Figure 8-2 records the substantial increase in construction prices during the economic expansion from 2004 through 2007, followed by a rapid decline, another increase, another decline, and then relative stability for several years. The variability shown in Figure 8-2 represents a significant risk for agency programs that are forecasting condition trends. The 10-year asset management plans states develop need to include an assumption of expected expenditure levels for bridges, pavements, and other assets and an estimate of how much those levels will achieve in sustaining condition levels. During the risk process, monitoring risks such as futures prices for oil, diesel, gasoline, asphalt binder, cement, and steel can indicate the degree to which budget forecasts are at risk.

These leading indicators can be considered key risk indicators. They are "canary in the coal mine" type indicators that can alert agencies where conditions are developing that put their objectives at risk. The agency can extract from the risk registers the key risks that provide insights on whether future performance is likely to be achieved. Capturing these increasing risks early can allow adjustments that can head off performance problems later.

Extracting key risk indicators can support an agency's performance management objectives and provide the agency with insights into future performance as well as understanding of its past performance.

# Communicating with and Monitoring the External Environment

The internal monitoring processes described in this chapter are essential, but are not complete. The agency also needs to monitor the external environment and communicate with key external stakeholders. This is needed to do the following:

- Share with external stakeholders the risks that create uncertainty about whether the agency can achieve its objectives
- Inform decision makers about the key risks for which their assistance is needed
- Learn from outside sources changing conditions that may affect the risks the agency faces

Communicating to external shareholders the agency's risks and how it is managing them can be accomplished by sharing the risk update reports described in this chapter. Discussions of risks also can be included in presentations to metropolitan planning organizations, legislators, the media, and other organizations.

The key consideration is for the agency to frequently communicate with outside stakeholders and seek information that could influence the agency's understanding of its risks.

### **Consulting with Stakeholders**

Closely related to communicating with stakeholders is consulting with them to ensure the agency is addressing their critical risks. This can be particularly important in public agencies that exist to serve stakeholders but also is critical to for-profit companies that must meet customers' demands. ISO notes that a consultative approach with stakeholders can ensure the agency has fully recognized its risk context, that it has understood stakeholder concerns, and that impacts upon stakeholders of risks or treatments are appreciated.

# Measuring Risk Management Maturity

As agencies advance in their risk management practices, they may want to assess their progress or maturity. Maturity can be measured for the entire agency or for units within it. This section presents a brief maturity model.

The British Treasury Department and the Australian state of Victoria have developed guidance on measuring the maturity of an organization's risk management processes. Both frameworks resemble the asset management maturity model used in the AASHTO Transportation Asset Management Guide—A Focus on Implementation, which also resembles the software development maturity model used in the information technology industry. All allow an agency to assess itself on a four- or five-level scale, from initial consideration of the competency to advanced levels. The maturity model shown in Table 8-4 is a composite of the British and Victorian maturity models.

#### Level 1: Awareness

An agency at the initial level of risk management maturity may have an awareness of what are risks and how they can affect its performance. It may occasionally manage risks, but the efforts tend to be episodic and dependent on the initiative of highly motivated individuals taking it upon themselves to manage particular risks. Or the agency may manage risks based on external pressures to achieve performance in a particular area or prevent a particular threat. Risk management is done on an ad hoc basis without the benefit of a clear process to define, measure, or manage risks. Once the initial risk or set of risks is managed, the risk management process is set aside.

#### Level 2: Initiating

At the second level of maturity, the agency begins to develop basic risk management processes and procedures. It may identify key risks, such as those to strategic objectives or to critical projects and programs. The risks may be owned by key individuals, but are not widely understood throughout the organization. Follow-up and monitoring of the risks depend on the initiative of the risk owners and are not driven by organization process, cycles, or formal policies. Risks are not clearly defined and the risk management process has not been documented or used as the basis for training. Policies and procedures are not clearly documented.

#### Level 3: Emerging

At the next level, the agency begins to adopt formal processes, policies, definitions, and procedures to regularly identify and manage risks. Generally, risks that are managed are considered to be threats or variability that could affect performance. Opportunities are not regularly identified, assessed, and capitalized on. The risk process may extend across the key objectives, programs, and projects, but it does not extend to activities or affect frontline workers. Training is provided, but it is limited to key personnel only.

#### Level 4: Competent

At the competent level, risk management is deeply ingrained in the organization and can be witnessed at the front lines of daily operation. The agency has well-defined policies, procedures, tools, and training that reach the majority of employees. Agency personnel understand the various risk appetites applicable to their

programs, projects, and activities. They actively accept well-defined risks when the potential for greater rewards has been defined. Risks and opportunities regularly influence key decisions, such as strategic planning, programming, project selection, materials selection, and other basic processes. The agency regularly monitors its external environment for changes in risks and communicates its risk decisions to stakeholders.

Risk Maturity Matrix					
Element	Awareness	Initiating	Emerg- ing	Compe- tence	Excellence
Ad hoc	•				
Crisis driven	•				
Requires individual initiative	•				
Only threats managed	•	•			
Definitions and policies document- ed		•	•	•	•
Spreads to most programs and ac- tivities			•	•	•
Training offered but limited			•		
Training widespread				•	•
Policies and procedures mature				•	•
Opportunities managed				•	•
Risk influences planning, program- ming, and activities				•	•
Monitoring and communicating mature and effective				٠	•
Costs and benefits documented					•
Opportunities recognized and seized					•
Leading risk indicators used					•
Front lines manage risks and opportunities					•

#### Table 8-4. Risk Maturity Matrix

#### Level 5: Excellence

At the excellence level, the organization has relied on risk management for several generations of decisions and can document the benefits it has achieved. It is able to document the cost savings, performance improvement, and risk-reduction it can achieve. It produces well-understood metrics that indicate how it has reduced risks to its objectives and the costs and benefits of those efforts. Risks are considered at all levels of the organization, training is common, and employees are adept at identifying, measuring, managing, and documenting the results of their risk-management efforts.

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# Chapter 9: Managing Risks to Key Programs

### Summary

This chapter illustrates a paradox of U.S. transportation agency risk management. On the one hand, few U.S. agencies practice enterprise risk management that manages risks across their entire organization. For many, the terminology of risk management is unfamiliar. This chapter, however, documents that U.S. transportation agencies do actively manage risks. Risks are managed in the areas of highway safety, bridge design and inspection, some areas of asset management, and in many business operations such as purchasing and information technology. However, in the U.S. these risk-based activities are described with non-risk vocabulary. Once U.S. risk-based approaches are re-interpreted as forms of risk management it will be easier for U.S. transportation agencies to "scale up" their current risk programs from the project or program level to the enterprise level. This chapter also provides international examples of how risk management is applied to everyday transportation issues.

This chapter examines applications of risk management to seven major transportation agency program areas:

- Asset management
- Safety
- External threats
- Finances
- Information
- Business operations
- Project and program management.

## Managing Risks to Transportation Assets

The use of risk management to help manage assets is common in Great Britain, Australia, and New Zealand and will become more common in the United States as new asset management plans are developed. The MAP-21 requirement for states to adopt risk-based transportation asset management plans has its precedent in similar requirements in Great Britain, Australia, and New Zealand. By 2017 it is expected that all 50 states, Puerto Rico, and Washington, DC, are to develop risk-based asset management plans.

In Australia, in particular, state and local governments are required to have robust risk management programs that extend to their management of assets. The logic is that it requires a strategic, long-term application of resources to sustain transportation assets in sound condition for the indefinite future. An agency that seeks to achieve a sustainable, well-funded, long-term transportation program will face many uncertainties, variables, threats, and opportunities. As agencies develop asset management plans and programs, they need to identify, measure, manage, and mitigate the risks to their assets and transportation asset management plans (TAMP). Over the 10-year course of an asset management plan, the agency could experience significant variability in funding levels, asset performance, external events such as floods, or changing public demands. Producing a 10-year plan without acknowledging these uncertainties reduces the credibility of the plan and deprives decision makers of critical information.

### **Examples of Risk in Asset Management Manuals**

The following summaries from asset management manuals illustrate the breadth of risk management applications to transportation asset management. This section examines U.S. and international manuals that have existed for many years and risk management applications in the early generation of U.S. transportation asset management plans.

### **Asset Management Manuals**

An Australian/New Zealand engineering association<sup>53</sup> provide a 23-page section on risk in the *International Infrastructure Management Manual* (IIMM). The relevance of the IIMM risk management discussion to transportation asset management primarily is in identifying and preventing physical asset failures. The asset failures referenced in the IIMM risk management discussion often occur incrementally rather than instantly and catastrophically, as they can in an aviation incident or a bridge collapse. IIMM describes "failure" not only as acute and complete, but also as incremental, including the following:

- Structural: when the physical condition of the asset is the measure of deterioration, service potential, or remaining life
- Capacity and utilization: when it is necessary to understand the degree to which an asset is under-or over-utilized compared to the desired level of service
- Level-of-service failures: when reliability or performance targets cannot be met
- Obsolescence: when technological change or lack of replacement parts renders the asset uneconomical to operate
- Cost or economic impact: when the cost to maintain and operate an asset is likely to exceed the economic return expected or is more than the customer is willing to pay

Understanding these failure modes allows the organization to take the appropriate countermeasure. The consequences from these failures can include the following:

- Repair costs
- Income loss
- Service loss
- Death or injury
- Property damage
- Failure to meet statutory requirements
- Third-party losses
- Credibility or image loss

<sup>53</sup> Association of Local Government Engineering New Zealand (INGENIUM) and Institute of Public Works Engineering of Australasia. International Infrastructure Management Manual, Version 3.0. INGENIUM, Wellington, New Zealand, 2006, pp. 3.53–3.76.

The AASHTO Transportation Asset Management Guide—A Focus on Implementation associates risk with uncertainty.<sup>54</sup> While focusing on risk as an aspect of uncertainty, the guide notes that all types of transportation assets have risk that accrue as risks to the agency. This accumulation of risk leads to a recommendation that risk be viewed as a core business driver for the agency, not as an isolated function.

The guide notes that some assets are more important than others in the functional role they play or the number of customers they serve. The guide says the risk identification process should also pinpoint critical assets with high consequences if they fail. This identification can lead to renewed emphasis on the timely treatment of an asset at critical points in its life cycle, and can also lead to continuity plans that anticipate continuing service through the unexpected loss of the asset or an emergency response plan to deal with failure if it occurs.

The guide's focus on addressing uncertainty and the disproportionate importance of some key assets leads to an emphasis on network resilience and asset criticality. Assets can be ranked on their importance to public safety, network continuity, connectivity, economic activity, or social well-being. Resilience generally is viewed at a network level, not an asset level. Therefore, redundancy in the highway network can improve resilience.

The guide's focus on criticality leads to the conclusion that consideration of risk management in transportation asset management requires the following:

- Identification of critical assets
- Consideration of the network's ability to cope with identified risk events
- Consideration of risk events that could affect multiple assets, such as an earthquake
- Development of risk management plans that reduce risks to an agency

If the *Transportation Asset Management Guide* is reviewed with a broader interpretation of risk, it includes many other references that relate to risk. Two of these perspectives are risk that the asset will fail to perform as desired and risk that the value of the transportation assets will decline. The guide addresses these issues indirectly with little reference to risk, but they easily could be categorized as important risks.

One of the earliest FHWA documents<sup>55</sup> to discuss risk management in asset management was the report on the 2005 international scan examining asset management practices in Australia, Canada, England, and New Zealand. This report noted that by 2005, risk management was well established in the asset management practices of all of the agencies studied. The officials in those agencies viewed risk assessment as a way to educate elected officials and obtain support for asset management.

In England in 2005, risk management was cited in national guidelines as a basic component of good stewardship of assets, along with the use of life-cycle costing, long-term strategies, performance monitoring, sustaining assets, and continuous improvement. Risk management is among a suite of complementary strategies that enhance asset management. Highways England incorporates risk in numerous policies and guidance documents, such as the code of practice for lighting and standards for bridge project selection.

In New South Wales, Australia, the Roads and Traffic Authority (now called Roads and Maritime Services) included risk as a basic component of its vision, along with ensuring value for money and providing effec-

<sup>54</sup> American Association of State Highway and Transportation Officials. AASHTO *Transportation Asset Management Guide—A Focus on Implementation*. AASHTO, Washington, DC, 2011, pp. 5-50–5-56.

<sup>55</sup> Geiger, D., et al. *Transportation Asset Management in Australia, Canada, England, and New Zealand,* Federal Highway Administration, Washington, DC, 2005, pp. xii, xiii, 5, 11, 13, 20, 27, 37–39, 42, 46, 52–53, 56, 59, 63, 83, 88.

tive governance.<sup>56</sup> The New South Wales Treasury also incorporates risk management as a basic component of sound governance and requires agencies to develop risk management plans for their assets and to ensure compliance with regulatory programs. As a result of this strong focus, risk management permeates Roads and Maritime Services' asset management practices.<sup>57</sup>

The Queensland, Australia Main Roads Department (since renamed the Department of Transport and Main Roads) likewise incorporated risk as a major departmental consideration, including in its asset management plans and strategies. Risk considerations run through agency operations in areas such as ensuring that sound data support sound decision making. Risk management is evident programmatically in that it is a strong component of the bridge management system, which has guidance that notes that using the management system provides defensible, risk-based decision making on bridge investment.<sup>58</sup> The agency's management system multiplies a bridge's probability of failure by its consequence of failure to assist with investment decision making. The risk of individual bridges is aggregated at a programmatic level, showing total risk by state and region, in addition to the risk to individual structures. The agency tallies department-wide bridge risk and compares it to an optimum or preferred risk. By speaking of bridges in terms of "risk," Queensland officials believe they are using verbiage that elected officials understand.

In the Australian state of Victoria, the VicRoads transportation agency integrated risk management into its asset management practices after analyzing investments and realizing that programs such as grass cutting reduced far less risk than programs such as slope stabilization. As a result, risk became a basic component of programmatic decision making. The incorporation of risk was further emphasized by a 2004 act that reduced road officials' immunity and required them to have in place a process for reasonably reducing risks. The emphasis on risk in asset management also created renewed interest in pavement friction as a crash-reduction strategy and elevated friction's consideration in pavement management activities.

The Queensland, Australia, Department of Transport and Main Roads *Guide to Risk Management* provides general direction for the agency for comprehensive risk management that is stratified from the top down at strategy, portfolio, divisional, program, project, and operational levels.<sup>59</sup> For each level, it provides guidance, tools, techniques, templates, and direction. The guide notes that Queensland has legislation requiring agencies to adopt and publish risk management plans. The guide says risk management should be embedded in all business activities and should provide a platform for innovation and opportunity. It reiterates the universality of the key steps from communication and consultation through risk management techniques to all levels, from the strategic to the operational. In this nesting fashion, the same approach to risk management is incorporated from broad organization-wide strategies to individual projects.

References to risk can be found throughout asset management-related publications developed by the Queensland Department of Transport and Main Roads. For instance, the *Skid Resistance Management Plan* notes that it takes a risk-based approach to managing skid resistance. Low skid resistance and surface texture can increase the risk of crashes.<sup>60</sup> Its risk-based approach is consistent with the department's risk-management requirements. It is proactive, does not rely only on reactive assessment of crash sites, and aims

<sup>56</sup> Asset Management Committee. Total Asset Management Guide. New South Wales Government, Sydney, Australia. 2003.

<sup>57</sup> New South Wales Treasury. *Risk Management Toolkit for NSW Public Sector Agencies: Volume 1, Guidance for Agencies.* New South Wales Government, Sydney, Australia. 2012.

<sup>58</sup> Bridge Asset Management Structures Division. *Bridge Inspection Manual.* Queensland Department of Transport and Main Roads, Brisbane, Australia. 2004.

<sup>59</sup> Queensland Department of Transport and Main Roads. *Guide to Risk Management.* Queensland Department of Transport and Main Roads, Brisbane, Australia. 2011.

<sup>60</sup> Road Asset Management Branch. Skid Resistance Management Plan. Queensland Department of Transport and Main Roads, Brisbane, Australia. 2006.

to provide a level of skid resistance appropriate to the road environment. A comprehensive skid-resistance program also helps defend the department in liability lawsuits resulting from crashes.

Risk also is cited in the "Pavement Maintenance" chapter of the Queensland asset-management guidance.<sup>61</sup> It notes that its pavement inspection practices reduce the risk of providing low levels of service and help defend the department in lawsuits. The *Bridge Inspection Manual* integrates risk extensively with high-risk bridges singled out for more frequent inspections.<sup>62</sup> Structure management plans are developed when a bridge's risk reaches a certain threshold. WhichBridge software uses a risk-based multi-criteria calculation to identify bridges for maintenance, repair, and replacement. It notes that certain categories of structures, such as timber bridges built before modern design standards were developed, pose elevated risks and are singled out for specific inspection and treatment. Several asset management publications refer to the Financial Accountability Act of 2009, which states that risk management is a core business function for state and local governments in Queensland.<sup>63</sup> The department also has an Audit and Risk Committee that addresses risk and liability throughout the department.

In 2013, the New South Wales Division of Local Government audited the asset management plans of local governments throughout the state.<sup>64</sup> It noted that asset management reduces risks by doing the following:

- Fully recognizing the resources required to maintain all infrastructure in the local governments
- Providing comprehensive and consistent information on the condition of assets to assist with decisions on maintaining, renewing, and replacing assets
- Communicating to decision makers the assets they own, the services the assets provide, the life-cycle costs of the assets, the asset conditions, and plans for sustaining asset conditions
- Highlighting the life-cycle cost obligations taken on when new assets are built
- Identifying future funding liabilities
- Documenting exposure to natural disasters
- Indicating the risk of infrastructure loss through lack of adequate maintenance.

The New Zealand Transport Agency *Risk Management Process Manual* discusses risk management in detail.<sup>65</sup> The manual defines risk as applied in New Zealand as "the chance of something happening that will have an impact on objectives. It is measured in terms of a combination of the likelihood of an event and its consequence." The manual explains that the intent of the risk management process "is to provide a set of tools that will help minimize threats to Transit's business and maximize opportunities to enhance it. Specifically, the risk management process is designed to raise awareness of threats and opportunities and to minimize such risks as: program/project overrun (in cost or time), litigation, network unavailability/delay, death/injury, community and road user concern, and environmental damage."

<sup>61</sup> Queensland Department of Transport and Main Roads. Part 4, Pavement Maintenance Manual. Queensland Department of Transport and Main Roads, Brisbane, Australia. 2002.

<sup>62</sup> Bridge Asset Management Structures Division. *Bridge Inspection Manual*. Queensland Department of Transport and Main Roads, Brisbane, Australia. 2004.

<sup>63</sup> Queensland Parliamentary Counsel. *Queensland Financial Accountability Act of 2009*, Part 4, Sec. 61. 2009 [cited Dec. 1, 2014]. Available from <u>https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/F/FinAccountA09.pdf</u>.

<sup>64</sup> Division of Local Government. Local Government Infrastructure Audit. New South Wales Government, Sydney, Australia, June 2013, pp. 64–69, 109–112.

<sup>65</sup> New Zealand Transport Agency. *Risk Management Process Manual*, 0-478-105560-6. Version 3. New Zealand Transport Agency, Wellington, New Zealand. 2004.

The manual notes that risk management is more than dealing with financial uncertainty and is about managing "all sources of uncertainty that may impact upon (the agency's) ability to meet objectives, obligations, and stakeholder expectations in relation to all anticipated outcomes."

The New Zealand *State Highway Asset Management Plan 2012–2015* includes risk considerations throughout the asset management process.<sup>66</sup> Risk management is applied to both internal staff and suppliers. Managing risks relates to both asset improvement and asset management. The agency has a risk register that it uses as a tool to manage key risks. Contracts stipulate the requirement for risk management to be conducted following the provisions detailed in the *Risk Management Process Manual*.

The Transport Scotland *Road Asset Management Plan* includes a chapter on risk management, illustrating the common use of risk management in that nation's government.<sup>67</sup> Transport Scotland applies risk management at the strategic, tactical, and operational levels to identify, analyze, assess, and manage risks associated with service delivery and in some cases to determine the service required. It notes that a simple definition of risk could be "the chance of something happening that will impact on safety or service." Risk management plays an important role by ensuring that decisions on the control and management of risk are made in an informed, rational, and structured manner. Transport Scotland uses many private contractors to perform maintenance. Specified risk-based activities such as inspections are inherent in their contracts. Road safety inspections that look for items such as missing signs or other immediate hazards are required twice weekly, and detailed inspections are required annually. Serious defects must be addressed on major routes by 6 a.m. the day after they are identified, while less-critical ones are scheduled for repair within 24 hours. Maintenance needs not classified as urgent or safety critical are scheduled on a needs basis using a value-management approach.

In the Australian State of Victoria, the VicRoads *Risk Management Policy* states that risk is inherent in all day-to-day operations.<sup>68</sup> Risk management, therefore, is not an add-on, but a primary activity of the organization. It says the organization needs to manage risk to enable it to "get on with the job confidently and responsibly, knowing that relevant risks have been identified and dealt with appropriately." It says all staff need to identify, evaluate, and manage risks during their normal business activities.

The policy emphasizes that VicRoads has statutory obligations to ensure that its risk profile is critically reviewed at least annually. It must ensure that its risk management framework is implemented across the organization at all levels and operates effectively to control risks to a satisfactory level. The chief executive will attest in the VicRoads *Annual Report* to implementing an effective risk management system, consistent with Risk Management Standard AS/NZS 31000:2009, and achieving satisfactory risk management outcomes. VicRoads will reinforce a culture of risk management and ensure that risk management principles are adopted in its business procedures. To achieve its risk-management objectives, it will ensure that staff are property trained and that risk management is incorporated in its management systems.

The emphasis on risk-based asset management in Australia was renewed after a court decision effectively revoked the long-standing immunity highway agencies had against claims that infrastructure deficiencies contributed to crashes. As a result, agencies must rely on a "policy defense," or the defense that they have

<sup>66</sup> New Zealand Transport Agency. State Highway Asset Management Plan: 2012–2015. New Zealand Transport Agency, Wellington, New Zealand. 2011.

<sup>67</sup> Transport Scotland. Road Asset Management Plan. Scottish Government, Edinburgh, Scotland. 2007.

<sup>68</sup> VicRoads. Risk Management Policy. VicRoads, Melbourne, Australia. 2008.