scan report. This is a midterm priority.

Governance

Create AASHTO Subcommittee on Risk Management. The AASHTO Subcommittee on Organizational Management has a Task Force on Risk Management. This group could potentially own the implementation initiatives. Currently this group does not have a high profile. This is an important subject that requires elevation to a joint technical committee at a minimum. Immediate efforts should focus on ensuring proper committee status. It may have some difficulty in effectively pushing risk management on a national basis. This is a long-term priority.

Appendix A. Scan Team Members

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Team Biographies

Joyce A. Curtis (cochair) is the associate administrator for the Federal Highway Administration's (FHWA) Office of Federal Lands Highway. Curtis oversees 18 State Division offices with more than 450 professional, technical, and administrative staff members across the Nation. She is responsible for establishing performance measures and accountability for the divisions' performance as well as FHWA's corporate risk assessment and yearly strategic implementation plan. She is a member of FHWA's leadership team, having a key role in determining the future of the organization. In the past, Curtis served as the FHWA Resource Center director, overseeing technical experts who provided training and technical assistance in many functional areas. Curtis was the assistant division administrator for FHWA's Virginia Division and the director of engineering and operations in the former FHWA Regional Office in Baltimore, MD. She graduated from Villanova University with a bachelor's degree in civil engineering. Curtis is the past secretary of the Transportation Research Board's (TRB) Committee on Urban Transportation Data and Information Systems and a member of the American Society of Civil Engineers (ASCE).

Daniel D'Angelo, P.E., (cochair) is the deputy chief engineer, director of the Office of Design, and director, Recovery Act, for the New York State Department of Transportation. He is responsible for overseeing the statewide project design program and all aspects of the highway, bridge, transit, ferry boat, and rail programs of the Federal Recovery Act. D'Angelo has served with the agency for more than 27 years and has experience in project delivery, program delivery, resource management, strategic planning, workforce development, and risk management. He has a bachelor's degree in civil engineering from the University of Buffalo, a master's degree in business administration with specialization in organizational leadership from Norwich University, and a graduate certificate in adult teaching and learning. D'Angelo is a licensed professional engineer in New York State. He teaches undergraduate courses on critical and creative thinking. He serves on the Technical Coordinating Committee for the Strategic Highway Research Program and on committees of the American Association of State Highway and Transportation Officials (AASHTO).

Dr. Keith R. Molenaar (report facilitator) is the department chair and K. Stanton Lewis Professor of Construction Engineering and Management in the Department of Civil, Environmental, and Architectural Engineering at the University of Colorado Boulder. Molenaar's research focuses on risk management and alternative delivery strategies for the construction of infrastructure and facilities. His responsibilities include coordinating a collaborative research effort aimed at exploring the integration of risk management and project delivery and disseminating research results to owners, designers, constructors, and students. He was previously a faculty member at the Georgia Institute of Technology, where he was group leader of the Construction Research Center's Procurement and Project Delivery research initiative. Molenaar has a bachelor's degree in architectural engineering and master's and Ph.D. degrees in civil engineering from the University of Colorado Boulder. He is a member of ASCE, the Design-Build Institute of America, and the Construction Management Association of America.

Joseph S. Dailey is the division administrator for the FHWA Wyoming Division in Cheyenne, WY. He is the principal representative of the U.S. Department of Transportation (DOT) in Wyoming and is responsible for administering the Federal-Aid Highway Program in the State. Dailey provides guidance and direction to State and local officials on identifying surface transportation needs and related priorities that, when implemented, carry out State and national transportation goals. In the past, he served as director of financial management in the Office of the Chief Financial Officer, overseeing the development and execution of national financial policy supporting the $40 billion-plus annual Federal-Aid Highway Program. Also, Dailey was responsible for internal control policies and integration of the agency's risk management program into the Fiscal Integrity Review and Evaluation program. He has served with FHWA since 2006. His government financial management career spans more than 28 years and includes work in the areas of budget, finance, accounting, programming, manpower, and grant management. Dailey has a bachelor's degree in education from the University of Louisville and a master's in business administration from Syracuse University. He is a certified governmental financial manager and a certified defense financial manager. Dailey is a member of the Association of Government Accountants. He previously

served as the U.S. DOT representative on the AASHTO Standing Committee on Finance and Administration.

Steven D. DeWitt, P.E., is chief engineer for the North Carolina Turnpike Authority, responsible for all engineering activities related to the planning, design, and construction of toll projects. DeWitt's 26-year career with the North Carolina Department of Transportation (NCDOT) includes a variety of statewide positions in construction management, contract procurement including design-build and public-private partnership approaches, and related activities. He is a graduate of the University of North Carolina at Charlotte with a bachelor's degree in civil engineering. DeWitt is a licensed professional engineer in North Carolina. His professional activities include leadership roles on various committees, subcommittees, and task forces with TRB and AASHTO related to project procurement and delivery and general construction.

Michael J. Graf, P.E., is the team leader for FHWA's Program Management Improvement Team. He leads a team of engineers and analysts responsible for improving management of the Federal-Aid Highway Program, implementing the agency risk management program, conducting national program reviews, improving customer and partner satisfaction, and advancing organizational quality. In addition, Graf leads the National Review Teams, which conduct reviews of Recovery Act projects around the country to ensure accountability and consistency. He graduated from the FHWA Highway Engineer Program in 1990 and has held many positions, including team leader for the Program Improvement Team, assistant division administrator in the Delaware Division, Technical Services Team leader for the Central Artery–Tunnel Project in the Massachusetts Division, district engineer in the Mississippi Division, and area engineer in the Georgia and South Carolina Divisions. Graf has a master's degree in public administration from Wilmington University and a bachelor's degree in civil engineering from the University of Maine. He is the secretary of AASHTO's Subcommittee on Organizational Management and a registered professional engineer in South Carolina.

Timothy A. Henkel is an assistant commissioner for the Minnesota Department of Transportation in St. Paul, MN. Henkel directs the department's Modal Planning and Program Management Division and is responsible for managing the State's delivery of passenger rail, highway capital programs, performance measures, freight and commercial vehicle operations, transit, aeronautics, modal innovation, and transportation data and analysis. He has been with the agency for more than 26 years. Henkel's overall transportation career spans more than 28 years, including work in the private sector in planning, program management, and delivery for all modes of transportation. He is a graduate of Bemidji State University–Minnesota with a bachelor's degree and a certificate in civil engineering and land surveying from Dunwoody College–Minneapolis in Minnesota. Henkel is a member of the AASHTO Standing Committee on Planning and serves on technical panels monitoring National Cooperative Highway Research Program (NCHRP) projects conducted by TRB, such as NCHRP *Report 658–Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs.*

Dr. John B. Miller is president of the Barchan Foundation, Inc., a 501(c)(3) public charity that collects and transmits comparative information on how public infrastructure projects are delivered and financed across the world. Miller was an associate professor at the Center for Construction Research and Education at Massachusetts Institute of Technology's (MIT) Civil and Environmental Engineering Department from 1995 to 2003. He was one of two reporters for the American Bar Association (ABA) 2000 Model Procurement Code Project and the ABA 2007 Model Code for Public Infrastructure Procurement. He earned a bachelor's degree in civil engineering, master's degree in soil mechanics, and doctor of philosophy degree in infrastructure systems, all from MIT, and J.D. and L.L.M. in taxation degrees from Boston University School of Law. He is a member of ASCE, ABA, American Public Works Association, Boston Society of Civil Engineers, Construction Specification Institute, Design-Build Institute of America, International Bar Association, and International City/County Management Association and a fellow of the American College of Construction Lawyers.

Dr. John C. Milton, P.E., is the director of enterprise risk and safety management for the Washington State Department of Transportation (WSDOT) in Olympia, WA. He is responsible for both program and project risk management-related issues. Milton also has oversight responsibility for the WSDOT Highway Safety Program and serves as chair of the

Highway Safety Executive Committee. He has more than 24 years' experience in engineering and has served in planning, traffic, design, and construction roles. Milton has a bachelor's degree in civil engineering and a master's degree in engineering management from St. Martin's College. He also has a master's degree and Ph.D. in civil engineering from the University of Washington. He has served on numerous National Academy of Sciences research panels on highway safety and data analysis. Milton's professional activities include leadership roles on various committees, subcommittees, and task forces for TRB and AASHTO. Milton chairs the TRB Committee on Highway Safety Performance.

Darrell M. Richardson, P.E., is the assistant State roadway design engineer for the Georgia Department of Transportation (GDOT) in Atlanta, GA. He oversees two design groups of 12 transportation engineers who design multiple roadway projects around the State. His oversight includes department-wide and project-specific engineering decisions and directives, resource allocation, man-hour estimates, budget, training, and quality control and assurance. Richardson's previous GDOT experience involved managing as many as 180 projects from the development process into construction. He started with GDOT in 1986, working his way up through the design and project management ranks to his current position. Richardson graduated from Southern Polytechnic State University with a bachelor's degree in civil engineering and earned his Georgia professional engineer's license. He serves on the AASHTO Technical Committee on Cost Estimating.

Robert E. Rocco, P. E., is associate vice president and risk manager for AECOM Transportation in North America. He is responsible for enhancing the value of AECOM's risk management product as part of the company's Center of Excellence Group in New York City. This entails developing new risk management tools, processes, and training. Rocco is assigned to the Second Avenue Subway Project in New York City, where he is responsible for risk management and for meeting Federal Transit Administration guidelines on enhancing the project's management practice. He has developed and implemented risk programs for several other projects, most recently the Central Subway Project in San Francisco. Rocco has performed risk assessments for numerous projects, including the Dallas Area Rapid Transit, Central Corridor Light Rail Transit in Minneapolis-St. Paul, San Diego Airport Terminal expansion, and Lincoln Center Development Project in New York City. Before joining AECOM, he was employed by Raytheon Engineers & Constructors, managing the firm's Advanced Technology Office in Princeton, NJ. Rocco has a bachelor's degree in civil engineering from the University of Detroit and a master's degree in engineering management from the New Jersey Institute of Technology. He is a licensed professional engineer in New York, New Jersey, and Ohio. He is a member of the Project Management Institute and ASCE.

Appendix B. Amplifying Questions

The amplifying questions provide detail on the scan team's topics of interest. They served as a framework for the team's discussions with officials of the organizations it visited. The team asked the organizations to answer the questions directly or provide examples of successes and failures. The team requested documentation of policies and procedures and examples of risk management activities.

The amplifying questions are organized into the following topics:

- **Organization—**The context of your organizational and risk management structure
  - General context
  - Risk management organization
  - Development of risk management program
  - Risk management factors
- **Application—**The manner in which your organization applies risk management
  - Definition of risk
  - Risk communication
  - Organizational risk management
  - Program risk management
  - Risk management information systems
- **Process—**The systematic series of risk management actions
  - Risk identification
  - Risk assessment and analysis
  - Risk response
  - Risk allocation
  - Risk monitoring
- **Improvement—**The actions to continuously improve your risk management process
  - Process measurement
  - Lessons learned

Organization

General Context

1. Generally describe the key aspects of transportation program delivery within the political, economic, and technological structure of your country.
   a. Please describe the owner structure, market structure, market competition, and the roles and responsibilities of the primary stakeholders in the transportation program delivery life cycle.
   b. Please describe your organization's mission, goals, and objectives.
   c. Please describe your agency's organizational structure.

Risk Management Organization

2. Please describe the organizational structure for risk management in your organization.
   a. Who is responsible for ensuring that your organization effectively manages risk as a whole and at appropriate levels in the organization?
   b. Who in your organization is responsible for developing risk management policy?
   c. Does your agency adhere to, or apply, the ISO 31000 Risk Management standard?

Development of Risk Management Program

3. Please describe how your risk management program was developed and how you maintain a culture of risk management.
   a. How did your risk management program evolve (e.g., creation through a top-down executive directive or a bottom-up staff initiative)?
   b. What is the involvement of executive staff, middle management, and staff?
   c. If a specific risk management person or group is charged with your overall program, what are the competencies required to ensure adequate background in this or these roles?
   d. What competencies are important to the organization's risk management process, and what type of training does the organization provide?

Risk Management Factors

4. Please describe the areas that your organization's risk management program addresses.
   a. Are costs, other than financial, considered in risk management (e.g., impacts to the environment, impacts to key stakeholders, etc.)?
   b. How are nonmonetary risks weighed against financial or schedule risks?

Application

Definition of Risk

5. How does your organization define the term "risk?"
   a. How does the definition of risk differ at the organizational, program, and project levels?
   b. What motivates (or motivated) your organization to employ risk management efforts?

Risk Communication

6. Please describe how your organization communicates risk issues and/or considerations with internal staff and external stakeholders?
   a. How does your organization communicate the results and benefits of risk management to external stakeholders?
   b. How do internal staff members know about the specific risks associated with their business area?
   c. How does risk management promote transparency of your decisions to the public and other stakeholders?
   d. What quantitative and visual risk management tools are available to communicate risk, complexity, and uncertainty to stakeholders?

Organizational Risk Management

7. Please explain how your organization applies risk management at the organizational level.
   a. How does your organization incorporate risk management in its overall strategic planning, budgeting, performance measurement, and implementation efforts?
   b. How does your organization integrate risk management results into its business objectives and operations?
   c. Has your organization's "risk tolerance" been identified? How was this done?

Program Risk Management

8. Please explain how your organization applies risk management at the program level. This includes major modal decisionmaking (i.e., rail, transit, highways, etc.) and major project decisionmaking (i.e., size of project, delivery methods, etc.).
   a. Discuss how your organization communicates cross-functional risks across organizational boundaries between projects and programs.
   b. How do risk analysis and risk management inform your organization's decisionmaking processes for long-range system planning, major project description and cost estimation, priority programming, and project development?
   c. Is your agency using risk analysis to support programming and project delivery decisions, such as public-private partnerships and long-term maintenance agreements?
   d. Does your organization have a full inventory of assets and deterioration rates that help forecast programmatic waves of risk?
   e. Does your organization include risk management processes in policy decisions, such as implementation of a new specification, design requirement, or other related elements?

Risk Management Information Systems

9. Please describe your organization's risk management information systems.
   a. How does your organization collect and manage the data from risk analysis and risk management efforts?
   b. What quantitative and visual tools do you apply in your risk management?

Process

Note: This section of the amplifying questions focuses on the process of risk management. When answering these questions, please provide examples of organizational, program, and project risk management activities, as appropriate.

Risk Identification

10. Please describe your organization's process of risk identification.
    a. Who conducts your organization's risk identification?
    b. What tools does your organization use to identify risks?
    c. Does your organization consider both threats and opportunities equally?
    d. Does your organization maintain risk checklists or categories of risks (e.g., a risk breakdown structure)?

Risk Assessment and Analysis

11. Please describe your organization's process for assessing and analyzing risks.
    a. How does your organization prioritize key risks?
    b. Does your organization consider risk likelihood and potential impacts in its prioritization?
    c. Does your organization use both quantitative and qualitative risk assessments? Please describe the benefits and challenges of the different tools.
    d. What is done to avoid optimism or bias in risk assessments?
    e. What level of certainty does your organization assign to risks throughout the project development process?
    f. Is there a specific cost-benefit approach that your organization uses?

Risk Response

12. Please describe your organization's process for risk response.
    a. Does your organization have specific response strategies to address common risks?
    b. How do your internal controls address identified risks?
    c. Are contingencies (time and/or financial) set aside when program risks are identified?
    d. If you use project risks to develop contingencies for programs and projects, do you budget for the worst-case scenario cost, a mean cost, or something else?

Risk Allocation

13. Please describe how risk management output informs the risk allocation process in your organization.
    a. How does your organization use information from risk management to make contract-related decisions with key industry partners?
    b. Does your organization use risk management information to select project delivery options (i.e., design-build, public-private partnerships, and maintenance contracting)?

Risk Monitoring

14. Please describe the processes that your organization uses to monitor risk.
    a. How does your organization monitor risks and risk mitigation actions?
    b. Is risk monitoring done at a global level or at lower level in the organization?
    c. How do your organization's risk-monitoring methods relate to contingency management and resource allocation?

Improvement

Process Measurement

15. Please describe your organization's strategies, methods, and tools for measuring the results of its risk management program.
    a. Who evaluates your organization's effectiveness in managing risk and what measures do they use?
    b. How does the output of your organization's risk management efforts relate to its overall strategic plan and performance measures?
    c. How does your organization ensure that risk management processes align among leadership, program management, and staff?
    d. How do you make improvements to your risk management plans, policy, and framework?
    e. What type of risk management training does your organization provide for the various levels of management and staff? What are the key competencies for success?

Lessons Learned

16. Please provide any advice that you would give to an agency that is embarking on a new risk management program.
    a. What are the key resources for a successful risk management program?
    b. How does an organization achieve and maintain a risk management culture?
    c. What are some key mistakes to avoid when developing a risk management program?

Appendix C. Bibliography and Recommended Readings

The following readings relate to enterprise (i.e., agency), program, and project risk management. They come from a variety of sources, but the principles apply to managing transportation risk. The scan team members have found them useful for broadening their understanding of the topic and developing programs and policies on risk management at all levels.

Committee of Sponsoring Organizations of the Treadway Commission (2004). *Enterprise Risk Management—Integrated Framework.* Committee of Sponsoring Organizations of the Treadway Commission, www.coso.org.

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Appendix D. Risk Management Process Stages and Terminology Comparison

Risk Management Process Stages and Terminology Comparison								
	Organization: Document							
Process Stage	FHWA: Guide to Risk Assessment and Allocation for Highway Construction Management (October 2006)	NCHRP 20-24(71): Guide for Managing NEPA-Related and Other Risks in Project Delivery (NCHRP Web-Only 183)	NCHRP 08-60: Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Costs (NCHRP Report 658)	ISO 31000:2009, Risk Management—Principles and Guidelines	Project Management Institute: Project Management Body of Knowledge (PMBOK Guide, ANSI/PMI 99-001-2008)	Project Management Institute: The Standard for Program Management (ANSI/PMI 08-002-2008)	Committee of Sponsoring Organizations of the Treadway Commission: Enterprise Risk Management—Integrated Framework	
0	-	-	-	Communication and Consultation	-	-	Internal Environment	
1	-	Structuring	-	Establish Context	Plan Risk Management	Plan Program Risk Management	Objective Setting	
2	Risk Identification	Risk Identification	Identify	Risk Assessment: Risk Identification	Identify Risks	Identify Program Risks	Event Identification	
3	Risk Assessment	Risk Assessment (Qualitative)	Assess/Analyze	Risk Assessment: Risk Analysis (Quantitative or Qualitative)	Perform Qualitative Risk Analysis	Analyze Program Risks (Quantitative)	Risk Assessment	
4	Risk Analysis	Risk Analysis (Quantitative)		Risk Assessment: Risk Evaluation	Perform Quantitative Risk Analysis			
5	Risk Mitigation and Planning / Risk Allocation	Risk Response Planning	Mitigate and Plan / Allocate	Risk Treatment and Allocation	Plan Risk Responses	Plan Program Risk Responses	Risk Response	
6	Risk Monitoring (Tracking) and Updating	Risk Monitoring and Control	Monitor and Control	Monitoring and Review	Monitor and Control Risks	Monitor and Control Program Risks	Control Activities / Information and Communication / Monitoring	

The following are the stages of risk management and the terms used for each stage by various organizations and their publications. The terms used for each stage generally have the same meaning and intent (**bold** indicates the most commonly used term):

- **Plan** = **structuring** = establish content = objective setting
- Identify = risk **identification** = event identification
- Assess = **assessment** = perform **qualitative analysis**
- Analyze = **analysis** = perform **quantitative analysis**
- **Mitigate** = risk **response** planning = mitigate and plan = **allocate** = **treatment** and allocate = plan response = management planning = risk response
- **Monitor and control** = monitoring and updating = **tracking** = **monitoring and review** = management implementation = control activities = information and communication = monitoring

Other common risk management terms with similar meanings and intent (**bold** indicates the most commonly used terms):

- Risk **appetite** = risk **tolerance**
- **Likelihood** = **frequency** = **probability**
- **Consequence** = **effect** = **impact**

References for the definitions include the following:

- Federal Highway Administration (2006). *Guide to Risk Assessment for Highway Construction Management.* Report FHWA-PL-06-032, U.S. Department of Transportation, Washington, D.C.
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- Project Management Institute (2006). *Standard for Program Management.* Project Management Institute, Newton Square, PA.
- Committee of Sponsoring Organizations of the Treadway Commission (2004). *Enterprise Risk Management—Integrated Framework.* Committee of Sponsoring Organizations of the Treadway Commission, www.coso.org.

Appendix E. Host Country Representatives

Links to Transportation Organization Web Sites

Country	Links to Transportation Organizations
Australia	Department of Transport and Main Roads, Queensland www.tmr.qld.gov.au/ VicRoads, Victoria www.vicroads.vic.gov.au/ Roads and Traffic Authority, New South Wales www.rta.nsw.gov.au/
England	Highways Agency of the Department for Transport www.highways.gov.uk and http://www.dft.gov.uk
Germany	Federal Highway Research Institute (BASt) www.bast.de/
The Netherlands	Ministry of Transport, Public Works, and Water Management (Rijkswaterstaat) www.rijkswaterstaat.nl/ www.government.nl/ministries/ienm
Scotland	Transport Scotland www.transportscotland.gov.uk/

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Publication No. FHWA-PL-12-029
HPIP/8-12(3.5)EW