

INTERNATIONAL TECHNOLOGY EXCHANGE PROGRAM

Transportation Asset Management In Australia, Canada, England, and New Zealand



U.S. Department of Transportation
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N O T I C E

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16. Abstract A significant challenge for U.S. transportation agencies is managing the transportation asset base while funding expansions of the network to meet increasing demands. The Federal Highway Administration, American Association of State Highway and Transportation Officials, and National Cooperative Highway Research Program sponsored a scanning study of asset management experience, techniques, and processes in Australia, Canada, England, and New Zealand. In its study, the U.S. team observed that asset management as an organizational culture and decisionmaking process is critical to transportation programs facing significant capital renewal and preservation needs and that successful programs require top-level commitment. The team also learned that agencies in the countries studied used asset management practices to obtain funding for transportation infrastructure. The team's recommendations for possible implementation in the United States include using asset management principles to assess and invest in the Interstate System, creating a National Asset Management Steering Committee to distribute information and provide training, developing a Web-based asset-management toolbox, and conducting research on asset management topics.					
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Transportation Asset Management In Australia, Canada, England, and New Zealand

Prepared by the International
Scanning Study Team:

David R. Geiger (Co-Chair)
FHWA

Paul T. Wells (Co-Chair)
New York State DOT

Patricia Bugas-Schramm
*Portland Transportation
Maintenance Bureau*

Lacy D. Love
North Carolina DOT

Dr. Sue McNeil
University of Illinois at Chicago

Dennis L. Merida
FHWA

Dr. Michael Meyer
(Report Facilitator)
Georgia Institute of Technology

Robert Ritter
FHWA

Kirk T. Steudle
Michigan DOT

Donald R. Tuggle
FHWA

Larry Velasquez
New Mexico DOT

and

American Trade Initiatives, Inc.

for the

Federal Highway Administration
U.S. Department of Transportation

American Association of
State Highway and
Transportation Officials

National Cooperative Highway
Research Program

FHWA International Technology Exchange Program

The Federal Highway Administration's (FHWA) Technology Exchange Program accesses and 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 recreate advances already developed by other countries.

The main channel for accessing foreign innovations is the International Technology Scanning Program. The program is undertaken jointly with the American Association of State Highway and Transportation Officials (AASHTO) and its Special Committee on International Activity Coordination in cooperation with the Transportation Research Board's National Cooperative Highway Research Program Project 20-36 on "Highway Research and Technology—International Information Sharing," the private sector, and academia.

FHWA and AASHTO 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. Scanning 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, FHWA has organized more than 60 international scans and disseminated findings nationwide 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.

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Abbreviations and Acronyms

AADT	Annual Average Daily Traffic	GIS	Geographic Information Systems
AASHTO	American Association of State Highway and Transportation Officials	GPS	Global Positioning Systems
AIMS	Asset Inventory and Management System	HAPMS	Highways Agency Pavement Management System
AIT	Alberta Infrastructure and Transportation	HDM	Highway Development and Management System
AMP	Asset Management Plan	HMMP	Highway Maintenance Management Plan
APWA	American Public Works Association	HPMA	Highway Pavement Management Application
ARMIS	A Road Management Information System	IRI	International Roughness Index
ASCE	American Society of Civil Engineers	ITS	Intelligent Transportation System
BAMS	Bridge Asset Management System	IWT	Infrastructure Working Team
BCR	Benefit-Cost Ratio	KPI	Key Performance Indicators
BDI	Bridge Inventory	KPM	Key Performance Measures
BEADS	Bridge Expert Analysis and Decision Support	LRFP	Long-Range Financial Plan
BIS	Bridge Information System	LTCCP	Long-Term Council Community Plan
BMS	Bridge Management System	LTNZ	Land Transport New Zealand
BSI	Bridge Structural Index	LTP	Local Transport Plan
BVPI	Best-Value Performance Indicator	MAC	Managing Agent Contractor
CIC	Capital Investment Committee	MCM	Maintenance Contract Management
CCT	Compulsive Competitive Tendering	MPMA	Municipal Pavement Management Application
CMMS	Computerized Maintenance Management System	NAMS	National Asset Management Steering (committee)
CPI	Capital Planning Initiative	NCHRP	National Cooperative Highway Research Program
CVI	Coarse Visual Inspection	NESS	Network Expansion Support System
dTIMS	Deighton Total Infrastructure Management System	NLTP	National Land Transport Plan
DVI	Detailed Visual Inspection	NOMAD	National Optimization of Maintenance Allocation by Decade
EPA	Environmental Protection Agency		
ESA	Equivalent Single Axle		
FHWA	Federal Highway Administration		

NPV	Net Present Value	SWEEP	Software for Whole-of-life Economic Evaluation for Pavements
NRM	National Roughness Measure	TfL	Transport for London
NSW	New South Wales	TAIMS	Traffic Asset Information Management System
PPP	Public-Private Partnership	TAM	Total Asset Management
PEM	Public Enquiry Management	TAMP	Transport Asset Management Plan
PMS	Pavement Management System	TIMS	Transportation Infrastructure Management System
PQ	Pavement Quality Index	TLRN	Transport for London Road Network
Q/A	Quality Assurance	TMP	Transport Master Plan
RAB	Resource Allocation and Budgeting	TNZ	Transit New Zealand
RAMM	Road Asset Maintenance Management	TOPS	Transit Oversight Permitting System
RAMPS	Road Asset Maintenance Policy and Strategy	TRACS	TRAffic Condition Surveys
RAMS	Road Asset Management System	TRB	Transportation Research Board
RAMSC	Road Asset Maintenance Steering Committee	UKPMS	United Kingdom Pavement Management System
RAS	Road Asset System	WERD	Western European Road Directors
RCI	Ride Comfort Index	WGA	Whole-Government Accounting
RCIS	Road Crash Information System		
RCQ	Roads Connecting Queenslanders		
RSM	Road System Management		
RIMS	Road Infrastructure Management System		
RME	Road Maintenance Effectiveness		
RSP	Results and Services Plan		
RTA	Roads and Traffic Authority		
SACP	Structural Annual Cost Profile		
SCMI	Structures Condition Marking Index		
SAI	Structural Adequacy Index		
SCRIM	Sideway-Force Coefficient Routine Investigation Machine		
SDI	Structural Distress Index		
SEITA	Southern and Eastern Integrated Transport Authority		
SLDB	Streetlight Data Base		
SMIS	Structures Management Information System		
SRRS	State Road Referencing System		
STAMP	Structures Asset Management Program		
STE	Smooth Travel Exposure		

Executive Summary

Most nations of the world have made significant investments in transportation infrastructure. In the United States alone, such investment is estimated at more than \$1.75 trillion. However, as this infrastructure is used and exposed to natural forces, its condition will deteriorate. In the United States, in particular, a significant challenge facing national, State, and local officials is how to preserve the functionality of the existing transportation asset base while at the same time funding expansions of the transportation network to handle increasing demands. Although transportation officials often spend considerable time and energy on new roads, transit facilities, airports, and pedestrian/bicycle facilities, by some accounts, the Nation will spend more money over the next several decades preserving and maintaining the existing transportation base than it will building new facilities.¹

The purpose of this scan was to investigate asset management experience, techniques, and processes in the world. Lessons from this experience could help the United States better understand how asset management applications can be used to enhance the effectiveness of decisionmaking and infrastructure management in Federal, State, and local transportation agencies. The United States faces a significant infrastructure preservation and capital replacement challenge. The lessons learned from this scan could provide important indications of how those who have been practicing effective asset management for some time have approached the challenge from both an institutional and technical point of view.

Scan Team

The Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), and National Cooperative Highway Research Program (NCHRP) jointly sponsored this scan. In addition to FHWA officials (at the headquarters and field levels), the panel included representatives from the departments of transportation (DOT) for the States of Michigan, New Mexico, New

York, and North Carolina; an official from the Portland, OR, Office of Transportation representing the American Public Works Association (APWA); a university professor representing the Transportation Research Board (TRB) Committee on Transportation Asset Management; and a university professor who acted as the report facilitator. These panel members represented a diverse set of interests and expertise in the areas of asset management, bridge and pavement management systems, transportation policy and planning, and transportation system operations.

The scan team sent each host of a site visit a set of amplifying questions that outlined the specific information the team desired. These questions provided a framework for the scan team's investigations of asset management practice, and gave the host government an opportunity to organize its information dissemination in response to these questions. In many cases, the team received written responses to the questions. In others, audiovisual presentations were coded so that the scan team knew exactly which questions were being discussed at that moment. In addition, the host agencies provided many documents and Web references relating to their asset management practice.

General Observations

The concluding section of this report presents a complete set of observations and lessons learned from this scan. The following list focuses on the observations that are most critical to understand the results of this scan.

Leadership and Organization

Any sustained organizational effort requires the involvement of organizational leaders and champions. In all of the sites visited, asset management practice has been occurring over at least 10 years and is continuing to evolve. Continuity in agency leadership and long-term organizational commitment to asset management as a business process were apparent in

¹ See, for example, Kane, Anthony, R., "Why Asset Management Is More Critically Important Than Ever Before," *Public Roads*, March/April 2000- Vol. 63- No. 5, <http://www.tfhr.gov/pubrds/marapr00/kane.htm>; Government Accounting Office, "HIGHWAY INFRASTRUCTURE: Interstate Physical Conditions Have Improved, but Congestion and Other Pressures Continue," GAO-02-571, May 2002, <http://www.gao.gov/new.items/d02571.pdf>; American Association of State Highway and Transportation Officials, "Transportation: The Bottom Line," 2002. <http://transportation.org/bottomline/bottomline2002.pdf>; U.S. Department of Transportation, "2002 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance," Report to Congress, 2003. <http://www.fhwa.dot.gov/policy/2002cpr/>.

each case. Specific observations from the scan include the following:

- Top-level agency commitment (at the very highest levels) in support of asset management was apparent in every case.
- Asset management officials identified changing the culture of the organization to think of asset management as a key business area as a key challenge.
- Each agency had a management position or office responsible for asset management.

Asset Management's Role in Decisionmaking

Aligning asset management with an agency's decisionmaking process is one of the most important factors in developing an effective and credible asset management program. Specific observations from the scan include the following:

- In some cases, transportation agencies were competing for resources across all government programs, and officials pointed to an effective asset management program as one reason they were successful in competing for additional funding in such an institutional environment.
- Asset management programs are based on defined levels of service for different types of assets. When funding levels change (e.g., go down), the desired service levels are reexamined to see if they are still reasonable given fewer resources.
- National or state legislation, in some cases, has been an important catalyst for viewing asset management as an important component in an agency's decisionmaking structure.
- A good asset management program conveyed to elected officials a sense of strong stewardship of transportation assets, and has been an important consideration in increasing funding for transportation.
- Asset management has been integrated into many agency planning and policy documents.

Technical Approaches and Data Use in Asset Management

Asset management is a data-driven process that provides transportation officials with a very important analysis capability. Specific observations from the scan include the following:

- Life cycle costing (also known as whole-of-life costing) had been adopted in each site as the basic approach to program and project costing.
- Although the scan team looked for examples where tradeoff analysis occurred among different asset categories or among different program areas (such as maintenance, capital expansion, and capital renewal), in only a few cases did agencies make any effort to conduct such technical tradeoff assessments, and these were heavily based on engineering judgment.
- All of the agencies studied used risk assessment in developing their asset management programs. Agency officials

also viewed risk assessment as a way to educate and obtain asset management buy-in from elected officials.

- Government accounting procedures were viewed in several cases as inappropriate for assigning value to assets and as a driver for asset management decisions. In these cases, asset management approaches were used to assign a value to assets.
- Instead of creating one comprehensive database for asset management, agencies rely on locational referencing systems to link existing asset databases.
- The experience with deterioration modeling is not uniform across the agencies visited, and in many cases, was quite limited. In some instances, however, the approach to deterioration modeling and scenario analysis was quite sophisticated.

Program Delivery

Asset management practice leads to the development of a program of investment and capital renewal. Specific observations from the scan include the following:

- Several of the visited sites have many years' experience with incorporating strong asset management principles in public-private partnership (PPP) agreements. The lessons learned in this experience are important for the United States.
- Private contracts for delivering maintenance and minor capital construction programs were used at varying levels of application. Although asset management practice does not require or depend on such outsourcing, the opposite was found to be true. If an agency is going to outsource program and service delivery, an effective asset management program needs to be in place.
- Efforts were made in each case to reach out to public officials and, in some cases, the general public, to convey the importance of an asset management policy.
- In some cases (e.g., New Zealand and England), very active asset management professional associations and user groups, spearheaded by local officials, have developed asset management materials and training programs aimed at both public officials and practicing transportation professionals.

Human Resources

An effective asset management program has a strong human resource element. Every agency the team visited noted that a good asset management program requires knowledgeable staff capable of understanding the data-collection process and what the data mean. Observations from the scan include the following:

- Several agency personnel systems have created positions with asset management as a job responsibility.
- Asset management training has been an important aspect of asset management strategy in many of the agencies vis-

ited, not only for their own staffs, but also for other jurisdictions using asset management approaches.

Lessons for the United States

A number of lessons for the United States resulted from this scan (see Chapter 7 for a more extensive list). The most important lessons include the following:

- As this scan found, asset management practices and processes have been used successfully to obtain funding for transportation infrastructure, when competing for funds with other government programs, and even during budget declines.
- It is clear that asset management as an organizational culture, business decisionmaking process, and policy direction is a critical foundation for transportation programs facing significant capital renewal and preservation needs. The United States clearly faces such a challenge.
- Adopting an asset management approach in an organization does not mean that dramatic change has to occur. In the cases examined, agencies had clearly adapted their asset management efforts to the organizational context, and in many cases these efforts have evolved over many years.
- Where outsourcing of service or program delivery is used, a strong asset management program needs to be in place to provide overall direction and strategic guidance on service delivery. Agency officials described this as being a “knowledgeable owner.”
- Creating asset manager positions or at least assigning responsibilities for the asset management function is an important foundation for an effective management program.
- All of the asset management programs the team studied used the concept of risk for establishing investment priorities. Most U.S. asset management experience does not have the same level of application. Risk concepts need to be incorporated more systematically into U.S. asset management efforts.
- Asset management systems are much more appropriate for determining asset valuation than are straight-line depreciation accounting rules.
- Asset management efforts are best achieved when they are linked to strategic goals and desired outcomes.
- The most common asset management performance measures relate to condition, function, and capacity of the assets. In some cases, these categories of performance characteristics could provide the basis for cross-asset evaluation and investment prioritization.
- Asset management should be strongly linked to planning and system operations.
- Perhaps one of the most important lessons for the United States is in integrating asset management concepts into public-private partnership agreements. A comprehensive

asset management effort needs to be part of any agreement to ensure the asset is returned to the owner in good condition, but also to deliver good service to users during the life of the contract.

- Developing an asset management culture in an organization does not have to wait the many years it would take to develop database information systems. Agencies can start with modest efforts and evolve over time into a more comprehensive approach.
- Data collected should have a clear purpose and be directly related to asset management decisionmaking. Data-collection costs should be tracked and data itself treated as an asset, with the same design, build, operate, maintain, and life cycle cost analysis used for other assets.
- The concept of a gap analysis was used to identify asset management needs. Condition and performance criteria are used to measure current asset status, desired operational outcomes are linked to strategic agency goals, and the most cost-effective improvement strategies are then identified.
- Cross-functional teams, consisting of engineers, planners, finance analysts, operations staff, and communications experts, can serve as the best means of understanding the many aspects of asset management, such as data collection, strategy development, and quality assurance.
- The use of focus groups to establish and/or validate resource apportionments for different asset categories is a useful tool in asset management programs.
- Asset management training for all levels of transportation officials is an important initiative for changing the culture of an organization and establishing asset management expectations among key stakeholders.

Implementation Strategies, Dissemination, and Recommendations

The scan team identified several short- and long-term strategies for disseminating and furthering the results of this scan.

Short-Term Strategies

1. The scan results should be disseminated as widely as possible throughout the transportation community. Presentations will be scheduled for the annual meetings of TRB, AASHTO, and 6th National Asset Management Conference planned for fall 2005. Other opportunities will be identified by scan team members. The Transportation Asset Management community practice Web site will be repackaged to incorporate scan results.
2. The AASHTO Subcommittee on Transportation Asset Management will be encouraged to continue development of the asset management software NT and PT by AASHTOWare. The subcommittee will also prepare a resolution for AASHTO board consideration that reinforces asset management as an important national and State policy.

3. The existing National Highway Institute (NHI) course on asset management should be updated to reflect what has been learned on this scan.
4. A senior executive forum on asset management should be organized to introduce senior leaders at transportation agencies to asset management concepts. This should be similar in format to the performance-based maintenance contracting workshop.
5. A national telecast/Webcast on asset management similar to such telecasts on freight should be organized. A target date for this is summer 2006.

Long-Term Strategies

The following three implementation strategies create a climate of continuous process improvement on transportation asset management in the United States.

Change the national viewpoint of the Interstate System from merely highway expenditures to investments in mobility of people, goods, and services by using an asset management-based methodology that focuses on future conditions while identifying the cost of competitiveness and economic power.

Objectives

1. Advance asset management principles as the strategic tools for assessing the entire Interstate System.
2. Compare and contrast the similarities with other countries' highway networks, England's trunk system in particular, and how asset management can support the new vision for the Interstate System.
3. Develop information on the economic impact of the degradation of the Interstate System.
4. Determine a risk-allocation process for the Interstate System.
5. Identify performance indicators and standards for the Interstate System to ensure its prominence in the delivery of goods and services for the entire Nation (e.g., smoothness, remaining service life) that are common across the system.
6. Assume a national leadership role to protect the highest level of the transportation system, and encourage State and local agencies to work collaboratively on the remaining public assets.

Tasks

1. Initiate a study to determine the benefits of using asset management plans for all segments of the Interstate System. The study should include analysis of the economic, social, and political impacts of requiring such plans and the mechanisms necessary to implement such a requirement.
2. Document asset management practice in England, including national policy, performance indicators, and reporting requirements for national and local agencies. Draft correlat-

ing policy indicators and reporting requirements for the United States, which could provide guidance on reporting national, regional, and local transportation network performance.

3. Target a State or region to take a holistic view of the entire public asset inventory that provides increased funding flexibility.
4. Develop linkage between transportation planning and programming and asset management at the metropolitan planning organization (MPO) level.

Join with other efforts, agencies, and resources to embed asset management into existing efforts on an ongoing basis. Create a National Asset Management Steering Committee (NAMS) in the United States. Such an effort provides a platform to distribute information, provide training, and document best practices on transportation asset management nationally and abroad. Develop an easy-to-understand toolbox for asset management that can be applied at different levels of government. The tools should look beyond transportation to best practices in other industries. These tools should be available on a Web site for free downloading.

Objectives

1. Develop a resource clearinghouse for asset management in the United States that draws from and is directly tied to equivalent efforts internationally and is available in the public domain.
2. Market this clearinghouse to all levels of U.S. agencies and across all types of infrastructure.
3. Investigate whether U.S. efforts to document best asset management practices and provide resources can be integrated with existing international asset management consortia.
4. Participate annually in a national asset management forum to review progress, document case studies, develop curricula, and coordinate research efforts across infrastructure and Federal agencies.
5. Inform all levels of transportation agencies—State, MPO, and local—of this resource clearinghouse.

Tasks

1. Meet/communicate with FHWA and the Environmental Protection Agency (EPA) to discuss potential alliance of asset management efforts.
2. Develop a white paper discussing the relationships among AASHTO, FHWA, and EPA priorities and opportunities presented in asset management.
3. Contact the international NAMS to identify copyright restrictions and opportunities to add the United States to existing efforts and document U.S. case studies for inclusion in the existing library of best practices. Develop

alternatives with recommendations for U.S. clearinghouse implementation.

4. Document the state of practice at the State and local transportation agency level in the United States as part of establishing a national approach to transportation asset management.
5. Communicate with State, MPO, and local transportation agencies to inform them of training, forums, and best practices.
6. Write articles for *APWA Reporter*, *Public Roads*, and appropriate State, municipal, and engineering journals.
7. Support benchmarking of the U.S. asset management process (rather than performance) for local, regional, and State agencies. This should include an assessment of the capability and execution of linking decisions to quantified asset-related costs and benefits as well as whether processes have been documented and how often this occurs. Efforts should consider incorporating the AASHTO self-assessment survey. Share results at various State, MPO, and local government conferences and in literature.
8. Create an automated survey tool in the public domain that participating agencies can complete and have results arrayed against comparable levels of governments.
9. Develop a national competition on transportation asset management under FHWA's Transportation Planning Excellence Awards Program.
10. Develop videos and training materials aimed at various levels of government.

Extend U.S. asset management practice through NCHRP and other research opportunities.

The scan team identified several potential research projects:

1. Conduct before-and-after studies on the effectiveness of asset management efforts and the identification of benefits.
2. Establish state-of-the-art practices for data collection and analysis for asset management.
3. Define and quantify risk categories for an asset management program.
4. Synthesize data management principles, collection, sampling, and auditing techniques for asset management.
5. Examine world experience with high-speed deflectograph technology, looking at the Denmark technology identified in the England case study.
6. Examine more closely transportation assets other than bridges and road pavement, such as appurtenances, transit, streetlights, etc.
7. Synthesize practice with how three-dimensional (3-D) or design files are linked to geographic information systems (GIS).

Chapter 1: Introduction

Most nations of the world have made significant investments in transportation infrastructure. In the United States alone, such investment is estimated at more than \$1.75 trillion. However, as this infrastructure is used and exposed to natural forces, its condition will deteriorate. In the United States in particular, a significant challenge facing national, State, and local officials is how to preserve the functionality of the existing transportation asset base while at the same time funding expansions of the transportation network to handle increasing demands. Although transportation officials often spend considerable time and energy on new roads, transit facilities, airports, and pedestrian/bicycle facilities, by some accounts, the Nation will spend more money over the next several decades preserving and maintaining the existing transportation base than building new facilities.

Transportation asset management has been defined many different ways. In essence, it is a strategic approach to inventorying, monitoring, and managing at desired levels of performance the many different assets that constitute a transportation system.

The purpose of this international scan was to investigate best-case examples of transportation asset management techniques and processes in the world. Lessons from this experience could help the United States better understand how asset management applications can enhance the effectiveness of decisionmaking and infrastructure management in Federal, State, and local transportation agencies. The United States faces a significant infrastructure preservation and capital replacement challenge. The lessons learned from this scan could provide important indications of how those who have been working on this issue for some time have approached the problem from both an institutional and technical point of view.

Scan Team

Asset management is an important concept to transportation professionals working at many levels of government and in the private sector. To reflect this range of potential application, the scan panel represented a diverse set of interests and concerns for national, State, and local-level decisionmaking. The Federal Highway Administration (FHWA), American

Association of State Highway and Transportation Officials (AASHTO), and National Cooperative Highway Research Program (NCHRP) jointly sponsored this scan. In addition to FHWA officials (at the headquarters and field levels), the panel included representatives from departments of transportation (DOT) for the States of Michigan, New Mexico, New York, and North Carolina (in addition to representing the AASHTO Subcommittee on Transportation Asset Management); an official from the Portland, OR, Office of Transportation representing the American Public Works Association (APWA); a university representative representing the Transportation Research Board (TRB) Committee on Transportation Asset Management; and a university professor who was the report facilitator. These panel members represented a diverse set of interests and expertise in the areas of asset management, bridge and pavement management systems, transportation policy and planning, and transportation system operations (see Appendix A for contact information and biographical sketches for scan team members).

Scan Study

Several nations, states/provinces, and local governments are at the cutting edge of asset management practice. As the scan team found, however, even these asset management practitioners are in a continuous process of learning. Based on a scoping process of international experience in asset management, the scan team chose to investigate the asset management practice in Alberta and Edmonton, Canada; England and London, United Kingdom; New Zealand; and New South Wales, Queensland and Brisbane, and Victoria, Australia. This mix of site visits thus included two national experiences (England and New Zealand); four state/provincial experiences (Alberta, New South Wales, Queensland, and Victoria); and three local experiences (Brisbane, Edmonton, and London).

The scan team met with the following types of representatives during its 15-day study:

- National transportation agencies—England and New Zealand
- National rail provider—England
- Provincial or state departments of transportation—Alberta

(Canada) and New South Wales, Queensland, and Victoria (Australia)

- City transportation and infrastructure officials—Brisbane (Queensland), Edmonton (Alberta), in England (representing London and other local governments), and in New Zealand (representing urban and local communities)
- Transit provider—Brisbane (Queensland)
- Toll authorities—New South Wales and Victoria
- Public-private partnership concessionaires—New South Wales and Victoria
- Private providers of maintenance services—England
- Research organizations—England, New South Wales, and Victoria
- Professional engineering/asset management associations—Australia, England, and New Zealand

The scan team sent each host of a site visit a set of amplifying questions in advance that outlined the specific information the team desired (see Appendix B). These questions provided a framework for the scan team's investigations of asset management practice, and gave the host government an opportunity to organize its information dissemination in response to these questions. In many cases, the team received written responses to the questions. In others, audiovisual presentations were coded so that the scan team knew exactly which questions were being discussed at that moment. The team also received a great deal of supplementary material from the host agencies.

Report Organization

Given the different circumstances and challenges facing governments at the national, state/provincial and local levels, this report is organized by level of government. Chapter 2 examines the national government experience in England (even though it is a part of the United Kingdom) and New Zealand. Chapter 3 examines asset management experience at the state/provincial levels, focusing on Alberta, New South Wales, Queensland, and Victoria. Chapter 4 presents the results of the team's visit to local governments, including Brisbane, Edmonton, and London. Chapter 5 examines one of the aspects of good asset management practice that was not anticipated before the scan—the important role of professional and local government associations in asset management. Chapters 6 and 7 present general observations and lessons learned from this scan. The final chapter describes recommended implementation steps for the scan findings. To provide consistency among the different asset management experiences, each case description follows the same format. Each description provides sections on context, how the agency has organized for asset management, the drivers for asset management, asset management in the decisionmaking process, use of performance measures, asset management systems, data-collection strategies and

techniques, the analysis and prioritization procedures used to rank asset management strategies and projects, and general observations.

Given that the most effective asset management programs are often found within a larger agency performance-oriented decisionmaking structure, the concepts of performance measures and strategic planning become important points of departure for understanding effective asset management programs. To learn more about performance measures, see the scan report on performance measures, *Transportation Performance Measures in Australia, Canada, Japan, and New Zealand*, available at www.international.fhwa.dot.gov.

In each case, monetary amounts are reported in the country's own currency unit, followed by a conversion to U.S. dollars. Similar conversions are shown for metric distance measurements. In the case of currency, although much of the financing information is reported from planning and budgetary documents prepared over the past 10 years, the conversion rates into U.S. dollars were those on April 24, 2005. Although this suggests the buying power of the monetary estimates might be different from that intended in these documents, such a conversion serves the purpose of comparing investment levels consistently from one country to another.

Chapter 2: National Experience with Asset Management

Two of the sites the scan team visited represented asset management experience at the national government level. As might be expected, not only do national agencies have their own responsibilities for managing assets (e.g., road networks), but they also play an important role in educating, guiding, and in some cases mandating asset management practices to other governments. The scan team's two national experiences with asset management were those for England and New Zealand.

ENGLAND²

Highways Agency—www.highways.gov.uk

Context

England is a world leader in transportation, known for having one of the lowest road fatality rates of any country in the world as well as for applying innovative technologies and methods for managing its infrastructure. The road network in England can be considered in two parts. The strategic or national network is managed by the Highways Agency and the nonstrategic, or local, network is managed by local authorities. Although England has initiated important processes and procedures for asset management, it still has important challenges in improving the condition of the road network. A recent trend in major road deterioration was halted only in 2004 when significant funding was allocated to maintenance for this part of the network. Today, on local roads, almost 4,000 bridges still need strengthening and 2,844 need major maintenance. About 32 percent of England's lighting columns are more than 30 years old, their expected useful life.

One reason for this state of affairs is that local governments (of which there are 150 in England) are responsible for a large portion of the road network, but the funds they receive from the national government ostensibly for transportation purposes can be used for any governmental purpose. Not surprisingly, given strong public pressures for quality education and social services, some of this funding is allocated to nontransportation activities (an estimated 8 percent of the national transportation funding allocation).

At the national level, the Highways Agency of the Department for Transport is responsible for England's major roads. This includes about 7,754 kilometers (km) (4,818 miles (mi)) of major arterial roads, carrying 25 percent of England's traffic volume and 50 percent of its heavy vehicle movements. One interesting aspect of the Highways Agency's road network is that, unlike other countries the team visited, the mileage for which the Highway Agency is responsible has decreased each year over the past decade because the agency has been turning roads and bridges back to local governments (referred to as "detrunking").

The agency's annual budget is £5.5 billion (US\$11 billion), with about £850 million (US\$1.7 billion) going for road maintenance. The Highways Agency Business Plan for 2005/06 states that £2.5 billion (US\$5.0 billion) has been allocated over the next 3 years for road maintenance.

The road network is divided into 14 operational areas with each area managed by a managing agent (MA), a private consultant usually operating under a 5-year contract. There are two forms of MA. In the first form, the consultant is a separate organization from the contractor carrying out the

Transportation Infrastructure Managed

By Highways Agency (Strategic Roads in England)

- 7,754 km (4,818 mi) of roads
- 16,000 structures
- Communications equipment such as message signs, including 5,500 emergency roadside telephones
- Safety fences and 3,500 km (2,175 mi) of boundary fences

In England

- 275,000 km (170,885 mi)
- 65,000 bridges
- 4.7 million lighting columns

National Rail Infrastructure

- 40,000 bridges
- 25,000 km (15,535 mi) of major earthworks
- 700 tunnels
- 23,000 culverts
- 17,000 retaining walls
- 177 sea walls

² Most of the agency representatives participating in this visit represented England, not the United Kingdom, so Northern Ireland, Scotland, and Wales were not part of the discussions.

“Many people think asset management is just a fancy term for maintenance...it isn’t.”

—MAINTENANCE CONCESSIONAIRE

maintenance for the area. In the second form, the area is managed and maintained by a company that combines the managing consultant with the maintenance contractor. The agent for the second form is known as a managing agent contractor (MAC). These managing agents are an important implementing structure for the Highways Agency's asset management program. England has also been divided into four traffic operations regions.

The Highways Agency's stated aim is “Safe roads, reliable journeys, informed travellers,” with the following specific objectives:³

1. To deliver a high quality service to all our customers by:
 - Reducing congestion and improving reliability
 - Improving road safety
 - Respecting the environment
 - Seeking and responding to feedback from our customers
2. To ensure more effective delivery through better working relationships
3. To implement best practice and innovative solutions to improve service now and in the future
4. To be a good employer
5. To be an efficient agency with effective business processes and resource management systems

As the list shows, asset management is not a stated objective of the Highways Agency. This is in part because of its view of itself as a traffic service provider, as well as its philosophy that asset management is engrained into all of the agency's functions.

The strategic planning guidance for 2006 and beyond lists the following priorities for the road network:⁴

Highest Priorities

- Delivering the new traffic management role, including the progressive roll-out of traffic officers, regional control centers (jointly manned with the police) and supporting technology on the most congested parts of the motorway network. This will help to reduce congestion and delays to journeys through managing traffic, clearing incidents, and providing better-quality information to road users.
- Maintaining and improving safety on the network to deliver the safety target and meet the aim of the Safer Roads policy. This will be achieved through the safety benefits of

major projects and by carrying out a program of small safety schemes and improvements.

- Maintaining the network in a safe condition whilst minimizing the whole life costs. This helps avoid unplanned or more extensive and disruptive maintenance projects in future years.

Given the tremendous backlog in maintenance on local roads that accrued over the past decade (estimated at £3.75 billion (US\$7.5 billion)), the national government set targets to halt the decline in local road pavement condition by 2004 and to eliminate the backlog by 2010. Eliminating the maintenance backlog was a policy objective that local transport officials mentioned continually during the scan team's visit. Highways Agency officials stated that no maintenance backlog for road pavements exists on the national network, but they believed a backlog exists for local road maintenance.

Drivers for Asset Management

One of the most important drivers for asset management in England has been governmental directives on transport policy and accounting procedures. A tradition of managing road assets began in 1825 when Parliament stated that it was government's “duty to maintain” infrastructure built with public funds. The more recent evolution in asset management is best explained by examining governmental policies and procedures occurring over the past 10 years.

The national government published a white paper in 1998 entitled *A New Deal for Transport: Better for Everyone* and a report called *A New Deal for Trunk Roads in England*. Three major investment areas were identified in these reports—maintenance, operations, and capital improvement—along with investment criteria on safety, environment, economy, accessibility, and network integration. They also identified new directions for the Highways Agency, one of which was to “give priority to the maintenance of trunk roads and bridges with the broad objective of minimizing whole life costs.”

A Local Government Act of 1999 defined governmental responsibility as stewards of public funds as being a “general duty of best value.” A best-value authority must “make arrangements to secure continuous improvement in the way its functions are exercised, having regard to a combination of economy, efficiency and effectiveness.” This act was preceded

³ <http://www.highways.gov.uk/aboutus/intro.htm>, accessed 8/3/05.

⁴ Highways Agency, *Strategic Planning Guidance: 2006-07 and Beyond*, London: England, March 2005.

by a Compulsory Competitive Tendering (CCT) policy, which required local authorities to follow certain processes when delivering its services, thus leading to increased privatization of service delivery. This also changed the bid selection process from low bid to best value.

This concept of “best value” has found its way into many technical guidelines and processes. For example, *Delivering Best Value in Highway Maintenance*, published by the Institution of Highways and Transportation, is what is called a “code of practice” for maintenance management.⁵ In this document, the key principles of asset management are defined as follows:

- Focusing on life cycle costing
- Management of strategies for the long term
- Establishing and monitoring levels of service
- Managing risk of failure or loss of use
- Sustainable use of physical resources
- Process of continuous improvement

The code clearly places asset management at the center of guaranteeing best value in the road sector.

A Transport Act of 2000 gave local authorities a statutory requirement to produce local transport plans (LTPs) covering the timeframe of 2001/2002 to 2005/2006. A national program provided money (£1.6 billion/US\$3.2 billion) for local governments to hire private contractors to manage the condition of the network and reduce their maintenance backlog, with agreement that the governments would fund this responsibility after 5 years. So far, 20 local authorities have participated in this program.

The most recent Transport Act requires another round of LTPs covering the years 2006/2007 to 2010/2011. In the guidance to local governments for preparing this second round of plans, the Department for Transport used the following language. Because this guidance so clearly links asset management to transportation planning, the relevant sections are presented in their entirety.⁶

“Achieving value for money through asset management

Well-maintained local transport assets—including roads, footpaths, byways, bridleways and cycle paths—are essential to the delivery of better transport outcomes. They encourage walking and cycling, and contribute to road safety outcomes. They promote the quality and comfort of bus services, improve journey ambience, minimize wear and tear to vehicles, and promote

better environmental outcomes including emissions and noise. Well maintained roads, footways, footpaths, streetlights and street furniture make a vitally important contribution to the quality and livability of public spaces, and the quality of rural landscapes. LTPs should therefore clearly demonstrate how effective maintenance will contribute to the achievement of other targets and objectives. Local transport authorities may also wish to adopt effective and efficient maintenance as an important LTP objective in its own right—in particular through the development of Transport Asset Management Plans and Rights of Way Improvement Plans.

Local Transport and Highway Authorities should follow two key principles of value-for-money asset management when preparing and delivering their LTP:

- *Firstly, to achieve the best possible value for money, maintenance work must be carried out in good time. It is essential that authorities do not allow the total costs of maintenance to escalate by allowing assets to deteriorate to the extent the routine maintenance is no longer possible. Similarly, authorities should aim to ensure that maintenance works are not carried out more frequently than necessary.*
- *Secondly, authorities should consider carefully the future maintenance requirements of proposed new infrastructure before including it in their LTP. It may be that the whole life-time cost of a capital scheme will be such that the transport need that it is designed to address could be more efficiently met through less capital-intensive or even revenue-funded interventions.*

Transport Asset Management Plans

Local authorities have for many years been required to demonstrate that they are making the best use of their property and other assets, in the form of Asset Management Plans. These are made available to both Central Government and to their regional Government Office as required. The Department is now encouraging local authorities to extend this to transport assets, by drawing up Transport Asset Management Plans (TAMPs), informed by LTPs and other services and corporate plans. The County Surveyors Society,⁷ together with the Local Authority Technical Advisors Group, has produced a framework for highways asset management. The Department recommends local transport authorities develop asset management plans consistent with that advice. Public Transport Enterprises and other transport authorities should consider the management of assets related to the transport system that they own (such as depots and bus facilities), even if they are not part of the public highway network.

⁵ Institution for Highways and Transportation, *Delivering Best Value in Highway Maintenance, Code of Practice for Maintenance Management*, Basildon Essex, England, July 2001.

⁶ Department for Transport, *Full Guidance on Local Transport Plans*, 2nd ed., London, England, Dec. 2004, accessed at http://www.dft.gov.uk/stellent/groups/dft_localtrans/documents/page/dft_localtrans_504005.hcsp.

⁷ The County Surveyors Society is described in Chapter 5.

“Moving into asset management is all about changing organizational culture.”

—LOCAL GOVERNMENT OFFICIAL, ENGLAND

The compilation of a TAMP will provide an authority with a tool to:

- *Support the corporate provision of detailed information on the assets held by the whole authority—enabling better definition of longer-term corporate need and continual challenge to asset holding/use;*
- *Establish and communicate a clear relationship between the program set out by the TAMP and the authority's LTP targets and objectives, and ensure existing assets are in a condition compatible with the delivery of the LTP;*
- *Obtain and organize information to support the forthcoming (2006) requirement for Whole Government Accounting (WGA);*
- *Enable the value for money of local road maintenance to be considered more effectively against other local transport spending, and eventually assist local transport strategy and plan production.*

Effective TAMPs will provide the means for authorities to understand the value and liability of their existing asset base and make the right strategic decisions to ensure this base is exploited to its full potential and its value safeguarded for future generations. Where appropriate the TAMP strategy should be coordinated with those of neighboring authorities—for example, where there may be benefits from the co-ordination of maintenance work on a particular corridor. In some cases it may be appropriate for TAMPs to make reference to infrastructure owned or operated by bodies other than the authority itself, where the transport benefits of such infrastructure depend on the good upkeep of related authority-owned assets.

Evidence about the quality of asset management within local transport authorities will form a component of the Department's assessment of provisional LTP quality. Although TAMPs are not required to be submitted with the provisional LTP, it should provide evidence that the development of a TAMP has informed the development of the LTP. Provisional LTPs should include a short summary of such evidence—the LTP TAMP report (a page or so from each contributing local authority should be sufficient in most cases).

This should set out the state of each local authority's progress

in developing an effective TAMP, what has already been achieved, and any remaining challenges. As well as detailing progress towards a whole-life maintenance plan for existing assets, the LTP TAMP report should cover briefly such issues as the ambition and realism of LTP asset management targets, the whole-life maintenance resource implications of the major and other integrated transport schemes proposed in their local transport plans, and the implications of any LTP proposals to delay or bring forward maintenance work. The TAMP report should aim to demonstrate that authorities are exploiting their existing asset bases to their fullest potential and managing future maintenance liabilities efficiently. The Department will consider the evidence in LTP TAMP reports before deciding whether to require further evidence in final March 2006 LTPs.”

Another law, the Traffic Management Act of 2004, gave local authorities responsibilities for traffic management on local roads.⁸ All local authorities are required to appoint a traffic manager and this appointment gives the local authority the ability to take over traffic enforcement from the local police. This act has provided the Highways Agency with improved liaison with local governments on transport matters.

Legislation and government policies relating to procurement have also influenced asset management procedures. Several major studies during the 1990s highlighted problems with traditional methods of procuring and managing major projects, especially the awarding of contracts solely on the basis of lowest price. The 1999 Gershon Report entitled *Efficiency in Civil Government Procurement* emphasized the benefits of privatized service delivery. The 2001 report of the National Audit Office entitled *Modernizing Construction* made recommendations on how to achieve sustainable improvements in construction performance, resulting in better value for the taxpayers' money. Recommendations were also made to government departments to develop more sophisticated performance measures and to measure improvements in construction performance.

Perhaps even more important in encouraging greater attention to asset management were Treasury guidelines on resource allocation and budgeting (RAB).⁹ RAB is a system of planning, controlling, and reporting on public spending. Issued in 1993, the guidelines were followed by a 1995 gov-

⁸ See, http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_026488-01.hcsp#P15_304.

⁹ Department of Treasury, *Managing Resources, Full Implementation of Resource Allocation and Budgeting*, London, England, July 2001, accessed at : http://www.hm-treasury.gov.uk/mediastore/otherfiles/rab30_03.pdf.

ernment white paper that committed to the use of resource accounting as the basis of public expenditure planning and control. Asset remaining useful life must be used to arrive at a current asset value, usually determined through straight-line depreciation. All local authorities have until 2006 to report their asset accounts in this format; the Highways Agency has already done so for 5 years.

In addition to the RAB requirements, the Treasury has adopted financial reporting requirements for local authorities wanting to debt finance infrastructure improvements, something that until recently has not been allowed. Known as the Chartered Institute of Public Finance and Accountancy (CIPFA) Prudential Code, this document states that local authorities wishing to borrow funds must “prove prudent stewardship of their assets,” and specifies that a fully developed asset management plan will satisfy this requirement.

Organization for Asset Management

The Highways Agency has defined successful asset management as consisting of several steps:

- Setting strategy and standards
- Recording the asset
- Identifying maintenance needs
- Prioritizing and managing maintenance needs
- Managing work programs and outcomes
- Influencing maintenance through design
- Measuring performance
- Innovating and developing

At the top management level, the Highways Agency’s Business Plan identifies the performance measures that reflect the different products and services to be delivered. Other more technical guidance on asset management is available for specific asset categories. For example, asset management for roads and structures is guided by documents entitled *Continuous Value Management Guide: Roads* and *Continuous Value Management Guide: Structures*.

As noted earlier, the Highways Agency relies on the MA and MAC to achieve a single-point responsibility for asset management and maintenance in the operating areas. Begun in 2001, this program requires the MA/MAC to use quality management systems and to self-certify compliance, thus reducing the level of supervision. The MAC can design and undertake all projects up to a value of £500,000 (US\$1 million). Performance specifications for routine and winter maintenance are included, along with annual targets to measure and benchmark performance and to achieve continuous improvement.

Decisionmaking Approach

Figure 1 (see following page) indicates how asset management occurs in the Highways Agency. The references inside the “databases” box are the different management information systems discussed below. Four key documents guide the decisionmaking process in the Highways Agency—the Corporate Strategic Plan, Business Plan, Balanced Scorecards, and Annual Report.¹⁰ Each has asset management elements incorporated into it, although in some cases not in very prominent ways. For example, one aim of the latest Business Plan (2005/2006) is maintaining of the road network at minimum whole life cost, with pavement condition being a key performance indicator. In addition to these corporate documents, the Highways Agency has a developed strategic plan for maintenance.

Pavement asset data are the most used in supporting agency decisionmaking. Uses of this data include calculating a road condition index, availability key performance indicator, and safety key performance indicator; developing the investment program; supporting a quieter surface program; defining budget allocations; and linking to the agency’s Web site for public information. Table 1 (see following page) shows how the pavement asset data are used to support information requirements.

Performance Measures

National law requires the adoption of performance indicators for all publicly supported services and functions. Given the emphasis on best value, the scan team was not surprised to find that the most important indicators were called Best-Value Performance Indicators (BVPIs). These high-level indicators, few in number, provide annual snapshots of performance for government-supported activities. For the transportation sector, the Department for Transport has made the following BVPIs mandatory for annual reporting by local authorities.¹¹

- Principal road condition
- Nonprincipal classified road condition
- Unclassified road condition
- Total killed and seriously injured casualties
- Child killed and seriously injured casualties
- Total slight casualties
- Public transport patronage—based on the BVPI related to total bus patronage, but authorities may adjust the indicator to include other local public transport modes
- Customer satisfaction with bus service
- Footway condition

Authorities are expected to develop additional indicators that they can use to guide specific aspects of their service delivery.

¹⁰ See, Highways Agency, http://www.highways.gov.uk/aboutus/corp_docs.htm.

¹¹ Highways Agency, Business Plan 2005/2006, see: http://www.highways.gov.uk/aboutus/corpdocs/bus_plan/2005_2006/.

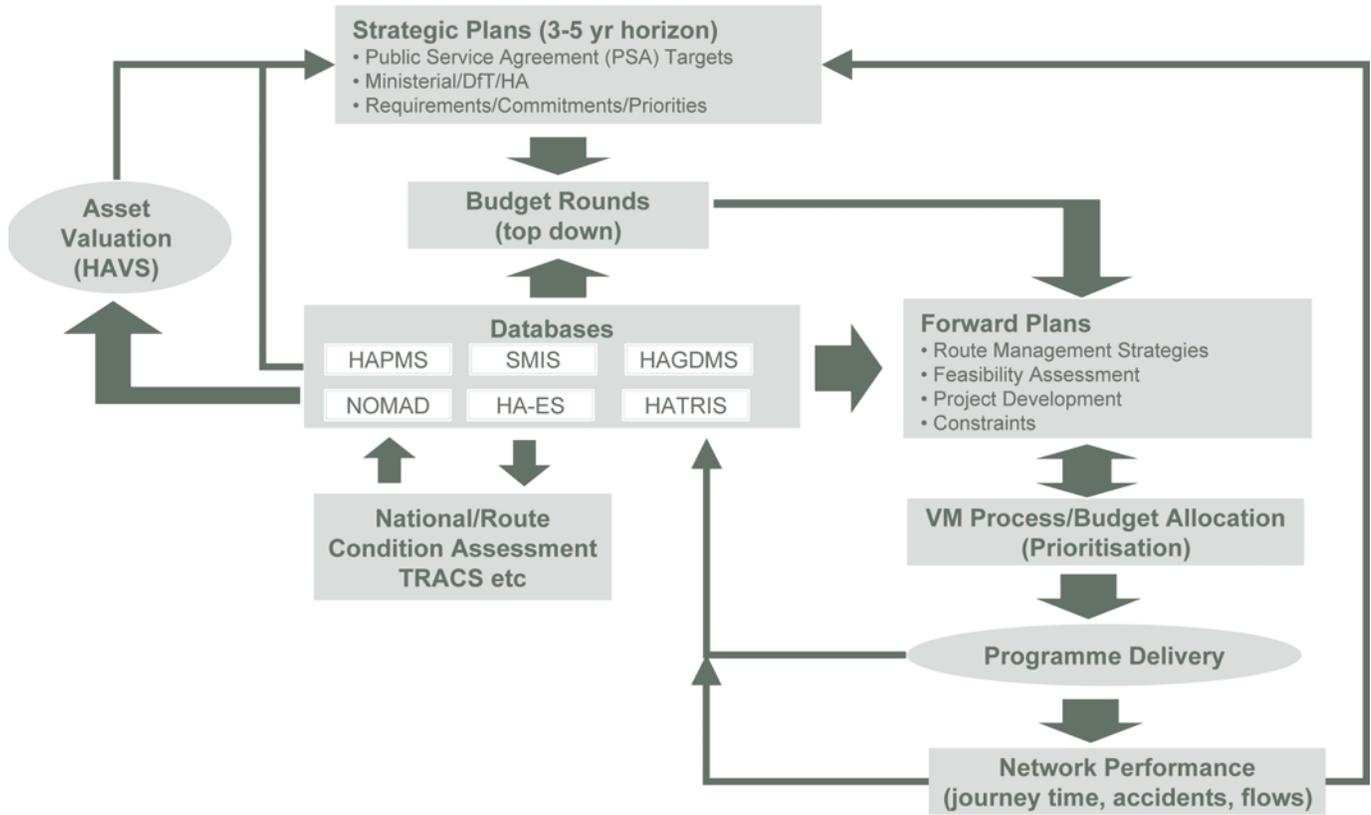


Figure 1. *Asset management practice in England's Highways Agency.*

Table 1. *Business uses of pavement asset data in England's Highways Agency.*

PAVEMENT ASSET DATA						
Information Requirement	Network	Inventory	Construction	Traffic	Lane Closures	Condition Data
Maintenance KPI	✓	✓	✓	✓		✓
Availability KPI	✓				✓	
Investment Program	✓		✓	✓	✓	
Asset Valuation	✓		✓	✓		✓
Quieter Surfacing Program	✓		✓			

KPI = Key performance indicator

“The best argument for asset management is that it provides service to the community in the most efficient way.”

—DEPARTMENT FOR TRANSPORT OFFICIAL

In the Highway Agency’s Business Plan, two measures relating to asset condition were reported as follows:

Measure	Target	Outcome Achieved
Estimated proportion of the network likely to require maintenance in the next year	7% and 8% (2000/01–2003/04)	7.9% (2003/04)
For safety, road surface condition index	100 ± 1 2005-2006 100 ± 1 2005-2006 100 ± 1 2006-2007 100 ± 1 2007-2008	99.4%

For the safety measure, the road surface condition index is based on surveys covering rutting, paved surface unevenness, cracking, and skid resistance.

The Highways Agency is also developing performance indicators for structures, some of which are still in the early stages of development. These indicators include the following:

- Condition—a measure of the physical condition of the structures stock
- Availability—a measure of the reduction in the service level provided on the network because of restrictions on structures, including long-term and temporary works restrictions
- Reliability—a representation of the ability of the structures stock to support traffic and other appropriate loading, taking into account the consequence of failure
- Structures Workbank—the cumulative cost of all work identified for and arising from inspections, assessments, and other needs

There was a sense among Highways Agency officials that the agency might be moving toward a composite, or what they termed an “amalgam,” asset management performance measure within the next several years.

The team noted some tension in the Highways Agency between goals to reduce congestion and maintain infrastructure. Given the political interest in showing progress toward congestion reduction, the natural tendency is to structure planning and performance dissemination around this goal. However, the need to maintain infrastructure not

only requires substantial funding, but also contributes to traffic congestion when projects are underway. It will be interesting to see how this tension between the two agency goals will play out in coming years, because it is a tension that many U.S. transportation agencies also face.

The performance measures local authorities use as part of their transport plan updates (which include asset management strategies) must be quantifiable and measurable targets. An example of this is found in highway lighting management. A group called the Roads Liaison Group developed a *Code of Practice for Highway Lighting Management* (November 2004), which recommended that local authorities use national performance indicators in their asset management efforts, but develop others more relevant to their own situation. As noted in this report, two main categories of performance indicators should be considered:¹²

1. Internal management information to monitor and control service delivery (it is not expected that this information will be published)
 - a. Average time to identify a fault
 - b. Number of actual patrols completed
 - c. Average time from identification of fault to issue of instruction for repair
 - d. Time from instruction to completion of fault repair
 - e. Percentage of return visits
 - f. Number of callouts to emergencies
 - g. For training, time from instruction to completion
2. To publish in the public domain (including reporting to the national government)
 - a. Total number of faults identified by:
 - i. Authority patrol
 - ii. Public reporting
 - iii. Other reports
 - b. Percentage of lights working as planned
 - c. Total number of failed or faulty service connections
 - d. Total number and cost of incidents of:
 - i. Vandalism/willful damage
 - ii. Vehicular impact.

Asset Management Information Systems

Historically, management information systems in the Highways Agency have been developed independently for all assets. The Highways Agency Pavement Management System (HAPMS) has been under development since 1998, and has cost about

¹² Roads Liaison Group and UK Lighting Board, *Well-lit Highways Code of Practice for Highway Lighting Management*, November 2004, found at: http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_037869.pdf.

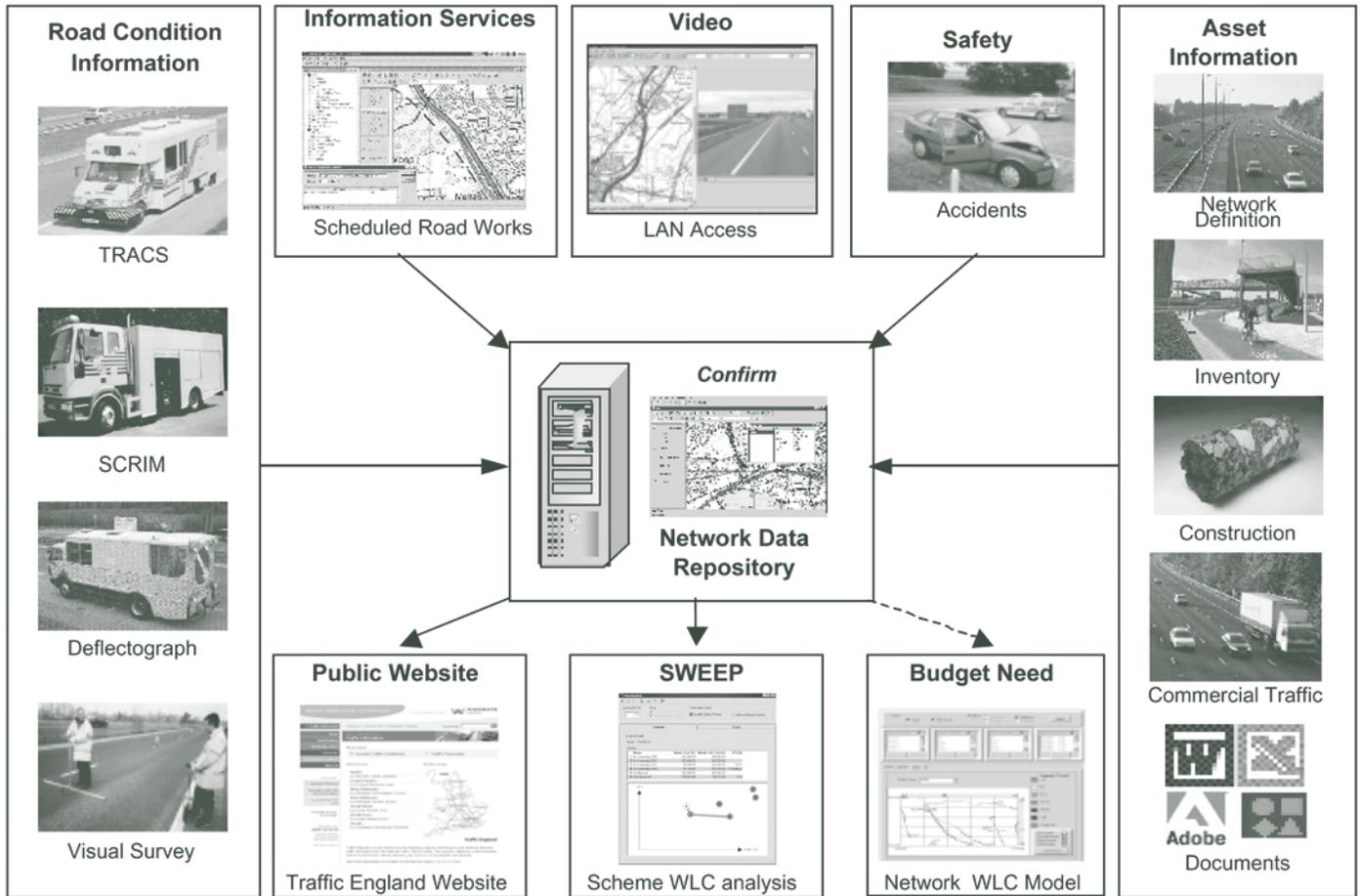


Figure 2. *Highways Agency Pavement Management System (HAPMS).*

US\$3.5 million per year (not including data collection) to develop. As figure 2 shows, HAPMS receives data from a variety of sources and provides outputs to a public Web site, a program investment development tool, and budget analysis. SWEEP in this figure stands for Software for Whole-of-life Economic Evaluation for Pavements, a tool that can be used to establish priorities for pavement investment strategies. Members of the Highways Agency and its transportation partners can access HAPMS.

Although not developed solely by the department for transportation purposes, a United Kingdom Pavement Management System (UKPMS) has been evolving over the past 15 to 18 years for use on local roads. In U.S. terms, UKPMS is an architecture for pavement management systems that suggests functionalities and characteristics, but does not mandate specific vendors or software systems. UKPMS has standard techniques for condition assessment and inventory, and provides facilities for recording inventory, assessing the condition of paved assets, and costing and prioritizing potential projects works on condition and economic factors. The

Department for Transport has been strongly encouraging local authorities to adopt UKPMS as the framework for their pavement management systems. To date, vendors of five pavement management systems have been accredited as meeting UKPMS conditions. The Highways Agency's pavement management system has not been assessed against the system architecture requirements.

The Highways Agency also has a Structures Management Information System (SMIS), a repository of condition data for all structures on the national network. Not surprisingly, given the age of England's bridges and the history associated with innovations in bridge design emanating from England, many bridges are considered "heritage" bridges, requiring special handling. For example, 60 percent of the bridges in Northumberland, located in northern England, are heritage bridges.

Other asset management systems that provide information to the decisionmaking process include HAGDMS, a geotechnical/slopes database; HATRIS, a traffic information system;

HA-ES, an environmental management system; and NOMAD, a technology equipment database.

Figure 3 shows Highways Agency's current thinking on a desired direction for an agency-wide infrastructure asset management system. As the figure shows, this desired structure includes closer integration of the different databases and a strong linkage to strategic management. The databases used as the traditional support systems for engineering decisionmaking remain as the foundation for future activities (the lower level in the triangle). However, the agency envisions new management systems to aggregate this data and to produce information for use in performance reporting and monitoring and ultimately in strategic management activities. In addition, several Highways Agency officials noted that a major focus of agency attention is on traveler information, which in figure 3 is a major recipient of the data stored in the databases.

The previously mentioned *Code of Practice for Highway Lighting Management* recommends that local authorities develop and operate detailed asset management systems of their public lighting stock to do the following:

- Assist in the effective maintenance management of the

assets in accordance with the authority's defined maintenance strategy.

- Enable appropriate risk assessment strategies to be formulated.
- Facilitate the purchase of electricity for unmetered equipment.

Fault and repair histories, together with the results of inspections and electrical and structural testing, were recommended to determine future asset replacement programs. The types of management information that would come from such a system include analysis of trends, identification of recurring faults and specific component failure, monitoring of response times, and a spatial distribution analysis to determine if some parts of a jurisdiction are experiencing unusual amounts of maintenance trouble.

Data Collection

Highways Agency staff members played an instrumental part in developing a data management guide for an organization called the Western European Road Directors (WERD). Much of what is in this guide reflects the philosophy of the Highways Agency on a data-collection strategy for asset management. For example, the seven steps to successful data management were described as 1) determine business

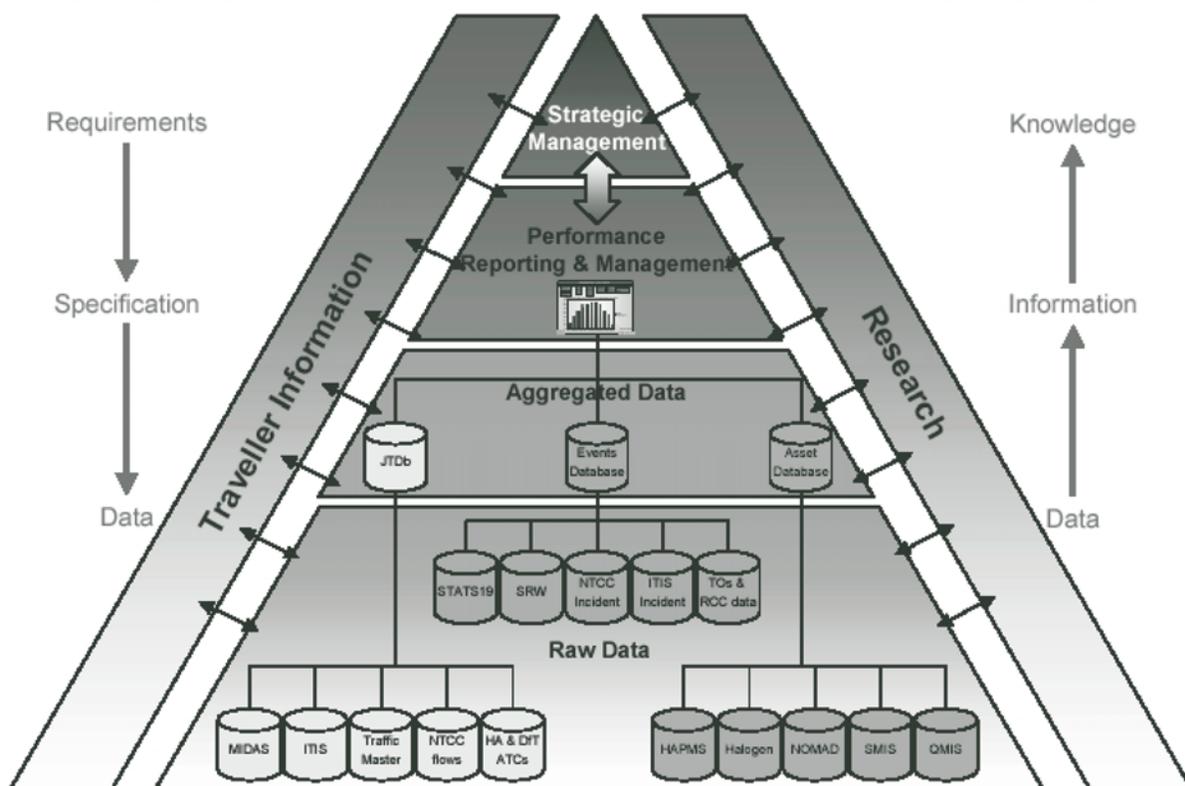


Figure 3. *Desired structure of a future asset management system for the Highways Agency.*

“We had bags of data, but not much information.”

—MAINTENANCE CONCESSIONAIRE

information needs, 2) review current situation, 3) analyze data, 4) design a data management regime, 5) develop an implementation plan, 6) establish a data management organizational structure, and 7) continually review and improve the strategy.

Much of the data collected as part of HAPMS relates to pavement condition, which has evolved over the past 30 years, as the following time line shows:

- 1977 Manual visual surface assessment (using 100 meter segments)
- 1984 Slow-speed machine structural assessment
- 1988 Medium-speed skidding assessment
- 1990 High-speed surface assessment
- 1998 First generation stand-alone integrated database
- 2001 Second generation desktop delivery

The types of data collection that occur in many local authorities include the following (taken from the instructions for the UKPMS):

1. **Coarse Visual Inspection**—Coarse Visual Inspection (CVI) is usually carried out from a slow-moving vehicle or by walking (often the mode of operation for local governments), and allows a large part of a highway authority's road network to be assessed each year. As the name implies, this inspection is conducted visually with teams of inspectors subjectively rating asset condition. This visual survey provides data to produce BVPIs on the condition of local authorities' roads.
2. **Detailed Visual Inspection**—Detailed Visual Inspection (DVI) is a more comprehensive survey, with defects identified by a larger number of more detailed classifications. DVI is a walking survey that is typically targeted at lengths already identified as defective and potentially in need of treatment by the CVI or some other information source. DVI records areas or lengths for a wider range of more closely defined defects. The defects collected for DVI are generally defined at a closer level of detail than found in CVI. DVI is used where more detailed information is required to support and validate treatment decisions and scheme identification.
3. **SCANNER Surveys**—SCANNER surveys are high-speed surface condition surveys on local roads based on the Highways Agency TRAFFIC-speed Condition Surveys (TRACS) consultant contract for national roads. SCANNER collects the following data:
 - 3-D spatial coordinates
 - Road geometry
 - Survey speed
 - Longitudinal profile

- Wheelpath rutting
- Texture profile
- Cracking

Measures of edge condition and overall transverse unevenness are being developed. Similar vehicles are used for SCANNER and TRACS surveys. The TRACS vehicle is capable of traveling at speeds of up to 70 kilometers per hour (km/h) and through the use of video cameras and laser sensors can detect cracks and measure ruts on the road surface.

4. **SCRIM**—The Sideway-Force Coefficient Routine Investigation Machine (SCRIM) was introduced in the early 1970s to provide a method of measuring the skidding resistance of wet pavements. The normal testing speed for the machine is 50 kilometers per hour (km/h), and skidding resistance values for the nearside wheel track only (usually the location of the lowest skidding resistance) are generally recorded as the average for each 10-meter (m) (10.9-yard (yd)) section. SCRIM surveys make use of functional defects, which in essence serve as triggering thresholds that prompt treatment if they are below the target value and can be shown to have contributed to an increase in the number of accidents.
5. **Deflectograph**—The deflectograph is used to assess the structural condition of flexible and flexible composite pavements. As a loaded wheel passes over the pavement, the pavement deflects, and the size of the deflection is related to the strength of the pavement layers and subgrade. Measurements of deflection are taken at approximately 3-m (3.3-yd) intervals in both wheelpaths while the machine is in motion. The Highways Agency has recently purchased a high-speed deflectograph from Denmark that will allow network data collection of pavement strength at traffic speeds.
6. **Machine-Measured Rutting**—Although it is possible to assess wheel track rutting manually, where SCANNER surveys are not used the preferred option is to measure rutting using machine-based technologies, either as part of a CVI survey or as a separate rut survey. Two special survey types of machines have been created that can support the collection of such data with visual surveys.

The above data-collection tools are primarily for road condition. The Highways Agency has received some criticism for not having data on several other asset types, such as light columns and drainage. Accordingly, the 2007/2008 target year for the agency's Business Plan has a goal of completing an inventory and condition record of all asset categories under the agency's responsibility.

“We used the term ‘optimize’ to mean obtaining the most economically efficient answer . . . however, given the broad reach of asset management, ‘optimize’ means supporting decisions with facts.”

—LOCAL OFFICIAL

Analysis Procedures and Prioritization

Similar to data collection, the analysis and prioritization approaches used in the Highways Agency have evolved over the past 30 years. For establishing priorities, this evolution has included the following:

- 1977–2000 Stand-alone condition-based trigger criteria
- 2000–2004 Whole-life cost spreadsheet
- 2005 + Integrated whole-life costing module in HAPMS

Project prioritization also includes identifying and managing risks associated with the road network. The prioritization process involves using a risk matrix in which projects or project types are assigned a score. Figure 4 illustrates the use of risk in assigning priorities to projects pertaining to bridges and other structures.¹³ As shown, each box in the figure relates to a probability of failure occurring for a specific reason, with higher likelihood of failure resulting in greater attention in the investment program. Probabilities are found in look-up tables in a Highways Agency manual. For example, the likelihood of a risk event can be calculated as the following:

$$L(\text{Risk Event}) = L(\text{Cause}) \times L(\text{Defect}) \times L(\text{Exposure}) \times L(\text{Effect})$$

where L stands for likelihood. Assume that the table 2 serves as the source of likelihood values (in reality, there would be separate tables for different components of the process in figure 5). For a particular project, it has been determined that the likelihood of cause is high (0.85), the likelihood of defect is medium (0.50), the likelihood of exposure is low (0.15), and the likelihood of effect is high (0.85). The risk associated with this project is thus estimated as the following:

$$L(\text{Risk Event}) = 0.85 \times 0.50 \times 0.15 \times 0.85 = 0.054$$

By conducting a similar assessment for all structures projects, one can identify the projects that pose the highest risk of failure and allocate funds to solve the most serious problems.

Table 3 (see page 16) is a scoring matrix used by managing agents and Highways Agency personnel to assign priorities to road maintenance projects. Value management workshops, which include participation from project sponsors, contract agents, specialists on pavement treatments, and Highways Agency program development staff, are used to review the

scores the managing agent has assigned to each project. Projects are classified as “committed,” “unavoidable,” or “desirable.” Each project must be analyzed with the software program SWEEP (the Incremental Economic Indicator (IEI) and user costs shown in table 3 are calculated with this software package). Base conditions are analyzed as well as future whole-of-life treatments over a 60-year analysis period. SWEEP will calculate the project cost (including traffic management costs) of each treatment option, as well as the associated user costs. The result of this analysis is a 4-year program of investment.

For asset valuation, the whole-of-government accounting approach requires valuation of the asset base (inventories needed), and depreciation (condition of asset needed). In renewals accounting, on the other hand, deterioration is based on condition change and differences from required

Likelihood Rating	Description	Range of Likelihood Values	Midpoint Values
Certain	Certainty	1.0	–
High	Highly likely	0.7–0.99	0.85
Medium	Likely	0.3–0.69	0.50
Low	Possible, but not likely	0.0–0.29	0.15

Table 2. Values for calculating likelihood of risk events.



Figure 4. Similar to other countries, England has significant challenges maintaining the condition of historic bridges.

¹³ Highways Agency, *Value Management of the Structures Renewal Program*, London, England, Oct. 2004.

levels of service. In England, valuations are required of all assets by 2006/07 and renewals accounting by 2007/08. The Highways Agency's road network is professionally valued every 5 years, using equivalent replacement cost. Depreciation is calculated, taking into account the condition of the network. Estimates based on inflation and construction cost indices are used to calculate values for in-between years. Renewals accounting is used for assets that meet the renewals criteria.

The Highways Agency has also adopted a policy to examine maintenance requirements during the project design phase to see if the design can be changed to lower the life cycle costs of the project. As an example of this, the Highways Agency has published a design standard for fiber-reinforced polymer (FRP) bridge decks that offer lower life cycle cost designs.

Asset Management at Network Rail

The extensive passenger transportation system in England afforded the opportunity to examine the asset management practices of other transportation modes. One of these modes was Network Rail, the owner of the rail infrastructure in England. (Rail operators pay Network Rail to use the rail network.) Network Rail is responsible for an extensive asset inventory, not the least of which is 40,000 rail bridges. The asset management process is guided by engineering policies that indicate required condition levels and acceptable performance ranges. About 300 inspectors examine the network each year, with one-sixth of the network subject to a detailed inspection and the remaining five-sixths undergoing visual inspection.

Network Rail has developed a costing model called Structures Annual Cost Profile (SACP) for use in policy development and regulatory review. In addition, a Structures Condition Marking Index (SCMI) is used for bridges, tunnels, retaining walls, culverts, and earthworks to assign priorities. Data are incorporated into a Structures Asset Management Program (STAMP), which is based on whole-life costing procedures. The STAMP rates assets on a score of 1 to 100, where each asset element is weighted from 1 to 10 and defect severity and extent also are rated from 1 to 10. Figure 6 shows the type of information that can be produced from the asset management program.

Network Rail also uses STAMP to assess the policy implications of different scenarios. For example, three scenarios used in a recent study include the following:

1. Return and maintain the stock to steady state using maintenance activities that will improve performance levels and the remaining life of existing assets.
2. Allow structures to deteriorate until repairs or replacements are essential to maintain operational requirements. At the time of intervention, carry out interventions that achieve lowest long-term costs for structures.

3. Allow structures to deteriorate until intervention is essential to maintain safety standards or raise performance to an acceptable level.

Observations

The Highways Agency is similar to many transportation agencies in the United States, facing important challenges not only with asset condition, but also significant political pressures to alleviate congestion. This has created tension between the two goals in terms of service delivery.

Several aspects of England's approach to asset management merit special attention. As in other cases, England seems to be ahead of most U.S. agencies in applying performance measures to asset management as well as other transportation goals. Performance measures or best-value performance indicators are found at all levels of government and provide consistency in the type of information produced at the national, regional, and local levels. This observation is not surprising, given that national legislation and government policy have encouraged this consistency for many years. An example of this consistency is found in the government policy of reducing the maintenance backlog by 2010; such a performance measure was found in plans at all levels of government.

Much of the road network service delivery in England is done with private contractors. The performance orientation and reporting of best-value performance indicators are found in these contracts as well. In addition, national policy has strongly encouraged the use of privately financed services to reduce the maintenance backlog, with the national government providing funding to pay for the first 5 years of such an approach to maintenance with an agreement for local government support thereafter.

England also appears much more concerned about some types of transport assets that receive less attention in the United States. For example, a great deal of attention has been paid over the past several years to the condition of streetlights. A deterioration model is being developed that will allow transportation agencies to prioritize investments for this asset. Similarly, more attention appears to be given to appurtenances and footpaths/sidewalks than is typical in the United States.

The Highways Agency is investing in new technologies for more efficiently collecting condition data critical to asset management decisions. An example of this is the high-speed deflectograph vehicle recently purchased from Denmark. Asset valuation is based on depreciated values, which are calculated with a straight-line depreciation method. Starting in 2007/2008, the Treasury will require a renewals approach to

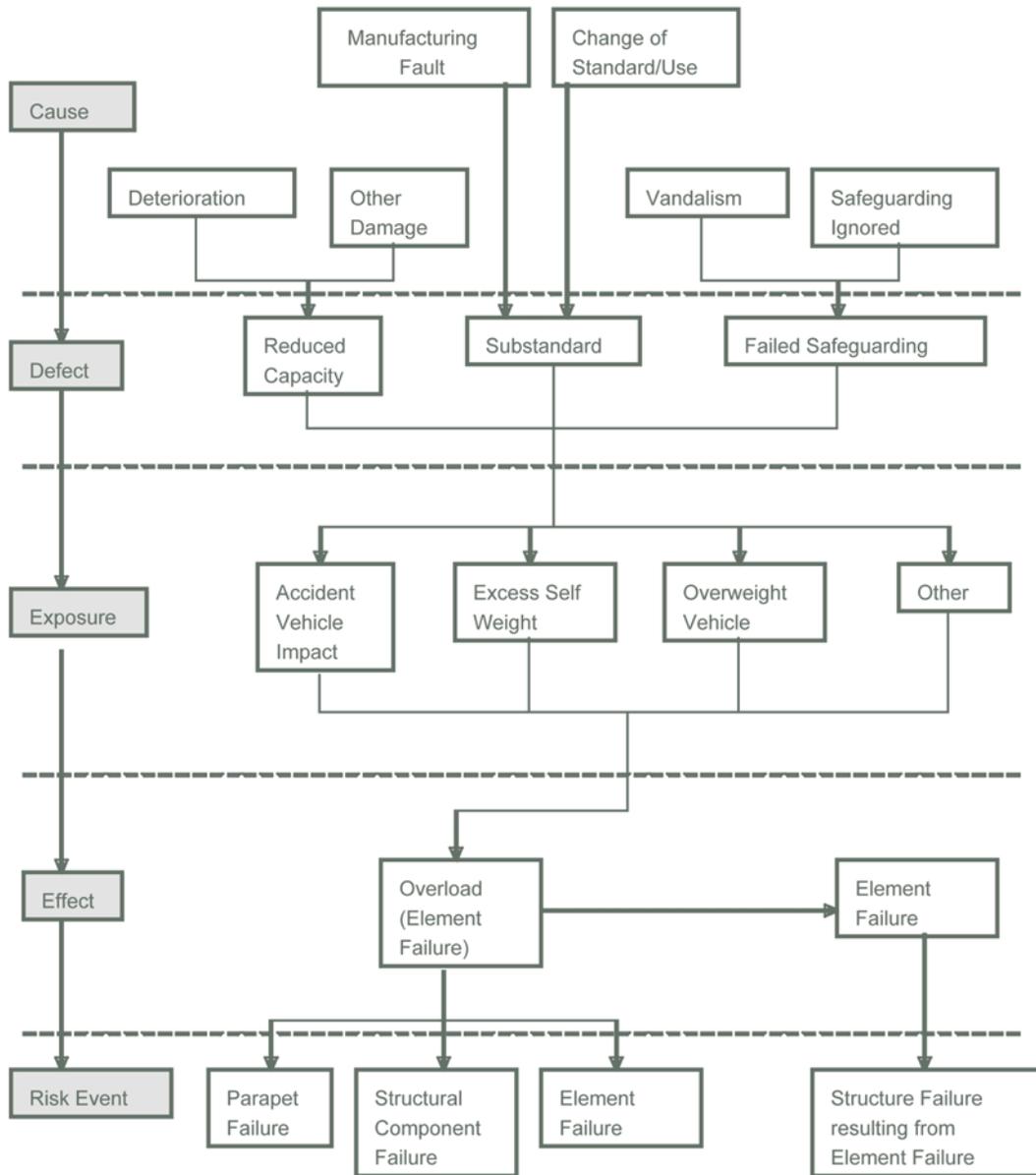


Figure 5. Calculation of risk of failure for structures in England.

asset value, which depends on asset management as a means of determining asset remaining useful life.

Local government and professional association involvement in supporting asset management is quite impressive. Similar to New Zealand (see next case), an association of asset management professionals and local officials has become very important in providing technical information on asset management. The documents it has produced are basic references on the subject, and the most influential document, *A Framework for Highway Asset Management*, has laid out the fundamental structure for asset management that all

levels of government appear to follow. Another group, the Roads Liaison Group, has produced codes of practice that guide local asset management formulation and decisionmaking.

Finally, the concept of an asset manager as a professional job appears to be evolving in England. Several regional and local groups market jobs this way, or have attached asset management as a responsibility to the more traditional civil engineering job description. It will be interesting to follow this development for its impact on human resource development strategies and university transportation programs.

Table 3. Value management scoring framework for maintenance projects in England.¹⁴

		Safety (0.2)	Value for money (0.3)	Reduction of disruption (0.4)	Environment (0.1)
80-100	Fully justified	Substantial deficiencies and linked high accident rating, supported by analysis	Proposed option is appropriate for the defects and has an IEI > 5.0 compared to “do minimum” option	Reduction of user costs > 50% relative to “do minimum” option	Projects will have a strong positive impact on a significant and clearly defined environmental problem
50-79	Good justification	Moderate deficiencies and linked, above average accident rating, supported by analysis OR substantial deficiencies and average accident rating	Proposed option is appropriate for the defects and has an IEI > 2.5 and ≤ 5.0 compared to “do minimum” option	Reduction of user costs > 25% and ≤ 50% relative to “do minimum” option	Projects will have a moderate positive effect on a significant and clearly defined environmental problem
30-49	Moderate justification	Moderate deficiencies and linked, average accident rating, OR substantial deficiencies and low accident rating	Proposed option is appropriate for the defects and has an IEI > 1.0 and ≤ 2.5 compared to “do minimum” option	Reduction of user costs > 10% and ≤ 25% relative to “do minimum” option	Projects will have a slight positive effect on an identified environmental problem
10-29	Poor justification	Slight deficiencies and average accident rating OR moderate deficiencies and low accident rating	Proposed option is questionable for the defects and/or has an IEI > 0.4 and ≤ 1.0 compared to “do minimum” option	Reduction of user costs > 0% and ≤ 10% relative to “do minimum” option	Projects are expected to have a neutral effect on the environment
0-9	No justification	Slight deficiencies and low accident rating, OR no deficiencies—Project will have neutral effect on safety	Proposed option is unnecessary or inappropriate and/or has an IEI ≤ 0.4 compared to “do minimum” option	Reduction of user costs ≤ 0% relative to “do minimum” option	Projects are likely to have a negative impact on the environment

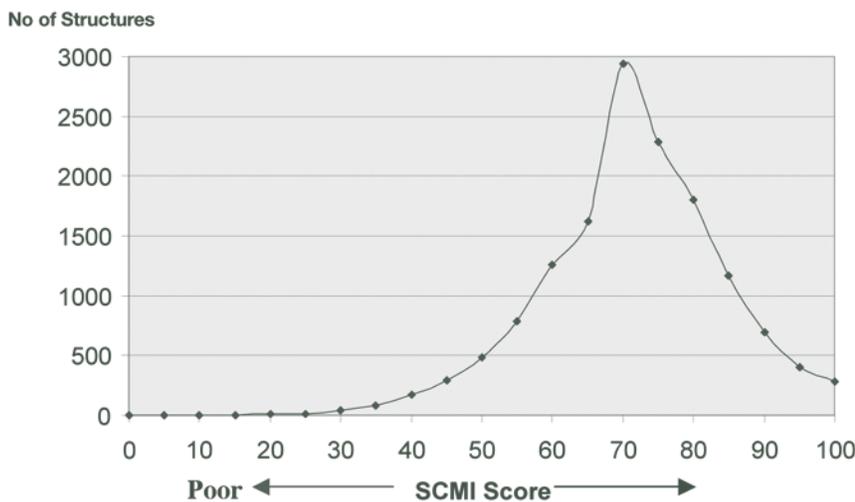


Figure 6. Bridge condition distribution, Network Rail, England.

¹⁴ Highways Agency, *Value Management of the Regional Roads Programme*, London: England, March 2005.

NEW ZEALAND

Transit New Zealand—www.transit.govt.nz

Context

New Zealand has been a world leader in many aspects of road network management. In asset management, New Zealand has implemented innovative performance-based maintenance contracts, established a performance-oriented asset management decisionmaking structure, and is the home of one of the most active local government and professional association-supported programs for furthering asset management goals.

Two national agencies have primary responsibility for New Zealand's transportation system (see figure 7). Transit New Zealand (Transit NZ)¹⁵ manages a 10,836-km (6,733-mi) national road network, constituting 11.5 percent of the length of New Zealand's roads. This national road network handles about 50 percent of the total vehicle-kilometers traveled each year in the country. Land Transport New Zealand (Land Transport NZ) funds police, safety programs, and public transportation. Transfund, part of Land Transport NZ, is the major source of funds for highway investment and a critical player in establishing transport priorities. According to New Zealand's Transport Strategy, Land Transport NZ's focus in its investment is on "improving system management, promoting alternative modes of transport, reducing reliance on motor vehicles, improving energy efficiency, and reducing adverse effects of transportation system use."¹⁶

Both agencies operate under national legislation that emphasizes not only an important role for transportation in moving people and goods, but also the critical linkages between transportation system performance and other national goals. For example, a recent law required government agencies to reexamine their operations to determine how they can better create a sustainable New Zealand. As a consequence, Transit NZ has adopted a mission statement that states that its responsibility is "to operate the state highway system in a way that contributes to an integrated, safe, responsive and sustainable land transport system."¹⁷

It is important to note that the transportation agencies in New Zealand compete with other nongovernmental programs for resources (except for revenues dedicated to transportation). This whole-of-government context places even greater importance on transportation agencies to justify their funding requests.

Transit NZ officials identified several challenges facing the country's transportation system. New Zealand faces increasing growth on the transportation system that far outpaces the addition of new capacity, both in passenger and freight movement. This is especially true in Auckland, the country's largest metropolitan area. In addition, the pavement replacement schedule is not meeting deterioration rates, and Transit NZ has found that some structures are not lasting as long as expected. The country also faces shortages in professional staff and construction/maintenance resources (all system operations and maintenance are outsourced to private firms).

Officials also stated that New Zealand has been fortunate that its pioneering history was based on lightweight and temporary construction, which ingrained a maintenance-first mentality into the culture. However, the officials admitted that it is becoming more difficult to convince elected officials of the desirability of this philosophy in light of demands for new infrastructure to match the rapidly escalating demand.

Drivers for Asset Management

Asset management has occurred in New Zealand for several reasons. First, a national law requires all government agencies to value the national assets under their jurisdiction. For the national highway network, the required valuation outputs are the replacement cost and depreciated value of the network. These are estimated annually on a regional basis with the results aggregated to a national total for the state highway network.

Second, the stewardship mentality found in great abundance in New Zealand for its natural resources is also found in the governmental perspective on its responsibilities to the people of New Zealand. Maintaining a functioning transportation system at desired levels of service is part of the governmental ethic guiding planning and decisionmaking. An asset management program was considered part of the management support structure that would achieve such stewardship. The Land Transportation Management Act of 2004 has also added a new twist to this stewardship role. By adding sustainability

Infrastructure Managed

- 10,836 km (6,733 mi) of paved road
- 2,600 bridges
- 16 timber bridges
- 1,400 culverts greater than 2 m in diameter
- 158,800 signs
- 37,000 street lights
- 7 tunnels

¹⁵ Note that the word "transit" in this case does not mean public transportation; Transit New Zealand is the agency responsible for the national strategic road network in New Zealand.

¹⁶ See <http://www.beehive.govt.nz/nzts/downloads.cfm>.

¹⁷ See http://www.transit.govt.nz/about_transit/index.jsp.

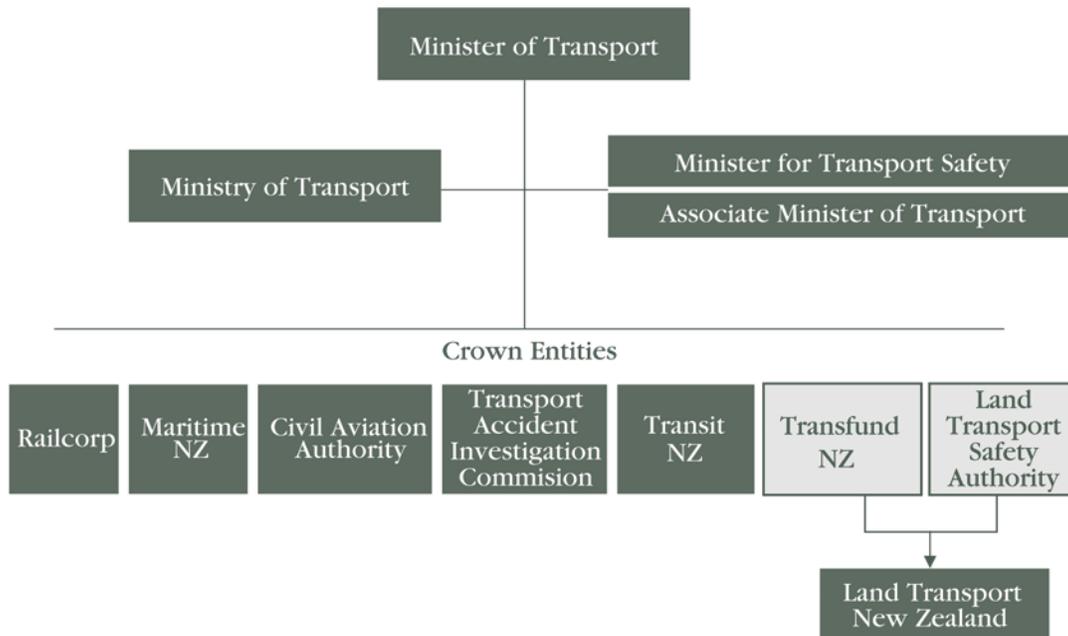


Figure 7. *Organizational structure for transportation in New Zealand.*

to Transit NZ’s objectives, asset management takes on an environmental quality element as well. The objectives are as follows:

- Ensure state highway corridors make the optimum contribution to an **integrated** multimodal land transport system.
- Provide **safe** state highway corridors for all users and affected communities.
- State highways will enable improved and more reliable **access and mobility** for people and freight.
- Improve the contribution of state highways to **economic** development.
- Improve the contribution of state highways to the **environmental and social** well-being of New Zealand, including **energy** efficiency and public **health**.

Third, given that maintenance activities on the national road network have been privatized, Transit NZ realized that managing this type of program delivery, and in particular determining the right mix of activities, required good information on the performance and condition of the network. About two-thirds of these 5- to 10-year contracts are performance based. This strategic program perspective has led to increased interest in a comprehensive asset management effort.

A final driver for asset management in New Zealand is a consortium of national and local government associations and consultants called the National Asset Management

Steering committee (NAMS), which was formed in 1995 to champion asset management. This group has played an important role in fostering improvements to asset management practice in New Zealand and through its publications in other parts of the world (see Chapter 5 for more discussion of NAMS).

Organization for Asset Management

Transit NZ is organized into four major groups/divisions, an organizational structure replicated in the regional offices—transport planning, network operations (where the asset management responsibility lies), capital projects, and organizational support. Within this structure, the agency has defined different job positions with asset management responsibilities. About 50 people nationwide have responsibility for asset management, including those in Transit NZ’s regional offices. Appendix C includes three job descriptions for asset management-related positions.

One of the scan team’s important observations on how asset management is organized in New Zealand is that it is part of the strategic planning, performance monitoring, and accountability structure established in all levels of government. Transit NZ and Land Transport New Zealand, for example, follow asset management guidance found in numerous plans, manuals, and statements of policy. The New Zealand case, perhaps more than any others, showed

a much higher level of integration of asset management concepts and principles into the day-to-day activities of the transportation organizations.

Reliance on outsourced maintenance service delivery also has had an impact on Transit NZ. Initially, the philosophy was that outsourcing allowed the client to significantly downsize and downskill. Perhaps inevitably, this has been found not to be so and Transit has had to rebuild the skill base, but for different functions (specifying performance, auditing, and interacting with its suppliers to achieve better outcomes). Overall, the human resources required to deliver the total package has been significantly reduced.

Contractors are required to maintain their own performance audit systems (open to review by Transit NZ); Transit NZ audits about 5 percent of the network to assure quality performance. If the performance is acceptable, determined at regular (at least annual) reviews, the contractor is provided first right of refusal for all work within his network up to a project value of some NZ\$400,000 (US\$280,000). This is a relaxation of normal competitive pricing rules to gain efficiencies of an established contractor who knows the network, has a team in place, and can offer good prices on the basis that it has up to 10 years' work secured through the maintenance contract. Eligible contractors usually end up undertaking all of the minor capital works projects in their network as well as the maintenance activities outside of the lump-sum maintenance contract (for example, major drainage work). All contractors are expected to be ISO 9000, or equivalently, certified. Each region also has a consultant contract to help monitor and supervise service delivery either within the contractor team for 10-year contracts or employed by Transit New Zealand for 5-year contracts.

The human resource element is another important aspect of organizing for asset management. Transit NZ conducts an annual asset management workshop, holds training seminars when new approaches or policies occur, supports conferences and technology seminars, and participates in local asset management forums with 72 local authorities. Regional network operational managers meet every 2 to 3 months to exchange information and experiences. Even more impressive are the activities of various local governments and professional organizations in furthering asset management principles. This is discussed in further detail in Chapter 5.

Transit NZ is also a major participant in the research efforts of Austroads, the association of Australian and New Zealand road transport and traffic authorities, as they relate to asset

management. This research focuses on pavement failures, levels of service, and cost models.

Decisionmaking Approach

Decisionmaking in the New Zealand transportation agencies is guided by several tiers of planning activities conducted annually.¹⁸ At the strategic level, agencies must prepare a statement of intent that identifies proposed investment activities over 3 years, including how such investment will achieve performance targets. Each agency also has a strategic plan, updated every year, that links adopted transportation goals to key result areas and agency activities. A national state highway strategy defines the capital and preservation strategies that will be used to meet adopted goals and performance targets. A network statement is also prepared for each of 25 contract areas that includes the following information on each infrastructure network: network description, overview of condition, issues/goals, performance measures and triple bottom-line reporting, asset management practices and strategies, current contractual commitments for maintenance, safety impacts, performance targets, a 10-year works program based on modeling (including pavement deterioration), and a description of any new initiatives. Performance agreements are also signed between the agencies and the responsible party (in this case, the Minister of Transport) that spell out how performance will be measured in the coming year.

At the more tactical level, network annual plans (again for the 25 contract areas) are prepared. (Regional networks range from 200 km (124 mi) to 700 km (435 mi) long). These annual plans are aggregated to form a national operate-and-maintain plan. These annual plans, based on levels of service, include funding requests; demonstrate delivery/historic trends, network condition, and future strategies; and provide justification for investment (for maintenance, this is often linked to the national asset management plan discussed below). Levels of service are defined by road type, usually tied to volume, (e.g., greater than 10,000 vehicles a day, 10,000 to 4,000 vehicles a day, 1,000 to 4,000 vehicles a day, and less than 1,000 vehicles a day). Every asset has associated level-of-service measures. If the budget for a particular asset category is cut, these level-of-service measures are revisited.

Most important from the perspective of asset management, Transit NZ uses a National Asset Management Plan (AMP) to guide transportation asset-related planning and resource allocation decisions (the latest version was in draft form at the time of the scan team's visit). This plan is instrumental in establishing the process and substance of asset management at the national level in New Zealand. Figure 8 shows the asset management process described in this plan. The AMP is

¹⁸ See the following website for copies of Transit New Zealand's publications, <http://www.transit.govt.nz/news/index.jsp>

organized in the following sections:

- Introduction and plan objectives
- Levels of service and performance standards
- Asset management business practices
- Asset portfolio description (inventory, condition, and performance)
- Future demand and growth
- Risk management
- Life cycle management, operations, maintenance, renewals, capital, and disposals (at the structural and corridor levels)
- Financial summary (cash-flow forecasts and valuation and decline in service potential forecasts)
- Plan improvement, review, and monitoring

The draft national operate-and-maintain plan to meet agreed levels of service is discussed and negotiated with Land Transport NZ. The effects of funding less than what the draft plan requires are discussed. The final funding reflects the balance between available funding and the need to maintain service levels. Land Transport NZ is also the source of funds

for police and public transport activities, so the existence of the asset management plan is viewed as an important basis for justifying budget requests.

Transit NZ is also incorporating asset management concepts into other activities and planning efforts. For example, given the government's emphasis on sustainability, Transit NZ has developed a new agency environmental plan, which is closely integrated with asset management. The types of asset management activities included in this plan are as follows:

- Recycling and reusing resources to reduce waste
- Adopting noise standards for routine maintenance works
- Using noise-reducing surfaces
- Using noise, water, and landscaping retrofitting as funding allows
- Experimenting with low-growth roadside grass species
- Reporting on environmental performance
- Working with suppliers to improve environmental performance

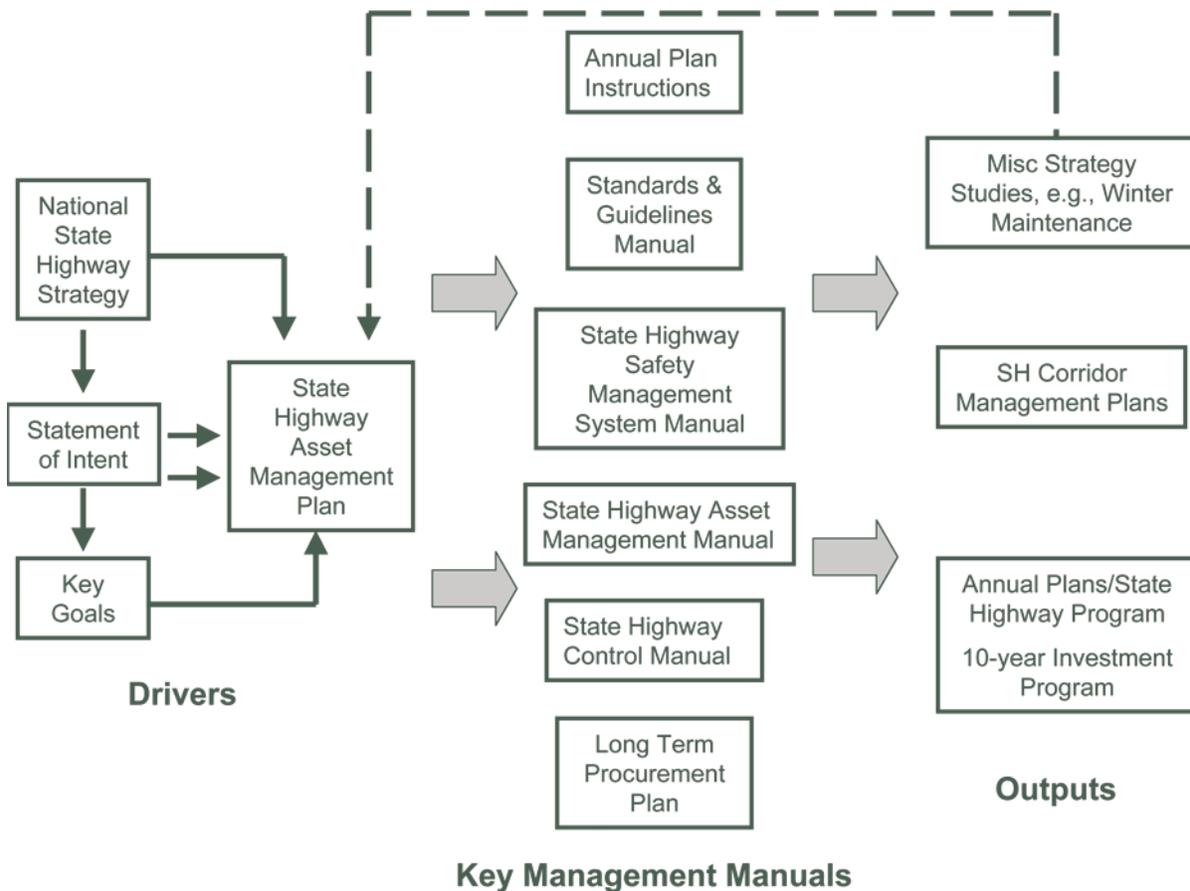


Figure 8. *Transit New Zealand's asset management process.*

The decisionmaking process for determining priorities is based on whole-of-life costing (known in the United States as life cycle costing) procedures, which includes deterioration modeling to determine useful lives. Whole-of-life costing considers all costs over the lifetime of an asset, discounted to the present. Given defined levels of service for each maintenance activity, a gaps analysis is used to determine maintenance needs.

Figure 9 illustrates the relationships among the many different components of the asset management decisionmaking process in New Zealand.

For funding priorities, Land Transport NZ uses a six-step allocation process as its primary decision support framework for making tradeoffs among many different projects. The National Land Transport Programme (NLTP), produced annually, covers funding for local roads, state highways, passenger transport, and other activities (in addition to its safety and police funding). It also includes a 10-year financial forecast. About 52 percent of NLTP funding goes to support the state road network and 30 percent to local roads. Of the total NZ\$1.16 billion (US\$812 million) allocated in the 2004/05 NLTP budget for state and local roads, about NZ\$300 million (US\$210 million) goes to maintenance of the State Highway network (another NZ\$300 million goes to subsidize local road maintenance).

Performance Measures

Performance measures and indicators are found at all levels of planning and decisionmaking in New Zealand (see figure 10). At the strategic management level, such measures and indicators are defined in the Statement of Intent, where targets are set at the start of each year and reconfirmed at midyear. An annual report shows progress on these indicators and presents information on the economic, environmental and social goals that constitute the triple bottom line. It also includes a pavement condition report that includes measures relating to roughness, rutting, texture, and skid resistance. Operational performance measures cover issues such as availability of the network, level of congestion, safety, and response times. Financial information is also presented for program progress and delivery accountability. In addition, a monthly traffic light report presents progress reports against key performance measures in the form of a green (okay), yellow (warning), and red (action required) color scheme.

At each level, performance is measured in both absolute terms and trends.

Transit NZ also collects information on user satisfaction with the road network. For maintenance and asset condition, it has established a target of 90 percent of road users rating their satisfaction with the road network as good or above. The road characteristics included in this survey are traffic flow, road safety, road surface, road marking, road signs, rest areas, and quality of the roadside environment.

At the network level, Transit NZ reports on numerous performance measures and indicators. An annual high-speed network condition survey provides input into key performance measures (KPMs) and key performance indicators (KPIs). An example of the type of information reported is shown in figure 11 (see page 22). Project-level performance measures include levels of service, pavement condition, and maintenance response times. Similar measures are incorporated into maintenance contracts covering network condition, operations, and system management. These measures govern what happens in the contracted service delivery. These measures are aggregated and combined with other data to produce a whole-of-network picture.

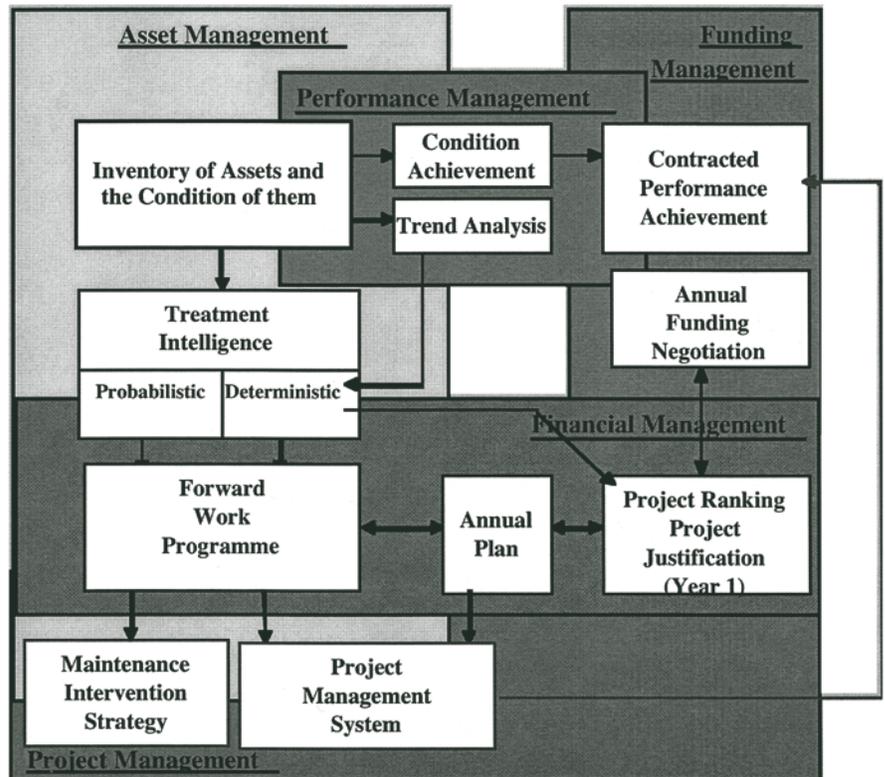


Figure 9. Business model of asset management in New Zealand.



Figure 10. *Use of performance measures in Transit New Zealand.*

Levels of service are defined for each work activity in the asset management plan. These levels of service were determined from historical trends and through a Delphi process with agency staff and other professionals, and with community input. Levels of service are also defined for each maintenance activity and used to support funding

applications to Land Transport NZ. These levels of service not only serve as the basis for performance reporting, but they also serve as the inputs into maintenance performance contracting.

Transit NZ learned many years ago that a smaller, more targeted number of performance measures is most useful to the agency. When the agency started using performance measures, it began with 230 measures. This was pared down to 32 when Transit NZ officials realized that 230 measures were too difficult to comprehend. Because of environmental and sustainability concerns, the number of measures now approaches 70.

Table 4 illustrates the type of asset management data presented to senior agency officials in various documents.

Land Transport New Zealand heavily depends on level-of-service measures when establishing funding priorities. For example, the latest guidelines to authorities in developing the

Proportion of Network with Rutting > 20 mm by NSHS Hierarchy 1998 - 2004

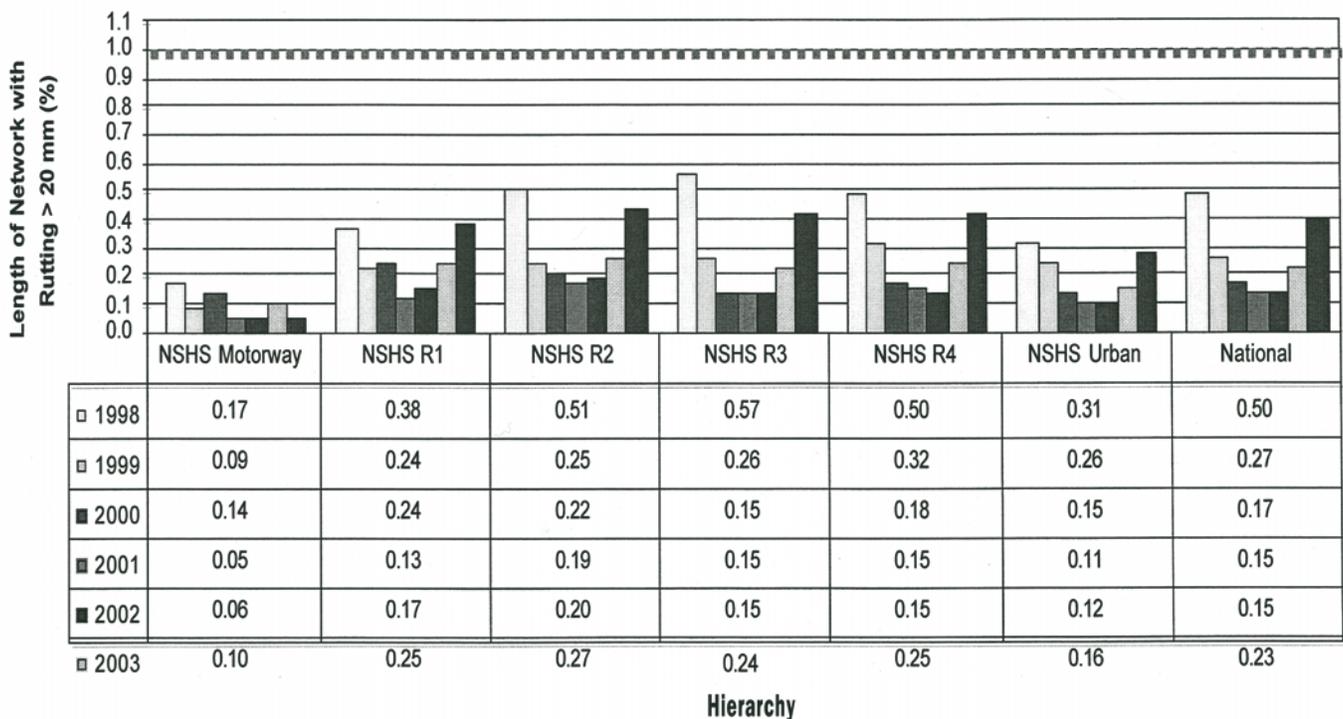


Figure 11. *Network rutting reporting in New Zealand.*

Land Transport Program included the following types of maintenance measures that funding submitters should consider:

Road User Satisfaction Measures

- Maximum average roughness on sealed roads
- Maximum roughness on roughest sealed roads
- Number of maintenance-related faults likely to affect driver behavior
- Adequacy of destination and directional signs
- Visibility not restricted by dust
- Corrugations on unsealed roads
- Availability of road after emergency closure
- Number of maintenance-related hazards on cycle ways requiring evasive action

Road Safety Measures

- Adequate provision, visibility, and reflectivity of traffic service facilities for safe travel at normal day and night operating speeds on wet or dry road
- Adequate skid resistance on all sealed roads
- Loose gravel on unsealed roads
- Sight distance is not restricted by vegetation growth/trees
- All traffic-restraining devices are maintained in an effective operating condition
- Where shoulders are provided, they are maintained in a state that allows safe stopping or recovery by vehicles
- Roadside safety zones are maintained free of unauthorized obstructions

Table 4. *Examples of performance measures used by Transit New Zealand.*

Percentage of the state highway network complying with agreed levels of service and standards for road conditions and geometry.				
Level of service and standard	Actual 2001/02	Actual 2002/03	Target 2003/04	Actual 2003/04
	Percent			
Percent of network classified as smooth	99	99	97	99
Percent of expectation of smooth travel	99	99	97	99
Percent of network <20-mm ruts	99.99	99.8	99	99.6
Percent of network with good skid exposure above threshold level	99	99	98	99
Percent of network with texture greater than 0.5 mm	99.5	99.6	98	99.5

Percentage of the state highway network with a current state highway or corridor management plan.			
Measure	Actual 2002/03	Target 2003/04	Actual 2003/04
	Percent		
Percentage length of network with current state highway plan	93	85	88

Percentage change in maintenance cost per 100,000 VKT (100,000 VMT).				
Maintenance Measures	2000/01	2000/02	2000/03	2003/04
Expenditure (\$ millions)	NZ\$242.9 (US\$170)	NZ\$247.6 (US\$173)	NZ\$273.5 (US\$191)	NZ\$285.3 (US\$200)
Total VKT (VMT) in 100,000s	16,977 (10,550)	17,571 (10,919)	18,061 (11,223)	18,681 (11,608)
Expenditure per 100,000 VKT (VMT)	NZ\$14,310 (US\$16,114)	NZ\$14,090 (US\$15,844)	NZ\$15,140 (US\$17,019)	NZ\$15,272 (US\$17,229)
Percentage change per 100,000 VKT or VMT	-6.0	-1.5	+7.5	+0.8

Table 4, continued

Change (because of investment, revocation, or depreciation) in the dollar value of the state highway asset.				
Total Asset Value	2000/01	2001/02	2002/03	2003/04
	NZ\$ (US\$) in millions			
Depreciated Replacement Cost	NZ\$11 (US\$7.7)	NZ\$12 (US\$8.4)	NZ\$12.5 (US\$8.7)	NZ\$13 (US\$9.1)

Percentage of forecast and actual annual dollar variance against state highway maintenance and improvement program.						
Expenditure	2003/04 Budget	2003/04 Target	2003/04 Actual	2003/04 (Revised Feb.)	2003/04 (Revised June)	
	\$NZ (\$US) in millions					
Maintenance	320.3 (224)		327.4 (229)	321.1 (224.7)	331.2 (231.8)	
	Percent					
	102.2	98-102		102	98.9	
\$NZ (\$US) in millions						
Replacement and Improvement	340.7 (\$238)		360.3 (\$252)	322.6 (\$226)	355.9 (\$249)	
	Percent					
	105.8	Less than 103		111.7	101.2	

Description		2003/04 Target	2004/05 Target	2005/06 Target	2006/07 Target
Variance in percentage terms between forecast and actual dollar expenditure on state highway maintenance program at February review		98-102	98-102	98-102	98-102
Periodic Maintenance Achievement	■ Percentage achievement of National Land Transport Program outputs	97.5-102.5	97.5-102.5	97.5-102.5	97.5-102.5
Levels of Service Percentage of state highway classified by:	■ Roughness	97	97	97	97
	— smoothness	97	97	97	97
	— smooth travel exposure				
	■ Rutting—less than 20-mm ruts	99	99	99	99
	■ Skid resistance—good skid exposure above threshold level	98	98	98	98
	■ Texture—greater than 0.5 mm	98	98	98	98

Table 4, continued

Structural Maintenance Measures					
Description	Unit	2001/02 Actual	2002/03 Actual	2003/04 Target	2003/04 Actual
Cost	\$NZ (\$US) millions	105.6 (\$74)	119.8 (\$84)	127.6 (\$89)	126.8 (\$89)
Length	km (mi)	10,783 (6,700)	10,786 (6,702)	10,798 (6,710)	10,837 (6,734)
Unit Cost	\$/km (\$/mi)	9,795 (\$11,045)	11,107 (\$12,534)	11,817 (\$13,264)	11,701 (\$13,216)
Resurfacing Measures					
Description	Unit	2001/02 Actual	2002/03 Actual	2003/04 Target	2003/04 Actual
Cost	\$NZ (\$US) millions	68.9 (\$48)	74.3 (\$52)	77.1 (\$54)	73.2 (\$51)
Length	km (mi)	1,298 (807)	1,328 (825)	1,450 (901)	1,231 (765)
Unit Cost	\$/km (\$/mi)	53,106 (59,480)	55,949 (63,030)	53,172 (59,933)	59,464 (66,667)_
Corridor Maintenance Measures					
Description	Unit	2001/02 Actual	2002/03 Actual	2003/04 Target	2003/04 Actual
Cost	\$NZ (\$US) millions	73 (\$51)	79.4(\$56)	82.7(\$58)	85.3(\$60)
Length	km (mi)	10,783 (6,700)	10,786 (6,702)	10,798 (6,710)	10,837 (6,734)
Unit Cost	\$/km (\$/mi)	6,768 (\$7,612)	7,361 (\$8,356)	7,659 (\$8,644)	7,871 (\$8,910)
Preventive Maintenance					
Description	Unit	2001/02 Actual	2002/03 Actual	2003/04 Target	2003/04 Actual
Cost	\$NZ (\$US) millions	4.3 (\$3.0)	5.2 (\$3.6)	5.8 (4,0)	5.4 (3,8)
Property Management Measures					
Description	Unit	2001/02 Actual	2002/03 Actual	2003/04 Target	2003/04 Actual
Cost	\$NZ (\$US) millions	8.2 (\$5.7)	9.1 (\$6,4)	9.3 (\$6,5)	10.2 (\$7,1)
Asset Value	\$NZ (\$US) millions	341 (\$239)	445 (\$312)	360 (\$252)	545 (\$382)
Emergency Works Measures					
Description	Unit	2001/02 Actual	2002/03 Actual	2003/04 Target	2003/04 Actual
Cost	\$NZ (\$US) millions	18.3 (\$12.8)	15.3(\$10.7)	17.8 (\$12.5)	26.5(\$18.6)

- Carriageway lanterns are maintained in an effective operational condition
- Traffic signals operational at all times

Asset Preservation Measures

- Change in pavement integrity index of sealed network
- Length of sealed network overdue for resurfacing
- Structural integrity of structures is not diminished by lack of maintenance
- All bridge waterways clear of significant obstructions
- All drainage facilities functioning satisfactorily
- Adequate pavement depth maintained for unsealed roads

In an overview document targeted at maintenance activities, Land Transport New Zealand identified several measures that were particularly important, including smooth travel exposure, a sealed road condition index, and a pavement integrity index.

Asset Management Information Systems

Transit NZ has a suite of asset information systems used in providing information to the decisionmaking and prioritization process (see figure 12). The Road Asset Maintenance Management (RAMM) system, begun in the 1980s, includes the primary road inventory, condition data, and treatment selections and interfaces with the pavement design system. It is used by Transit NZ staff and consultants, and can be used as a distributed system. Seventy-two local authorities also use this system. The National Optimization of Maintenance Allocation by Decade (NOMAD), a module of RAMM, develops a 10-year program of investments by treatment type. A pavement modeling tool, dTIMS, uses deterioration modeling to predict future pavement condition (there are 85 dTIMS licenses in New Zealand, but not all license holders use the software). In this application, the road network is segmented into like-performing roads and appropriate treatments are identified for different performance levels.

Transit NZ's Traffic Monitoring System (TMS) includes five weigh-in-motion sites (dial up and noncontinuous), 70 continuous traffic count sites, and 1,000 noncontinuous traffic count sites. TMS is used primarily for reporting traffic volumes and trends in growth and weight, and for enforcing truck weight restrictions. A bridge information system is available, but it is not as developed as RAMM. It consists simply of an asset register of bridge structures (BDI), a bridge structural index (BSI), and an overweight vehicle management system (Transit Overweight Permitting System (TOPS)). When combined with bridge management consultants, this relatively unsophisticated system has proved capable of managing the bridge stock. Transit NZ is developing a more sophisticated overweight vehicle management system to rectify some shortcomings in TOPS and giving some thought to more integrated bridge management systems. RAMM also includes a traveler infor-

mation system (0800) and a limited-access road database (LAR) for planning purposes.

Transit NZ is implementing a Location Referencing Management System with spatial capabilities designed to provide a more integrated database approach to future asset management activities. The desire is to integrate the process of information production, not develop one comprehensive database. Figure 12 also shows the future relationships that the referencing system will provide.

Data Collection

Pavement condition data drive the performance measurement process. Data are collected both visually on 10 percent of the road network each year and across the whole national network with a high-speed data-collection vehicle called a Sideways-Force Coefficient Routine Investigation Machine (SCRIM). This vehicle collects data at 10-m intervals for skid resistance, rutting, roughness, and texture and videotapes the network. These data are measured in both wheel paths to allow a comparison across the entire paved surface. The high-speed data collection occurs via private 3-year contracts (valued at NZ\$1 million (US\$700,000 a year), and covers about 22,000 lane-kilometers (13,670 lane-miles) each year. Tendering is on the international market and is now sourced from the United Kingdom.

Pavement strength data are collected with a falling weight deflectometer at 200 m. These data are collected via private contractor on highways with over 2,000 average annual daily traffic (AADT), and cover about 10,000 lane-kilometers (10,900 lane-miles) each year (or once every 3 years). Roughness is defined at 100-m (109-yd) and 20-m (21.9-yd) sections, rutting at 20 m (21.9 yd), skid resistance and rutting at 10 m (10.9 yd), and geometry at 10 m (10.9 yd). To calibrate this data-collection activity, Transit NZ uses 52 calibration sites throughout the country. A walking profilometer is used to validate IRI measurements.

Transit NZ also collects data from transportation users. Surveys of road users occur every 2 to 3 years. Focus groups also have been used. In response to survey information, Transit NZ has placed greater emphasis on providing more passing lanes and improving sections of road with the highest level of roughness (of concern to truck drivers). In addition, a NZ\$12 million (US\$8.4 million) to NZ\$15 (US\$10.5) program over 3 years was implemented to fix undulations in road vertical profiles, which the trucking industry had identified as a problem to truck ride quality. As Transit NZ officials noted, one challenge of this type of data is relating varying levels of user satisfaction to the service levels Transit NZ provides.

“We need effective processes in place so that we can be confident of identifying and managing significant risks to our business. . . . Better decisions, processes, plans, and programs are the intended results. The goal is to enhance our chances of success and to minimize the potential for failure through greater risk awareness and proactive management.”

—RISK MANAGEMENT PROCESS MANUAL, TRANSIT NZ, 2004

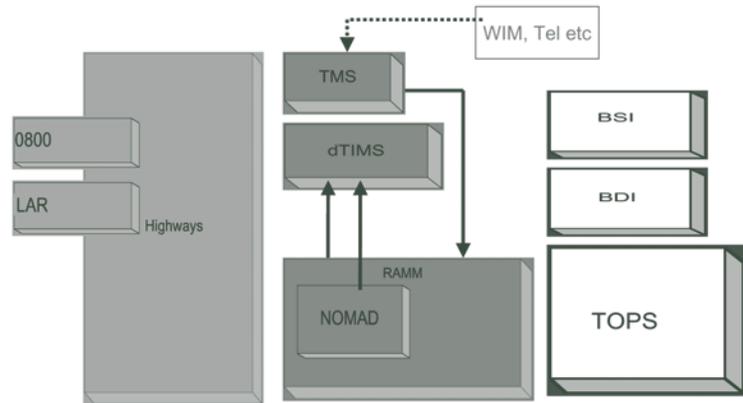
Analysis Procedures and Prioritization

Land Transport NZ does not propose projects, but instead reviews project requests. The funding priorities are determined by relating proposals to legislative requirements, including sustainability, economic development, safety, access and mobility, public health, and environmental quality. In early 2002, the government established specific priority areas for targeted land transport funding: severe congestion, public transport, walking and cycling, regional development, alternatives to roads, and safety. The government continues to identify key issues. Regional strategies that are part of transport plans are also important justifications for project priorities. For new capital projects, the seriousness and urgency of the need, the project’s effectiveness, and a benefit/cost ratio must be provided. Projects are rated as high, medium, or low priority. Given recent changes to legislation, Land Transport NZ officials believe that the quantitative thresholds for project justification might be lowered to account for factors not easily quantified, such as sustainability.

Maintenance has historically received first priority in Land Transport NZ’s prioritization scheme. Approved organizations (i.e., local authorities and Transit NZ) must prepare asset management plans, and present annual statistics that indicate changes in the asset base, network status as it relates to performance measures, and work achieved. Instructions to the approved organizations are issued early in the previous fiscal year and cover the type of information and analyses desired. Maintenance funding priorities are based on historic costs, trends in network condition, benchmarking with other organizations, links to national objectives, and relationship to the asset management plan. Land Transport New Zealand places a great deal of emphasis

on asset management planning, and it expects robust asset management practices to include complete inventory databases, optimized decisionmaking, life cycle strategies, long-term planning, level-of-service outcomes, and linkage to national and regional strategies.

Current Systems and Integration



Integrated Future

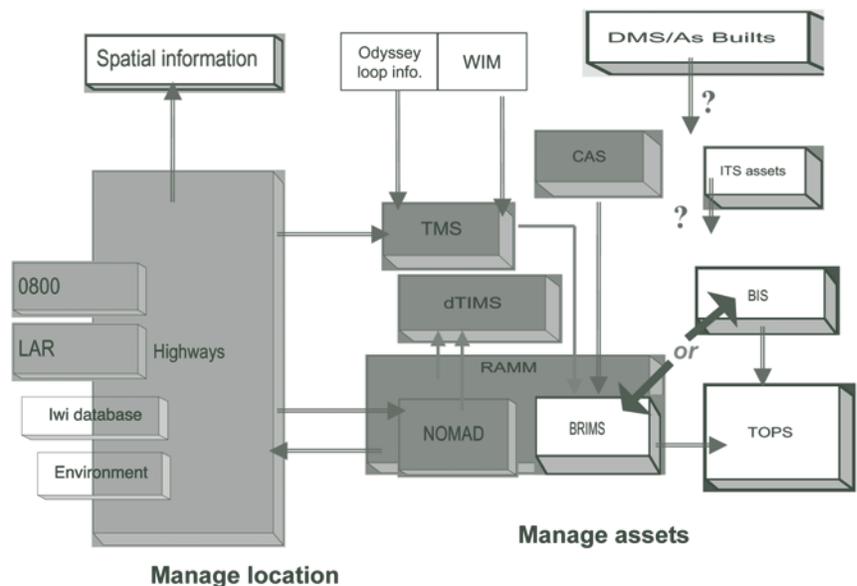


Figure 12. Current and future systems configuration at Transit New Zealand.

At the national level, Transit NZ uses a whole-of-life costing procedure to determine net present values of proposed projects (using a 10 percent discount rate). If the cost of the project is more than 10 percent of this value, it is elevated to the status of a reconstruction project. All projects must be justified, either by a benefit-cost ratio for capital projects or some other form of justification for smaller projects (e.g., least-cost analysis for renewals compares ongoing maintenance costs against replacement cost).

Scenario analyses of alternative budget assumptions and corresponding performance levels are conducted using dTIMS.

Transit NZ has developed an Asset Valuation Manual that defines the approach for valuing different assets (one-third of the network is revalued each year), calculating replacement costs (see table 5) and identifying remaining service life. Life cycle costs are assumed over 25 years for pavements, and pavement design life is assumed to minimize whole-of-life

costs. Transit NZ officials had concerns about the concept of remaining service life. Questions they are struggling with include the following: When is structural integrity compromised, and thus the end of useful life? For assets such as ITS equipment, how does one determine remaining useful life? As a performance measure, remaining service life becomes a check on contractor maintenance strategies. Transit NZ can determine, for example, if contractors are avoiding more costly maintenance and using up the structural life of the pavement. The measure for pavement replacement cost is based on the depth of granular overlay that would bring the pavement up to a 25-year remaining life.

Transit NZ depends on its regions and network service areas to develop plans and priorities for the networks for which they are responsible. Two such plans were reviewed for this report, Hawke's Bay Network Management Area and PSMC001 Network Management Area. In both cases, analysis was done on network characteristics relating to skid resistance, texture, pavement roughness, rutting, and granular overlay deficit. Other measures relating to safety and social/environmental factors were also discussed. These plans then examined maintenance needs and recommended treatments.

Observations

The New Zealand case provides an excellent example of a national government that has been using performance-based planning, operations, and maintenance for many years and has now integrated asset management into this mix. The investment program of Transit NZ (and of other agencies as well, such as the Land Transport NZ's financing decisions) is tied very closely to the government's policies and mandates. These agencies use performance measures to assure consistency in agency action at all levels of decisionmaking. This occurs not only at the strategic level, but also in the contracts used to provide maintenance services. This hierarchy allows a buildup of information from the most local level to a national perspective on the progress being made. New Zealand transportation officials have thought carefully about where asset management fits into the total business activities of their organization, not just the obvious ones of maintenance and preservation. The linkage between asset management and Transit NZ's environmental plan is an example of this, even though it is in its infancy.

One does not need to outsource service delivery to have a strong asset management program. However, the New Zealand case does suggest that

Table 5. Calculation of replacement cost.

Component	Basis for calculating replacement cost
Land	Valued at the same price per hectare as the surrounding land.
Formation	Unit rate obtained from contract records of highway construction (1–10 km lengths), and grouped in terms of terrain and width.
Pavement	Depth of sub-base and basecourse, and surfacing type determined from <i>State Highway Pavement Design and Rehabilitation Manual</i> requirements. Unit rates from contracts in the region. NOTE: From now on, pavements will be designed in accordance with the <i>Austroads Pavement Design Guide</i> .
Drainage	Unit rates from RAMM unit cost tables or better, from recent contracts.
Traffic Facilities	
Bridges	Unit rates from RAMM unit cost tables or better, from recent contracts.
Culverts/ Subways	Unit costs derived from Opus International Consultants database, dependent on cross-sectional area, and multiplied by length to give replacement cost.
Other Structures	Unit rates obtained from updated contracts in the region, if possible. Structures > \$50,000 are identified and valued as individual structures. Those < \$50,000 can be valued on a parameter basis (e.g., \$/km).

the opposite is true. Outsourcing service delivery requires a strong asset management program. Such a program provides some assurance that the agency is doing the right things, and that through performance monitoring, progress toward overall goals can be determined. One consequence of outsourcing for Transit NZ was a reduction in the number of staff. However, staff levels have increased because of the need to monitor the contracted service and provide strategic direction. Not only have the number of staff gone up, the skill set has changed for these new staff members.

The Land Transport NZ approach to budget allocation provides an interesting example of trade-off analysis among different budget categories at a general level. Land Transport NZ provides applicants very detailed instructions on the information required for their proposals, with common measures across different asset types. Priorities are set by how well a project makes its case for national funding. For capital projects, this usually entails a benefit-cost analysis. For maintenance projects, this requires a stronger linkage to systematic and comprehensive examinations of the problems focused on (e.g., linking a request to the asset management plan).

Because of legislation and regulation, asset management plans are required for agencies seeking funding from the national government, including Transit NZ. These asset management plans provide a strategic perspective of the problems, the types of strategies appropriate for different

Words of Wisdom and Experience

Based on many years' experience with performance-based decisionmaking and asset management, Transit New Zealand officials offered many observations of benefit to others:

"Asset management focuses organizational attention on what you are doing."

"The ability to have data and manipulate it at an area network level does change behavior and outcomes... (But) choosing performance measures that are both meaningful and relevant without inducing perverse behaviors is an art."

"Data collection is critical to successful asset management, but too much inaccurate, unfriendly data is worse than having none at all."

"Start off with basic performance measures and get them engrained before looking to refine and expand them."

"The ability to demonstrate that infrastructure is being preserved and to demonstrate the consequences of not investing in asset management are critical in today's environment."

"The only way to survive in the future is to protect that which we already have."

"We are not dealing with rocket science... All we need is a vision of what we want to achieve, and we will achieve it."

"Good asset management is having the right people, fostering the right relationships among these people, and supporting their activities with strong information systems."

"Balancing the auditing activities and actually doing something is rather complex... We want to be proactive, not reactive."

"Asset management is understanding what our customers want, defining ways of measuring our delivery to these expectations, identifying means of improving system performance, and then continually monitoring to see how we are achieving customer expectations in our job."

"This [asset management] is not a 'stop-building-nasty-roads' campaign, it is 'let's get value from what we are doing.'"

"The key challenge is to tell the story of asset management."

types of problems, and a process for determining the best mix of strategies. The concepts embedded in these plans are also incorporated into regional network plans, resulting in consistency across the country. The network management plans reviewed for this case (and these were small areas compared to typical U.S. jurisdictions) were more comprehensive than found in most U.S. jurisdictions. They were succinct, targeted, and focused on system performance.

Information systems serve as the decision support foundation for asset management. These systems, in turn, depend on the quality and efficiency of the databases that support them. Over time, Transit NZ has developed a set of good asset management systems (although the structures are behind pavements) that are now linked via a locational referencing system. With a common reference base, Transit NZ can obtain much more useful information while using existing databases.

Transit NZ has applied innovative methods to obtain public input into its asset stewardship role. Focus groups have been used to identify perceptions and desires of the community on asset management, and targeted outreach efforts have been used to solicit user input. A good example of this latter effort was the trucker input on ride quality.

Finally, New Zealand has one of the most comprehensive and institutionally supported asset management user groups in the world. The National Asset Management Steering (NAMS) Group is a support structure for asset management that plays an important educational and training role in New Zealand. It has developed several how-to manuals that have become important resources worldwide. Chapter 5 has more information on NAMS.

Chapter 3: State/Provincial Experience with Asset Management

Four of the sites the scan team visited represented asset management experience at the state or provincial government level. In the case of both countries visited, the federal government is not a major player in asset management, providing much less funding than the United States for transportation infrastructure. In Australia, for example, the federal government is proposing to remove itself even more from funding transportation systems. Thus, the states and provinces visited had a great deal of autonomy in developing asset management programs in ways that met their own needs. The four state/provincial government experiences with asset management included those for Alberta (Canada), and New South Wales, Queensland, and Victoria (Australia).

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www.infra.gov.ab.ca

Context

With just under 3 million people, Alberta is one of the wealthiest provinces in Canada, primarily because of its vast reserves of natural resources. Approximately the size of Texas, Alberta has a large road network that, because of wide temperature fluctuations and significant heavy truck use, experiences substantial preservation and maintenance needs. Critical transportation issues identified by Alberta transportation officials include 1) an aging existing infrastructure, 2) demands for new corridors (e.g., ring roads) around major cities, 3) a new fiscal framework on public-private partnerships, and 4) increasing competition for resources from other government ministries and for other types of infrastructure.

With an annual budget of just over Can\$4 billion (US\$3.2 billion), Alberta Infrastructure and Transportation (AIT) is responsible for overseeing not only the road network, but also other major types of infrastructure in the province. Partly because of this multiple responsibility, the scan team was particularly interested in seeing how the province established priorities among different asset categories. In addition, AIT's reputation for conducting state-of-the-art asset management provided an important motivation for this scanning study, a reputation supported by the team's observations.

Drivers for Asset Management

Several factors have influenced AIT's development of a comprehensive asset management program. Perhaps most important were economic worries in the late 1980s and early 1990s that put pressure on the government to downsize and become more efficient. By the mid-1990s, this led AIT to outsource much of its maintenance and capital renewal activity (planning, design, construction supervision, and maintenance operations) to private companies. This resulted in an AIT staff reduction from about 2,500 to less than 800 employees. With such a structure for program delivery, however, AIT officials realized that a process for systematically identifying deficiencies and allocating resources was an important part of its asset stewardship responsibilities. An asset management program was viewed as serving this function. In fact, AIT officials credit the agency's infrastructure management systems with establishing a credible maintenance backlog estimate of Can\$3.3 billion (US\$2.6 billion) that was accepted by government officials as the "real" infrastructure need in the province. The desire for an effective asset management program also occurred about the same time as AIT's pavement and bridge legacy management systems needed to be upgraded.

The evolution of government policy toward infrastructure has also had an important influence on the evolution of asset management practice in AIT. In the late 1990s, a policy of encouraging more coordinated capital planning was adopted, which in 1999 was incorporated into the government's business plan. In 2002, the government adopted a policy on alternative capital delivery mechanisms, which included encouraging public-private partnerships as a means of providing more infrastructure. Eliminating the maintenance backlog, which at the time was about Can\$1 billion (US\$800 million), became a priority.

Infrastructure Managed

- 26,200 km (16,281 mi) of paved road/4,600 km (2,858 mi) of gravel road
- 3,870 bridges
- 150 major water management facilities
- 510 km (317 mi) of main irrigation canals
- 1,860 government-owned buildings
- 310 leased buildings

*“Transportation infrastructure is not an expenditure;
transportation infrastructure is an investment.”*

—AIT OFFICIAL

In 2003, the first 3-year capital program under this new fiscal management structure was adopted, which was supported by a 5-year capital plan, a 10-year strategic plan, and a 25-year futures plan. Asset management was a critical theme in all of the plans; indeed, the decision support structure provided by AIT’s information systems was critical in the development of many of the strategies.

Although not exactly a driver for asset management, one reason AIT has been able to show such progress in its asset management program is the continuity in top leadership. The same political party has been in power since 1971, and government ministers responsible for AIT have had long tenures. This continuity in leadership, along with a policy of adopting business practices for governmental operations, has led to asset management techniques becoming part of the strategic management of the agency.

This combination of seeking greater financial efficiency in program delivery, providing oversight for outsourced functions, and the need to update its legacy systems led AIT to develop a comprehensive asset management system called the Transportation Infrastructure Management System (TIMS).

Organization for Asset Management

The asset management function in AIT is evolving. A small section in headquarters, the highway asset management section, deals primarily with high-level performance measure development, target setting, and reporting, and provides data for other areas. Program development is done by another group, which coordinates input from regional infrastructure managers. The development of AIT’s infrastructure management information system is the responsibility of another group. There are about seven staff members in the highway asset management section, 12 in program development and delivery, and nine regional infrastructure managers and engineers (in four regions).

As noted earlier, AIT outsources much of its activities, including maintenance functions. These contracts define the types of work activities that are to occur via contract activities and establish desired outcomes of such contracts, but AIT does not specify how to produce these outcomes.

Decisionmaking Approach

One of the important distinctions between the Canadian and U.S. transportation systems is that highway projects in the provinces are funded almost entirely by the provincial government. Therefore, highway budgets compete with other infra-

structure (e.g., schools and hospitals) as well as other budgetary priorities.

In 1997, the provincial government recommended that a more coordinated capital planning process be put in place to determine the best investment among competing demands. A Capital Planning Initiative (CPI) was included in the 1999 government business plan to “ensure effective and innovative capital planning and funding of government-owned and supported infrastructure.” Thirteen governmental ministries participate on a CPI committee, chaired by the deputy minister for infrastructure and transportation. Two of the first goals of this initiative were to develop a provincial strategy for alternative capital project delivery (e.g., public-private partnerships) and to eliminate the maintenance backlog on the province’s infrastructure. CPI also monitors trends on common (cross-asset types) performance measures, uses infrastructure management systems to determine the status and predicted performance of the province’s infrastructure, reports on the ministries’ statements of intent as their actions relate to performance measures, and identifies cross-government capital needs and priorities. The management systems include one for transportation (see below), but also systems for buildings and lands, water management, collections and exhibits, and municipal infrastructure.

The ministries submit a 10-year capital requirements plan and identify 3- and 5-year capital plan alternatives. These alternatives reflect ongoing preservation requirements, plans to eliminate maintenance backlogs, and major new capital priorities and other capital needs. Tradeoffs are determined among different asset investments based on criteria that relate to a ministry’s ability to deliver the program, expected performance, economic benefits, cost avoidance, cost effectiveness, and strategic alignment with the government’s priorities. Flexibility exists to move funds from one infrastructure category to another. An AIT official noted that the existence of a credible infrastructure management system has allowed AIT to “fight the fight” for increased transport funding.

Performance Measures

Performance measures are used by political leaders at the business plan level, by senior department executives to justify budgets, and by operations staff to identify potential work activities. Three categories of infrastructure performance are used for all asset types (including those outside the transportation sector) to measure current and future performance. These performance measures relate to condition, use, and functional adequacy. For condition, AIT rates pavement rough-

“You can’t do anything without performance measures.”

—AIT OFFICIAL

ness as good, fair, or poor using the International Roughness Index (IRI) averaged over 1-km sections. The condition measure is differentiated by road type: roads with speeds greater than 110 kilometers per hour (km/h) (68 miles per hour (mi/h)) or less than 110 km/h. “Poor” is defined as 1.9 m/km for 110 km/h roads, and 2.1 m/km for less than 110 km/h roads. Use is measured as the percent of road kilometers at service level C or better. Functional adequacy is determined as the percentage of kilometers that meet width standards, horizontal alignment standards, and appropriate road surface type for traffic volume levels, and that have no weight restrictions.

AIT has no difficulty reporting those sections of its highway network in poor condition. An AIT official noted that actually reporting on poor road sections represents a change in agency philosophy because 10 years ago this condition level would have been downplayed. Now, it is used to justify funding requests.

The 2005-2008 Business Plan for Alberta Transportation identified several performance measures considered important in achieving progress in the agency’s core business areas. The asset management-related measures included the following:¹⁹

Performance Measure	Last Actual 2003-04	Target 2005-06	Target 2006-07	Target 2007-08
<i>Physical condition of highways</i>				
% in good condition	65.5	62.0	58.5	56.0
% in fair condition	23.3	24.0	25.0	25.5
% in poor condition	11.2	14.0	16.5	18.5
<i>Use of provincial highways</i>				
% highways that accommodate current volumes at required LOS	99.9	99.0	99.0	99.0
<i>Functional adequacy of highways</i>				
% of highways not subject to weight restrictions and meeting current engineering standards	80.1	79.8	79.7	79.6
<i>Provincial highway paving</i>				
remaining kilometers of graveled provincial highways to be paved	630	560	500	430
<i>Construction progress on North-South Trade Corridor</i>				
% of four-lane road open to traffic	82.0	84.0	89.0	90.0
<i>Ring roads in Edmonton and Calgary</i>				
% of ring roads open to traffic	18.2	18.2	26.5	40.0

Asset Management Information Systems

AIT began developing its transportation infrastructure management system (TIMS) in 1996. By 2006, TIMS will consist of a suite of 20 software applications that cover such highway assets as bridges, roads, culverts, signs, signals, and other associated structures and appurtenances. TIMS is expected to integrate the different databases, allowing AIT to optimize program delivery. AIT officials estimate that even if only 20 percent of AIT staff use the finished system, it will have paid for itself. When done, TIMS will cover about one-third of all the province’s assets. AIT officials noted the following system benefits:

- Enables gaining best life-long returns on investments
- Documents the rationale for investment decisions
- Provides the tools to achieve excellence in all phases of asset creation and maintenance
- Enables preservation and optimum use of knowledge assets such as data, information, and human capital
- Provides an effective and efficient learning tool

The data included in TIMS are referenced to a common datum; highway attribute data are referenced to a common network. Data are collected using geographic coordinates and

reported using linear referencing. The provincial highway system, municipal road network, and bridges are included in the TIMS databases. Every AIT employee with access to a computer can use TIMS for a variety of purposes, including appurtenance inventory, bridge condition information, network expansion projects, a routing and permitting system, performance measurement, and quality assurance of data collection.

TIMS consists of several core components (see figure 13 on next page), including the following:

Network Expansion Support System (NESS)—NESS is a decision support system that uses expert opinion and objective information to define current and future conditions of the road network. It acts as an expert system by identifying work activities necessary to

¹⁹ Alberta Infrastructure and Transportation, Business Plan, 2005-2008, April 13, 2005, see <http://www.finance.gov.ab.ca/publications/budget/budget2005/infra.html#7>

deal with identified problems. Each highway section is rated from a technical (level of service and geometrics), safety (collision rates), and socioeconomic policy perspective. The degree to which each of the first two criteria deviate from the norm for the type of road being investigated is used to assess the level of problem experienced at that location. Different types of work activities—data collection, engineering analysis, and rehabilitation/capital improvement—are assigned to each section of road where problems exist or are likely to exist in the future. Figure 14 shows the concept of how different technical, safety, or socioeconomic factors can identify a section of

roadway as a candidate for improvement. The horizontal bars represent locations along a highway where these factors need to be addressed, and the cumulative bar at the bottom suggests where multiple work activities need to occur along this stretch of road.

Bridge Expert Analysis and Decision Support (BEADS) System—This prototype system examines different bridge strategies, combined over the entire bridge network, to facilitate short-term programming (3 to 5 years), analyze long-range budget scenarios (longer than 5 years), evaluate status of the bridge network, and assess impact of policy decisions.

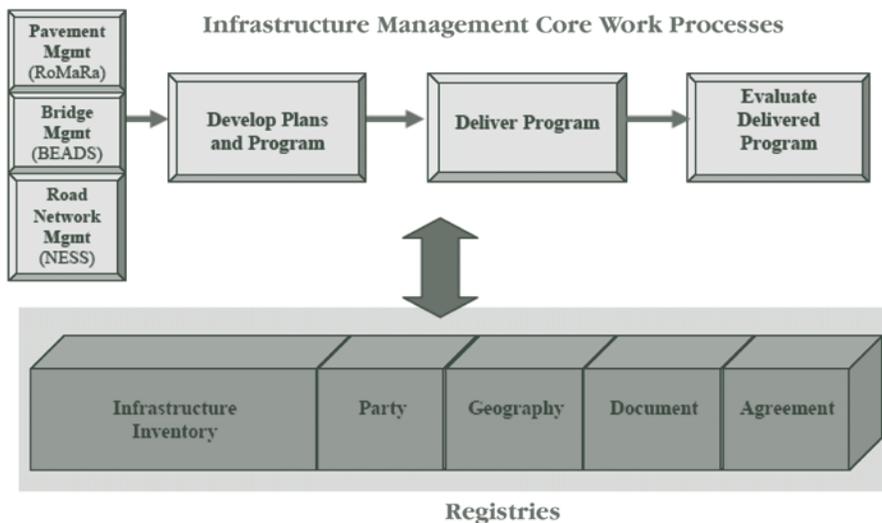


Figure 13. Core work processes in TIMS in Alberta.

BEADS consists of three modules: condition, function, and a strategy builder. The condition-related measures reflect the condition of the superstructure, paint, and culverts (see figure 15). The function-related measures reflect width, strength or load capacity, vertical clearance, and existence of bridge rail. Both modules include triggers that relate to work activities required at specific times in the life cycle of the bridge. Deterioration models are incorporated into the module aimed at a 65-year deterioration range. Interestingly, the function module also calculates the user costs associated with not completing possible work actions.

The strategy builder module is the most important module in BEADS. This module assembles life cycle strategies based on input from each module, and compares a large number of strategies on a life cycle economic basis. Two base strategies—“do nothing then replace” and “do nothing then close”—are considered for each bridge. Up to 13 additional base strategies can be developed, each assuming replacement in a future 5-year increment from the previous base strategy (e.g., replace in year 10, replace in year 15, etc.). The module uses a least-cost net present value (NPV) action plan from the condition modules, and keeps track of the cost of actions up to the replacement year and the user costs for functional deficiencies. The results of the strategy builder module include a list of ranked strategies for each bridge structure, a recommendation of a least-cost NPV strategy, a point

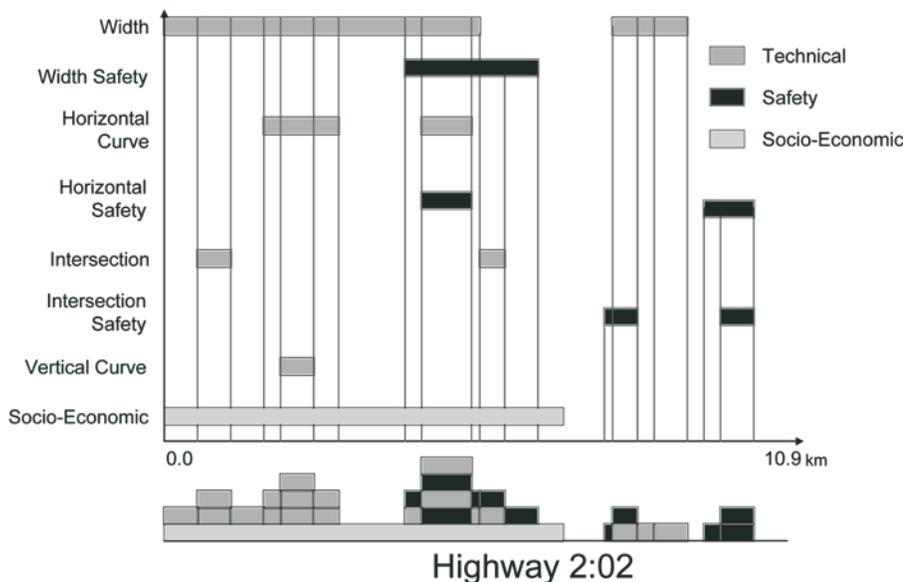


Figure 14. Buildup of candidate improvement road sections in Alberta.

of departure for an expert review by bridge staff, and a statement of need for additional inspection, assessment, and review of the bridge structure.

Highway Pavement Management Application (HPMA)—

This management system is similar to those used in the United States. It consists of an inventory of pavement assets, including pavement condition (current and historical data), an estimate of current and future network deficiencies and needs, the selection of maintenance and rehabilitation treatments, an economic assessment, and the selection of an optimal program of investment. HPMA provides visual representation of layer thickness, width, and material for both longitudinal and lateral sections on a roadway, and a record of the maintenance and rehabilitation activity on the pavement. It also represents visually the pavement surface type, International Roughness Index (IRI), distress index (SDI), structural adequacy index (SAI—deflection), and traffic data. Triggers are used in the IRI, SDI, and pavement quality index (PQI) measures to recommend short-term treatments, whereas prediction models are used to determine performance trends. Decision trees are used to select maintenance and rehabilitation treatments based on current and future conditions. The HPMA also allows the user to define a 5-, 10- and 20-year investment program, either to maintain certain condition levels or to meet budget constraints.

Data Collection

Data collected by AIT support the TIMS system and appurtenance inventory, are used in mapmaking, provide input into highway surface and geometric design, identify crash characteristics, feed into performance measurement, and support truck routing and permitting. Transverse paved-surface characteristics, vertical and horizontal geometry, line painting location and type, and location of appurtenances are obtained from video log data. AIT has embarked on a 3-year project (2002 to 2005) to collect base data on the provincial highway system on all driving lanes in each direction, which will be maintained over time with a slightly reduced coverage (e.g., IRI/rut collected in the driving lane in one direction, digital video logs

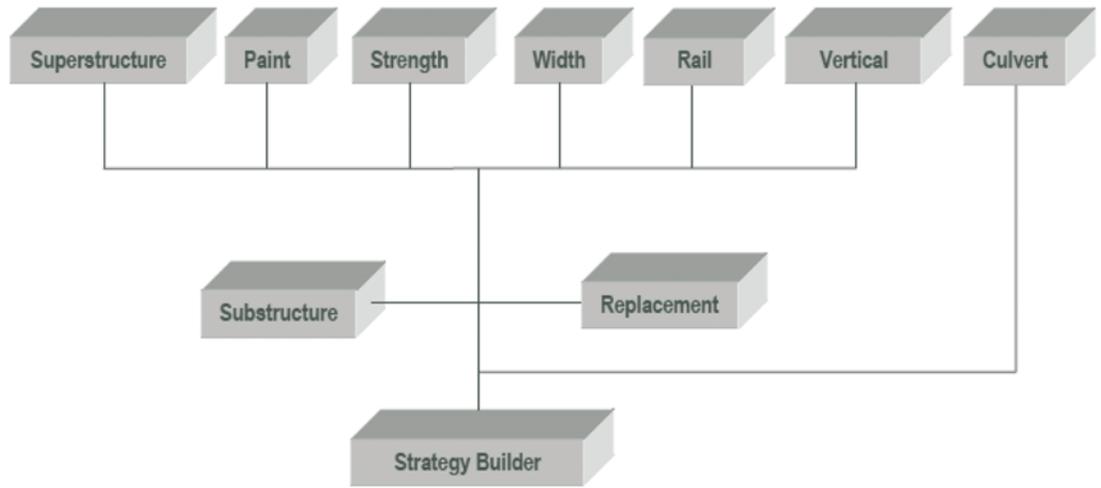


Figure 15. *BEADS components in Alberta.*

made in only the driving lane in both directions, and new data collected only on roads that have significantly changed status).

The data-collection program for IRI and rut data has been given to a private contractor, with strong management guidance from AIT. According to AIT officials, the key factor for success of this data-collection model has been applying quality assurance (Q/A) protocols. Ten Q/A sites were established jointly by AIT and the data-collection vendor: two IRI/rut calibration sites, traversed at the start and end of the collection season; six 500-m IRI/rut/geometric verification sites; and two 1,000-m IRI/rut/geometric verification sites. Twenty global positioning system (GPS) blind sites were established at locations unknown to the vendor. AIT used these blind sites to assess the quality of the data collection after delivery. For IRI accuracy, known sites had to be traversed once every 3,000 km/7 days (1,864 mi/7 days) and results submitted to AIT immediately for approval. The GPS location measured at these sites had to be within 2.00 m (2 yd) in the x, y directions and 1.75 m (1.9 yd) in the z direction 90 percent of the time. The IRI/rut values had to be within 10 percent of the actual IRI values plus 3 millimeters (mm) (0.12 inch (in)) for ruts of known values. The Q/A of video logs was related to established criteria for acceptance (e.g., bug splats, rain, and sun angle), with video data delivered every 30 days for review. Appurtenances are spot checked against ground truth locations where data has already been collected.

The various types of data have different schedules. For example, the IRI and rut data are collected annually on the entire network. Surface distress data, collected by AIT staff, are collected on a cyclical basis with 50 percent of the network

collected each year. The schedule for bridge inspection data depends on different classifications of highway. All bridge inspections are also outsourced. Data entry is done by the data collectors and verified by department staff. The cycles defined for Level 1 (or routine) inspections are based on structure type and roadway type, and include the following:

- Major bridges, standard bridges, and culverts on primary (2-digit) highways—every 21 months
- Major bridges, standard bridges, and culverts on secondary (3-digit) highways—every 39 months
- Major bridges on local roads—every 39 months
- Standard bridges and culverts on local roads—every 57 months.

Level 2 (or condition) inspections require specialized equipment or expertise and are determined as a result of information from Level 1 inspections.

The department's estimated annual costs for data collection include the following:

- IRI/Rut—Can\$550,000 (US\$441,000)
- FWD (strength data)—Can\$450,000 (US\$361,000)
- Surface distress data—Can\$200,000 (US\$160,000)
- Bridge inspections—Can\$600,000 (US\$481,000)
- Digital videos—Can\$400,000 (US\$321,000) every 3 years, with an annual update of Can\$80,000 (US\$64,000) for the remaining 2 years.

These costs total Can\$26 per lane-kilometer (US\$33.50 per lane-mile) with video and Can\$19 per lane-kilometer (US\$24.50 per lane-mile) without video.

Analysis Procedures and Prioritization

AIT uses scenario analysis to examine the implications of different investment strategies on the performance of the highway network. Typical scenarios include the following: What level of funding is necessary to maintain current performance? What happens if current budget levels are applied in future years? What happens with different investment budgets? To determine future road performance at the network level, it is assumed that the network deteriorates at a 5 percent per annum rate. AIT's business plan is based on this analysis.

Life cycle cost analysis is used throughout the asset management program. For individual projects, pavement life span is determined as the time it takes pavement quality as measured by the Pavement Quality Index (PQI) curve to reach a trigger level (e.g., PQI = 6.5 on a 0-to-10 scale). The life cycle will typically include two or three of these life spans, corresponding

to an analysis period of 50 years. Remaining service life is not calculated as part of the assessment. Bridge engineering uses a 50-year life with a 4 percent rate of return for life cycle analysis. As part of the life cycle analysis for bridges, a remaining service life is calculated and modified by condition data obtained from inspections.

Although AIT does not now use benefit-cost analyses to establish project priorities in program development, it is developing such an optimization module for TIMS. AIT officials now use a ranking system based on condition data and other factors as a guide in program development. The output from this ranking system is reviewed and adjusted by regional infrastructure staff.

The development and use of a cross-asset comparison and prioritization scheme was an interesting aspect of the Alberta case. The CPI committee set up a task group to identify a process for prioritizing among different asset types with a focus on capital projects. The resulting rating system assigns points to projects to the extent they help achieve government policies and meet program delivery criteria relating to condition, use, and functionality. A project can receive a maximum score of 100 points. Departments are responsible for prescreening projects before they are rated to confirm 1) the project's need, scope, and cost; 2) the proponent's ability to implement the project; and 3) that the project is a high priority for the agency. According to the prioritization guidelines, the points are assigned in the following way:²⁰

PROGRAM DELIVERY AND HEALTH AND SAFETY—UP TO 76 POINTS

This category assesses condition, utilization, and functionality restraints on program delivery outputs according to optimal and basic program delivery standards established by departments. It considers how seriously these standards will be compromised if the project does not proceed.

The rating system assumes all government programs (schools, hospitals, museums, etc.) are of equal priority and gives equal weight to all programs. Program Delivery is rated according to the intrinsic requirements of each program. Up to 72 points.

Where projects address health and safety hazards caused by the infrastructure itself, the system provides for increased points under the Health and Safety category. Up to 4 additional points.

ECONOMIC FACTORS—UP TO 24 POINTS

Three factors provide additional points based on economic

²⁰ *Capital Planning Initiative, 2003-2003*, Government of Alberta, <http://www.trans.gov.ab.ca/Content/docType52/Production/CPI%20Final%20Report%202002-03.pdf>

considerations, representing 24 percent of the maximum potential rating score.

- The Economic Benefit Factor is based on four key objectives of the Province's economic strategy. Up to 12 additional points.
- The Cost Avoidance and Savings factor awards points to projects that will result in future savings to the province or provincially funded agencies based on program delivery or facility operation and maintenance costs that will be saved if the project is implemented. Up to 8 additional points.
- The Value and Cost Effectiveness factor awards points where the capital cost funding commitment is less than indicated by provincial guidelines, usually because of funding from others (public-private partnership arrangements, fund raising, other governments, etc.). Up to 4 additional points.

MAXIMUM SCORE: 100 POINTS

Observations

AIT has made a major commitment to asset management as part of its business plan and as a key component of its role as a road manager. AIT was the only state-level agency the scan team visited where officials were responsible for more than road assets. Thus, the way tradeoffs occur among asset categories was an interesting aspect of this case.

Several important characteristics of the asset management approach at AIT stand out. It is very clear that high-level managers have bought into the asset management approach to network stewardship. In many ways, the entire organization has been reinvented to incorporate a different business and decisionmaking culture. Asset management is viewed as an important means of determining the best business decision for a large portion of the agency's budget. AIT's credibility with other agencies, the public, and, perhaps most importantly, the elected government is strongly tied to having a defensible and understandable technical foundation underlying its recommendations.

Another aspect of asset management in terms of the buy-in was the need for such a strategic perspective in an environment where much of the service delivery is outsourced. AIT has learned that outsourcing such services requires a more active role by the asset owner to make sure the right things are being done.

AIT is developing a state-of-the-art infrastructure management system. The many different modules and their roles in supporting agency decisionmaking were impressive. Once this system is completed, it could very well be at the leading edge of decision-support systems at state-level transportation departments. The use of a locational referencing system to tie databases together is also a useful model for other agencies. The BEADS and NESS functionalities were particularly impressive.

The use of TIMS to build up work activities (see figure 13) is a very important and useful capability. Once this entire system is in place and functioning, TIMS will likely become a critical tool for AIT in responding to asset deficiencies quickly and efficiently.

For cross-asset category comparisons, the use of similar performance measures—condition, use, and functionality—across infrastructure groups allows AIT officials to develop a best-value investment package. The scoring scheme developed for the CPI process is an innovative attempt to examine cross-asset prioritization. Although models and analytical procedures to provide a dollar-for-dollar comparison across these asset categories do not appear to be in place, tradeoffs are likely to occur and information from systems like TIMS can be critical in supporting the transportation asset portion of this comparison.

One of AIT's goals is to become a center of excellence for transportation in North America. At least in the asset management arena, it appears to be well positioned to become exactly that.

NEW SOUTH WALES, AUSTRALIA

Roads and Traffic Authority (RTA)—

www.rta.nsw.gov.au

Context

With more than 189,000 lane-kilometers of sealed road, New South Wales (NSW) has one of the most extensive road networks in Australia. The Roads and Traffic Authority (RTA) of New South Wales is the agency responsible for the major roads and bridges on this network. RTA's stated vision for its stewardship of this network is to assure "value for money" in its investment decisions, and to provide effective governance and risk management in partnership with industry and the state's communities.

According to RTA officials, the major challenges facing the transportation system include 1) major exponential growth in freight demand, 2) relatively flat growth in public transit use, 3) major exponential growth in private passenger demand, 4) increasing demands by utilities to use road corridors, 5) increased community expectations on safety and environmental quality, and 6) increasing roles for defense and security uses of the road, airport, and port systems. There has also been a trend toward bigger and heavier trucks being permitted on the road network, which has had design, safety, and operational consequences. From the asset management perspective, a 40 percent increase in truck mass limits since the 1960s has severely stressed an

“With respect to asset valuation, we tell the accountants that we will follow your rules, but we will not let them drive investment.”

—RTA OFFICIAL

Infrastructure Managed

By RTA

- 4,800 bridges
- 37 tunnels
- 3,300 signals
- 42,000 lane-kilometers (26,098 lane-miles) of arterial pavement
- 750 lane-kilometers (466 lane-miles) of unsealed road
- 200 million m² (239 million yd²) of surface
- 9 vehicular ferries

By local government, regional roads

- 13,600 km (8,451 mi) sealed roads
- 4,800 km (2,983 mi) unsealed roads
- 1,500 nontimber bridges
- 323 timber bridges

By local government, local roads

- 20,000 km (18,642 mi) urban sealed roads
- 40,000 km (18,642 mi) nonurban sealed roads
- 82,000 km (50,954 mi) nonurban unsealed roads
- 7,600 bridges, including 2,600 timber

Drivers for Asset Management

The RTA definition of asset management borrows from many other definitions offered by organizations in Europe, the United States, Australia, and New Zealand:

- Consists of a broad, integrated systems approach to respond to customer-level-of-service needs to maintain, upgrade, and operate physical assets cost effectively
- Competes with other portfolios for scarce public funds (e.g., health and education)
- Relies on economic analysis and deterioration models

The New South Wales Department of Treasury is a major

arterial and local road network built to the standards of the 1950s and 1960s.

New South Wales has 166 local government councils, and RTA has a road grant program of about A\$150 million per year to help these councils improve their regional road network. New South Wales will also cover 50 percent of the cost of improvements to timber bridges.

Similar to other Australian states, New South Wales has been using public-private partnerships to build some major new projects, and has contracted out a portion of its road maintenance activities to private contractors (two to three contractors). In both cases, the provision of asset management strategies is incorporated into the concession deeds or contracts.

driver for RTA's approach to asset management. The department has adopted a policy with a stated objective of “managing infrastructure as a long term renewable asset and to use an integrated package of recurring maintenance with capital renewal to achieve modern standards without increasing functional capacity.”²¹ Capacity increases are funded under a separate program. The Treasury expects each agency to adopt its own policy consistent with the Treasury's. It depends on RTA “to manage risks of technological redundancy and to separate expansion of effort from maintenance of effort.” The Treasury's policy is intended to address “past bias towards acquisition of new capital assets at the expense of appropriate asset maintenance.”

Of the sites the team visited during this scan, the NSW Treasury was one of the most active in encouraging asset management practice. The Treasury's directions for asset management in government agencies require the following:²²

- Develop an asset portfolio to support and demonstrate service delivery.
- Set priorities for the assets to be managed.
- Develop a gap analysis between existing and required assets.
- Identify asset-related risks that affect delivered services.
- Identify asset performance levels required to achieve service performance established in a Results and Services Plan (RSP).
- Address risk and compliance with mandatory requirements or asset standards.
- Define the relationships between the RSP and Corporate Plan.
- Provide information for capital investment, asset maintenance, and asset disposal.

In addition to the Treasury directives, RTA officials identified other reasons for greater emphasis on asset management in the agency. The government's transport minister and the community at large expect RTA to provide the most cost-effective service possible. Asset management helps RTA do this. In addition, asset management enhances RTA's relationship with other agencies, such as the Department of Infrastructure, Planning, and Natural Resources and the Treasury. It helps RTA compete for funds with other agencies at the state and federal levels, and provides greater scrutiny and accountability for program and project management. Finally, asset manage-

²¹ See <http://www.treasury.nsw.gov.au/pubs/tpp2004/tpp04-3.pdf>.

²² New South Wales, *Total Asset Management Template, Report TAM04-06*, Sydney, NSW, Sept. 2004. http://www.treasury.nsw.gov.au/tam/pdf/tam_template.pdf.

“We are not separate from the political process; we are part of government. Thus, our role in asset management is to inform this process and influence it.”

—RTA OFFICIAL

ment allows RTA to provide better workforce planning, an important challenge with its aging workforce. RTA has had very stable political leadership, with the most recent minister staying for 8.5 years. This has allowed RTA to develop a strong base of support for asset management among government leaders.

Organization for Asset Management

At the state level, a Cabinet Standing Committee on Infrastructure and Planning reviews and endorses major infrastructure proposals and asset strategies for roads, transport, energy and utilities, education, health, and housing. This committee must approve proposals before they can be considered by the Cabinet’s Budget Committee and subsequently included in an agency’s capital plans.

Within RTA, the Directorate of Road Network Infrastructure is responsible for network development and maintenance, spending about 70 percent of RTA’s budget. The Infrastructure Maintenance Branch in this directorate was responsible for preparing RTA’s Infrastructure Maintenance Plan, a plan credited with convincing politicians to allocate more funding to asset preservation. Other directorates, especially the Traffic and Transport Directorate and the Motorways Directorate, also share responsibility for asset management of the road infrastructure. This organizational structure has been endorsed by the Treasury and has been instrumental in securing increased funding for asset maintenance. For example, after RTA highlighted road infrastructure needs through this structure, the government agreed that revenue from recent increases in Sydney Harbour Bridge tolls and other road-user charges will be dedicated to maintenance work in Sydney and other parts of New South Wales.

Decisionmaking Approach

RTA’s investment decisionmaking and corporate resource allocation processes focus on two major types of projects, whose definition has been agreed to by the Treasury.

1. **Infrastructure asset management** entails “customer works and services to ensure route assets are available for reliable operation and performance of their existing functionality and are in compliance with current legislative, regulatory and community safety and environmental standards. The ‘existing functionality’ of route assets is defined as projects and services to ensure routes are open for travel under all ‘non-disaster’ weather conditions by all general access vehicles together with restricted access vehicles permitted on that route, at speeds up to the designated speed environment for that route without wide-

spread speed limits imposed for safety purposes.”

2. **Network development** entails “customer works and services that expand the functionality of routes to improve congestion, provide reliable and predictable travel conditions, support land use development, and enable travel by vehicles other than General Access and those Restricted Access Vehicles already permitted on that route.”

RTA’s definition of asset management excludes network development, but does allow the upgrading of bridges and pavements through rehabilitation or reconstruction.

Every NSW agency is required to have a strategic plan that explains how the agency intends to use its service delivery, back office, and funding/asset strategies to achieve its desired service delivery results. The plan typically contains the agency’s vision, mission and values. A service delivery strategy identifies and prioritizes the agency’s clients and their key service delivery requirements over the next 3 to 5 years. The strategy describes how the mix of services provided by the agency will lead to achievement of the agency’s desired results.

The Treasury requires each agency to also have a Results and Services Plan (RSP) that provides information on the following:

- Services an agency provides
- Results an agency is trying to achieve for the community
- Result indicators and service measures
- Emerging and strategic issues that may have an impact on service delivery or results
- Major risks that may prevent a service from being delivered as planned
- Risk-management strategies
- Major strategies or initiatives necessary to ensure organizational capability to deliver services and achieve results
- How strategic issues will be managed
- How performance will be reported

In some cases, the RSP could be satisfied by an agency’s Statement of Intent. Figure 16 (see next page) shows the alignment among the Corporate (or strategic) Plan, the Results and Services Plan, and the Asset Strategy. Figure 17 (see page 41) shows the flow of decisionmaking and information in support of RTA’s asset management program.

Performance Measures

RTA has used network performance measures for many years as part of its system stewardship and governmental accounta-

CORPORATE PLAN	RESULTS & SERVICES PLAN	ASSET STRATEGY PLAN
In what areas does your agency need to make a difference over the next three years? KEY RESULT AREAS	STEP 1 Identify Results	STEP A Select those Results which will be dependent on the agency's assets working well
In each of these areas what specifically do you want to achieve? RESULTS	STEP 2 Nominate Intermediate Results	STEP B Select those Intermediate Results which will be dependent on the agency's assets working well
What impediments are there to your intended results that you can do anything about? RISK ANALYSIS	STEP 3 Describe the strategies to achieve the Results	
What will you do to achieve the outcomes and manage the risks? STRATEGIES		
What service, to whom, when, where, to what standard, to what capacity SERVICE NEEDS	STEP 4 Identify & Group Services	STEP C Identify those Services which will be dependent on the agency's assets working well
	STEP 5 Identify Risks & Risk Management Strategies	STEP D Identify asset-related risk which may prevent the achievement of Services & Results
How will you judge how successful you have been? PERFORMANCE INDICATORS	STEP 6 Identify <ul style="list-style-type: none"> • Services Measures • Result Indicators 	STEP E Develop Asset Portfolio to support Services
		STEP F Identify the level of performance required by the assets to achieve the planned service performance level, results and to address risks
		STEP G Identify any existing asset performance standards relevant to the asset types held by the agency
		STEP H Develop performance measures to report on how well the assets meet <ul style="list-style-type: none"> • the standard necessary to support service and to address risks • the existing standards for the asset types
		STEP I Identify benchmarks and compare performance to them

Figure 16. *Alignment among Corporate Plan, Results/Services Plan, and Asset Strategy at the Roads and Traffic Authority.*

bility responsibilities. Performance measures are found in several different categories, primarily relating to customer outcomes, achievement of customer needs, and delivery of government commitments. Each performance measure has specific characteristics associated with it,

including management accountability, coverage and scope, reporting frequency, reporting level, information source, and benchmarking suitability.

For asset management, the performance measures used most often include those relating to community satisfaction, safety, asset retained value, age of pavement and structures, and network reliability. The asset management-related performance measure reported in the latest RTA annual report was ride quality and pavement durability (along with fatalities and traffic speeds/volumes for seven routes to and from Sydney). Figure 18 (see page 42) illustrates some of the measures RTA officials use to monitor network performance.

The NSW Treasury identified several key factors for performance indicators in its maintenance strategy guidance to other agencies. They are repeated below because they provide a good checklist for developing a performance-based asset management program.²³

- Indicators should focus on outcomes achieved rather than action taken.
- Consistency in definitions and methods of measurement is essential to ensure results can be analyzed and compared over time.
- Simplicity should be as highly valued as reliability. Complex approaches are expensive and often need a high level of expertise.
- Rarely do numbers alone tell the story. Qualitative information on performance is equally useful.
- Indicators should be explicit in their format and expressed as a percentage, ratio, or some other numerical format.
- The number of indicators used at any management level should be limited to a maximum of about seven.

²³ NSW Treasury, *Asset Maintenance Strategic Planning*, Report TAM 04-3, Sydney, NSW, Sept. 2004, See, http://www.treasury.nsw.gov.au/tam/pdf/asset_maintenance.pdf.

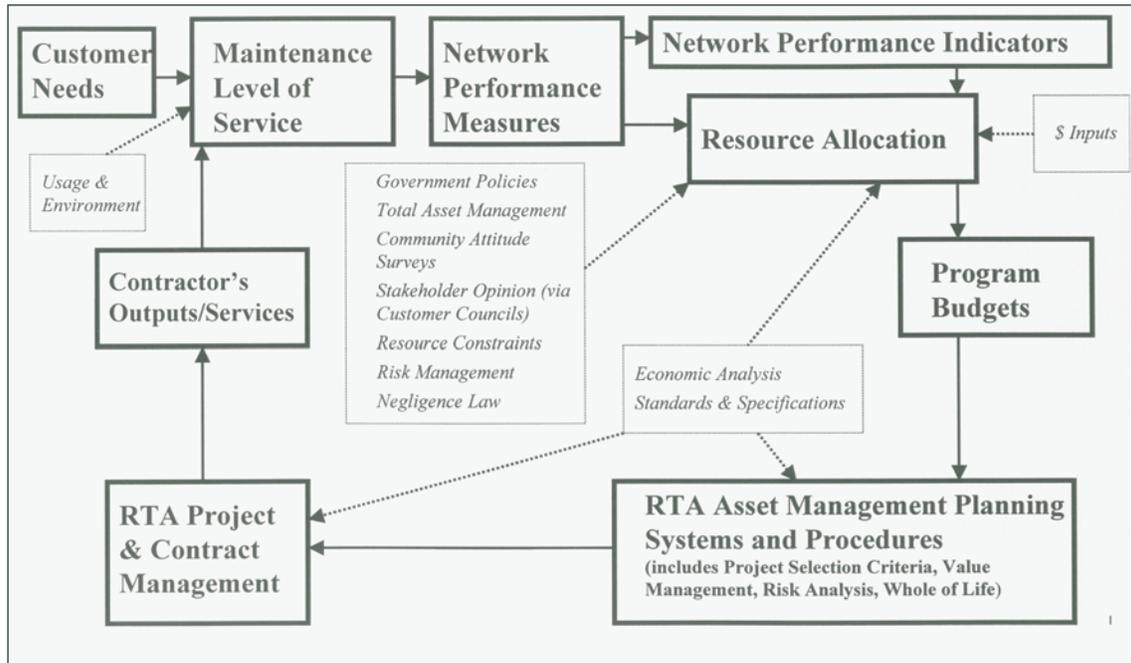


Figure 17. *Decisionmaking structure for asset management in New South Wales.*

Larger numbers of indicators tend to lose relevance and their impact is diluted.

- Indicators should be underpinned by an information system that enables the information required by the indicator to be readily available.
- In defining success, experience has shown that input at the development stage from those using the indicators will help engender ownership and support for the application of the indicators.

Because of the usefulness of the guidelines prepared by the NSW Treasury in developing an asset strategy, the NSW template for doing so is reprinted in Appendix E.

Asset Management Information Systems

RTA has information systems for inventory and condition data that can be used to assign project/work tasks as well as to monitor systems performance. The physical assets monitored include road pavements, bridges, corridor assets, traffic facility (signs, lines and markings), and traffic signals.

RTA has purchased commercial software to manage its road network inventory data. The Road Asset Management System (RAMS) is the repository of road pavement and corridor inventory and condition data, including engineering history. A Traffic Asset Information Management System (TAIMS) keeps track of the traffic facilities inventory (road signage, pavement markings, line marking, and safety barriers), including work

task scheduling and management. RTA has separately developed in-house information systems to manage bridges (BIS) and slope stability, works ordering, contract management, and project management systems.

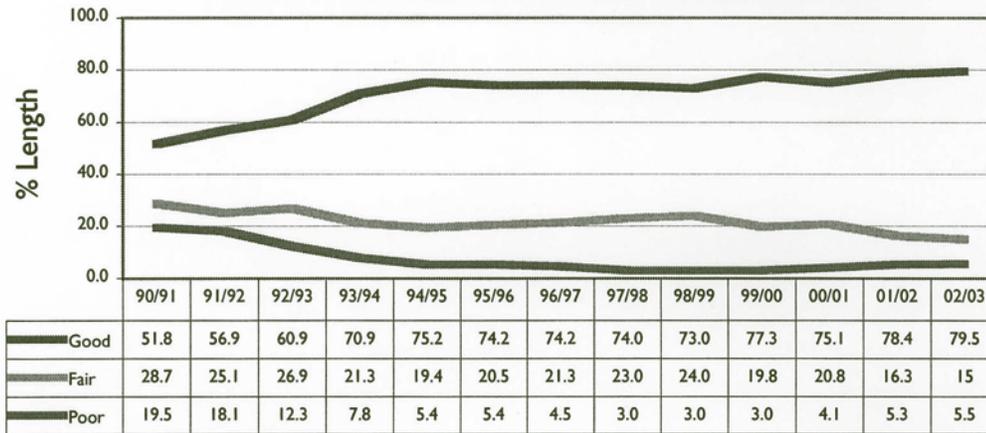
Maintenance work is tracked through a Maintenance Contract Management (MCM) system. When maintenance work is completed, reports are submitted to the asset management group for recording in RAMS, BIS, etc. Regional maintenance planners are responsible for tracking planned maintenance.

RTA uses a link/node location referencing system to locate its inventory and condition data on the state road network. This is used in conjunction with global positioning systems (GPS) technologies for asset inventory updates. Given a common referencing system, inventory and condition items can be co-located and displayed with other spatial characteristics.

Figure 19 (see page 43) shows the results of the integrated asset information system. The information describes key characteristics of a short portion of the highway from Melbourne to Brisbane. The information includes the condition and operational characteristics in comparison to performance measures, indicating deficiencies by color (red implies that standards or measures are not being met). The right side of the figure shows the projects planned in this corridor over the next 5 years.

Pavement Durability on Sealed Country State Roads (Including National Highways)

Since 97/98, new automated technology has been used to collect Pavement Durability data



Number of Structurally Deficient Bridges on State Roads (Including National Highways)

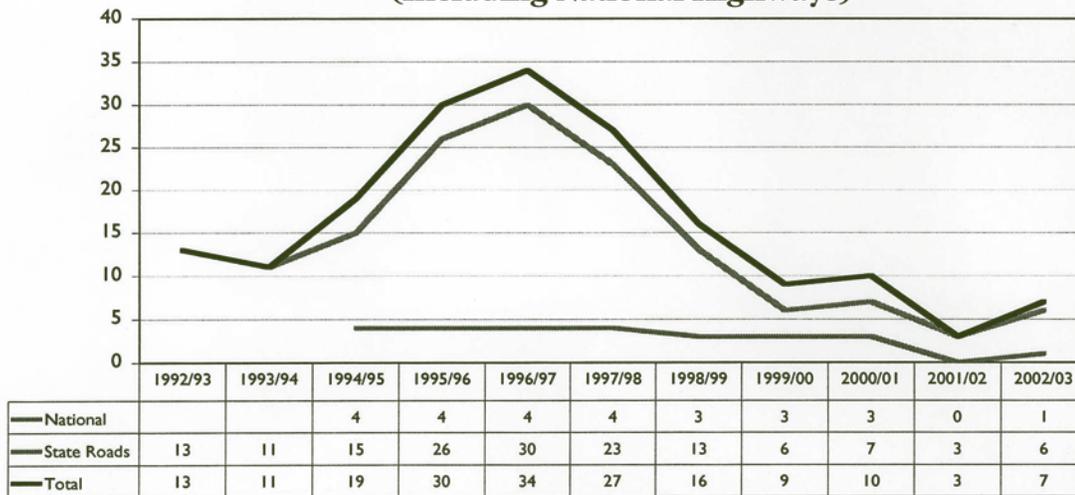


Figure 18. *Examples of Roads and Traffic Authority performance measures.*

Data Collection

Data collected for the asset management systems include 1) structural condition for pavements, bridges, culverts, vehicular ferries, and utilities under highways; 2) dimensions (widths and heights) for tunnels, truss bridges, utilities over highways, lane and shoulder widths, and turning space; 3) operational performance such as traffic flow, incident management systems, ventilation/fire management systems for tunnels, and frequency of road-passing opportunities; 4) safety such as skid resistance, road and bridge width, road shape, alignment, deformations, and ride quality and lane widths affecting driver fatigue; and 5) environmental characteristics such

as noise, pollutant emissions, and water pollution.

Road inventory data (including condition data) are collected through a combination of in-house resources and contract services. Road condition data (roughness, rutting, cracking, video, and skid resistance) are managed by a unit in RTA's central office. Data are made available to regions via corporate information systems. Bridge condition inspections are managed regionally, defined with a four-tier inspection regime (drive through, condition-rating elements, engineering inspection, and load capacity) and schedules depending on the criticality of the structure (timber bridges every year, other structures every 2 years, and underwater inspections every 4 years).

Smart sensor technology is starting to be used to monitor a variety of assets (slope and retaining wall stability

and bridge health monitoring), and to determine use (volume, load, and speed) and incident management response.

Analysis Procedures and Prioritization

The analysis procedures and prioritization schemes RTA uses depend on the type of asset program being considered. For network and road capacity expansion, benefit-cost analyses are used to justify investment. For maintenance-of-service effort, or what would be called infrastructure asset management, projects are prioritized through a risk management process. Separate program budgeting occurs for different types of projects and agency services triggered via a deficiency or gap analysis. Within the maintenance program,

“The challenge is to make asset management and maintenance management ‘sexy.’”

—RTA OFFICIAL

a two-stage process is used to prioritize allocations. These stages or prioritization levels include the following (in order of priority):

- Prior government commitments (e.g., disaster relief or financial assistance to local governments) and business management needs (e.g., data collection and information system support)
- Maintenance of the state road network, including keeping the route functioning (e.g., slope stability), assuring safety (e.g., pavement conditioning and bridge widening), assuring minimum risk to the value and integrity of the asset (e.g., painting bridges and reconstructing pavement to enhance useful life), and assuring productive and reliable level of service

After government commitments have been taken care of, priority is given first to safety improvements (risk minimization), then to retained value, and then to asset functional reliability.

Similar to other Australian states, heritage bridges provide an important challenge to the structures asset preservation program. Many bridges in New South Wales are considered historical, and the asset management process deals with such bridges as special cases.

The concept of risk management permeates the asset management prioritization process at RTA. Such an approach is based on Australian/New Zealand standards for risk management, corporate risk evaluation criteria,

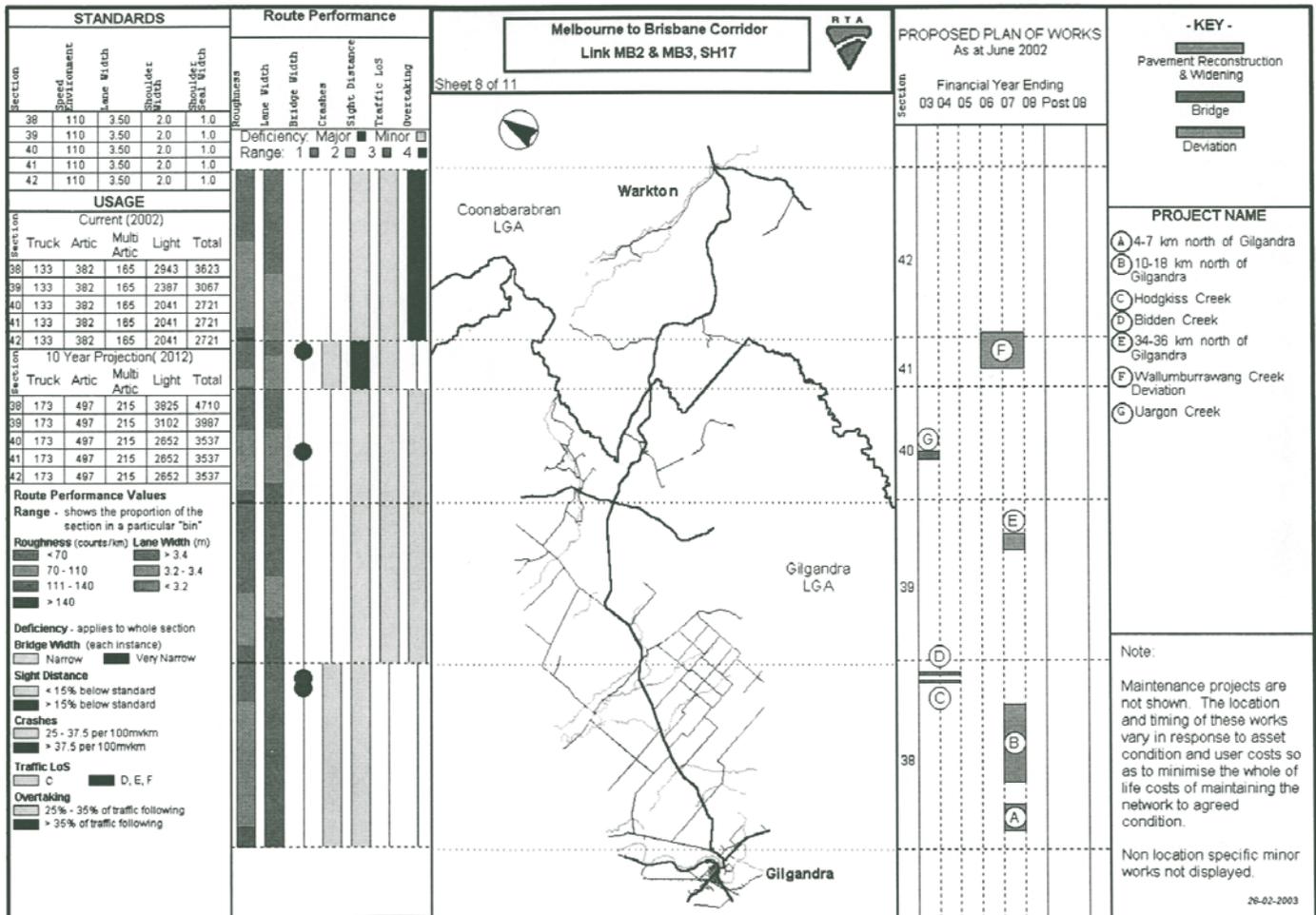


Figure 19. Results from the New South Wales integrated asset management system.

Innovative Public Agency/ University Partnership on Asset Research

A new road tunnel under Sydney Harbour was RTA's first BOOT (build, own, operate, and transfer) project. RTA entered into a 30-year contract with the Sydney Harbour Tunnel Company (SHTC) that expires in 2022. RTA/SHTC entered into an innovative partnership with the University of New South Wales as part of a project to monitor the corrosion of a new road tunnel under Sydney Harbour. The tunnel was designed with a 100-year life.

A transition tunnel structure was cast in-situ below sea level and under the Sydney Opera House. This structure was the most complicated and critical section for the long-term durability of the tunnel. The A\$750 million project was implemented under a public-private partnership, with a maintenance sinking fund established upfront to deal with periodic and unexpected maintenance needs. Routine inspections were part of the concession deed, with specific requirements for corrosion rate measurement and crack movement monitoring.

The University of New South Wales, in partnership with the tunnel authority, developed new and innovative concepts for maintaining this critical asset. The university developed a new curvature mapping projection that allows identification of corrosion hotspots, pioneered a micro cement crack injection capability that is a new corrosion remediation approach, developed a local cathodic protection technique, and conducts lab tests to identify the influence of crack width on corrosion rate.

The interesting characteristics of this case were 1) joint management of a maintenance sinking fund to ensure suitable condition at handover, 2) detailed analysis to identify and qualify risks, 3) novel remedial strategies to manage risks at minimum costs, 4) research to fill the gap in routine knowledge, and 5) state-of-the-art techniques to add value to the long-term durability of the tunnel infrastructure.

scenario analyses, and promotion of safety improvements as top-priority investments.

Asset values are determined by an estimated replacement cost approach (derived from recent construction unit rates and redetermined every 5 years with yearly increments in between) and straight-line depreciation to determine an asset value. Pavement and earthworks are depreciated at

different rates. Bridges are similarly valued, using different depreciation rates (steel/concrete at 100 years and timber at 60 years). The total road system asset value is estimated at A\$65 billion (including land).

Public-Private Partnerships

RTA has entered into several public-private partnerships (PPP) for toll roads. One such project, called the Eastern Distributor, was awarded a 48-year concession in 1997 to build, operate, and maintain a freeway connecting several of Sydney's major roads. The 48-year term was arrived at after lengthy negotiations involving public consultation over an acceptable design (the originally estimated concession term was 35 years). The resulting compromise included additional bridging over the toll road to create more open space, and moving the tunnel portals away from sensitive environments (botanical gardens and an art gallery). This road now averages around 3 million vehicles per month.

The operator's agreement required conducting routine maintenance and repair, identifying premature deterioration, keeping maintenance records, and making sure the asset met the handover obligations. The road operator provides a maintenance plan for such activities as inspection, cleaning, and consumable replacement; reports on unplanned maintenance; and undertakes planned major maintenance tasks (e.g., pavement resurfacing or replacement of major mechanical or electrical components such as a jet fan).

Another PPP project will open soon. This project placed a greater emphasis on asset management in the request for proposals. In this case, an asset management database is required that classifies assets according to hierarchy and spatial location, the historic profile of design and construction data, asset condition, and maintenance servicing records. An asset management system using deterioration modeling that predicts future asset condition and develops maintenance profiles (life cycle optimization) must be put in place. Condition deterioration (e.g., roughness and pavement condition) of individual assets is calibrated to actual historical profiles, and asset condition is assessed on a regular basis and reset after remedial work. Real-time monitoring of key performance indicators is part of the operator compliance with the deed requirements. In addition, an asset manager position must be created as part of the concessionaire's organizational structure.

The operator for a PPP project (not the concessionaire) discussed recent developments and emerging trends in PPP arrangements that will have different consequences

on different stakeholders. For example, the increasing use of maintenance standard codes in contracts clarifies the scope of maintenance tasks and reduces the risk of dispute. Incorporating key performance indicators into contractor agreements and monitoring operator performance against these indicators provides an excellent method for monitoring critical areas of performance, but runs the risk of entailing excessive costs for data collection. The trend toward using a contracting agent to operate a facility and passing additional risks from the concessionaire to this operator could result in substantial cost increases, and a shift from what has been a trusted partnership to a relationship based more on contract language.

Observations

Similar to other Australian states, RTA shows a high level of consistency among the agency's many levels of decisionmaking in what it is trying to accomplish. Performance measures are in large part a reason for this, as is a serious effort to think carefully about how one plan relates to another. Because of Treasury guidelines, asset management is integrated in these plans, as is an asset management policy.

RTA has reached an agreement with Treasury on what constitutes maintenance versus major rehabilitation. Sometimes a fine line exists between the two, and RTA has established the boundaries of its asset management program to include minor rehabilitation projects.

The Road Asset Management System (RAMS) appears to have very good functionality for decision support (see figure 17). It can display a variety of information useful to road managers, including condition and performance deficiencies, relevant standards, and proposed projects in the corridor.

RTA has concerns about whether straight-line depreciation and accounting standards are the appropriate way to value assets. RTA has discussed this issue with Treasury, and although RTA still reports value and remaining life according to the guidelines, it relies on its asset management systems to help define priorities.

Finally, the New South Wales learning experience with public-private partnerships and the appropriate role for asset management is very important. The evolution in the consideration of asset management responsibilities between the first project's and second project's concessionaire contract was dramatic (the same is true in the Victoria case).

RTA has adopted a serious approach to asset management as it pertains to PPP projects. This could be an important lesson for the United States, which is turning increasingly to public-private partnerships for major project investment.

QUEENSLAND, AUSTRALIA

Main Roads—www.mainroads.qld.gov.au

Context

Queensland is the size of Alaska (2.5 times the size of Texas), but has a population similar to that of Iowa. This could change, because Queensland expects a 50 percent population increase over the next 25 years, making it the fastest-growing state in Australia and possibly its most populous in 30 years. In concert with this population growth, freight demand is expected to double over the next 20 years. This is a particular challenge to road managers because much of this truck growth will be in the natural resource industry. Three of the top five exports are natural resource-related and the trucks serving this industry tend to be long and heavy. All of this growth places increasing pressure on Queensland's transportation network to handle significant increases in travel.

The Department of Main Roads is the agency responsible for 34,000 km (21,127 mi) of Queensland's road network, representing 20 percent of the state's total road network but carrying 80 percent of the traffic. This road network is the state's largest single physical asset, with a replacement value of A\$26.6 billion (US\$20.1 billion). To manage this network, Main Roads is divided into four regions and 14 districts. Routine maintenance of this network is often carried out with Road Maintenance Performance Contracts.

About one-third of the maintenance is done this way, and of this one-third, two-thirds is done by maintenance organizations or firms and one-third by local government. Although Main Roads has considered outsourcing all maintenance, the employment needs of rural Queensland have created political pressure to keep public employment. The prominent player in outsourced maintenance delivery is RoadTek, Main Roads' internal commercial business provider. With a usual contract period of 1 to 2 years, contractors become an important component of the network condition and operations management structure.

According to Main Roads' officials, the key transportation challenges Queensland faces include providing the infrastructure necessary to accommodate increasing travel growth, dealing with increasing congestion (including incorporating transit services into major road corridors), serving rural areas

Transportation Infrastructure Managed

By Main Roads

- 34,000 km (21,127 mi) of roads out of 174,000 km (108,122 mi)
- 2,740 bridges (560 timber)
- 20,000 major culverts

“In the short term, we must deliver our capital program, but over the long term, we are responsible for the investment in our road asset. . . . It is not an either/or decision; we must do both.”

—MAIN ROADS OFFICIAL

accessible only via roads, rehabilitating a large number of bridges subject to heavy truck loads, and meeting customer expectations in a financially constrained environment. Main Roads’ officials stated that they want their agency to be viewed more as a road management agency, not just a road builder.

Drivers for Asset Management

A 1994 law that required government agencies to adopt an outcomes-based approach to business decisions was a major impetus for Main Roads’ evolution toward asset management. This was the beginning of Main Roads’ concerted effort to adopt a road network strategy based on performance monitoring.

The first major steps in a government-wide approach to asset management occurred in 1997 when Queensland’s Treasury Department adopted the *Financial Management Standard 1997*, which required agencies to undertake asset strategic planning as part of their strategic and operational planning processes.²⁴ Such planning was charged with focusing on an asset’s life cycle, associated costs, and how the asset aligns with service delivery outcomes and government priorities. An asset strategic plan was required, which was intended to reinforce the government’s policy that public investment in infrastructure should adopt a whole-of-government approach so that limited resources could be focused on obtaining the most value to the community. Queensland’s public-private partnership (PPP) policy also states that when an asset has an initial capital cost exceeding A\$30 million (US\$22.6 million) or when the net present value (NPV) of the asset’s whole-of-life costs exceeds A\$50 million (US\$ 37.8 million), then agencies must, in conjunction with the *Asset Strategic Plan Guidelines* of the Queensland Treasury, undertake an analysis using a value-for-money framework.²⁵

Because the 1997 standard was so important in initiating asset management practices throughout Queensland’s government, it is worthwhile to examine what was required in the asset management plan. The plan required the following:

- Document an agency’s needs for asset resources.

- Outline the evaluation process used to determine the most appropriate solution to the asset needs identified.
- Improve analysis, planning, and monitoring of recurrent expenses by adopting a whole-of-life costing approach when procuring new asset resources.
- Improve the alignment of asset resources with output production requirements.
- Highlight the risks associated with asset resource acquisition and control.
- Encourage the examination of options for delivering services (capital investment, capital grants, and private-sector involvement).
- Foster a proactive planning culture of anticipating future asset requirements, which will minimize the risk of not providing needed services.

Although Main Roads had already begun some effort in pavement and bridge management before 1997, the standard spurred the agency to make its asset management program more comprehensive. In addition, as of 2000/2001, only one-third of local governments had some form of pavement management system, so the standard spurred interest among local officials as well for more comprehensive asset management efforts.

In 2000, Queensland Treasury issued guidelines to replace the 1997 standard that have had an especially strong influence on asset valuation. The *Non-Current Asset Accounting Guidelines for the Queensland Public Sector* provide guidance on identifying, valuing, recording, and writing off noncurrent physical and intangible assets.²⁶ This new guideline requires assets to be measured either at historical cost or fair value. This has resulted in Main Roads adopting an asset management approach to asset valuation that is one of the few such applications the team observed on this scan. This asset management approach has led to, or at least occurred simultaneously with, a changing Main Roads philosophy of wishing to be viewed more as a road manager than a road builder.

Another driver for asset management found in Victoria, but not as prevalent in Queensland, was the legal treatment of

²⁴ Queensland Treasury, *Financial Management Standard 1997*, Reprint 3C, Brisbane, QL, see: <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/F/FinAdminAudSt97.pdf>.

²⁵ Queensland Treasury, *Asset Strategic Management Guidelines*, Brisbane, QL, July 2003, see: <http://www.treasury.qld.gov.au/office/knowledge/docs/asset-planning/asset-strategic-plan-guidelines.pdf>.

²⁶ Queensland Treasury, *Non-Current Accounting Guidelines for the Queensland Public Sector*, Brisbane, QL, May 2001, see: <http://www.treasury.qld.gov.au/office/knowledge/docs/non-current-assets/non-current-assets.pdf>.

liability. Unlike Victoria, where the law on nonfeasance²⁷ was overturned (resulting in the need for a defensible investment decisionmaking process), Queensland has kept its nonfeasance law. Queensland is waiting to see what happens in Victoria to determine if it is workable and desirable.

Organization for Asset Management

Main Roads has established a Road Asset Maintenance Steering Committee (RAMSC) to oversee the development of road and bridge maintenance policies. This group oversaw the publication of the Road Asset Maintenance Policy and Strategy, a vision for road asset management practice in the agency. In the agency itself, the primary organizational unit responsible for asset management is the Road Network Management Division, although many other units contribute data and expertise. This division is responsible for asset management information systems, which, according to the division's description, are "integral to enabling our division to play a major part in the analysis of road network and maintenance solutions."

Important to the implementation of asset management in Main Roads are principal engineer positions that are responsible for network performance, including asset management delivery, which have been established in all regional offices. Main Roads' asset management program has also developed targeted training programs and courses aimed at improving the asset management capabilities of its own staff.

Main Roads has established a unique institutional structure for decisionmaking at the regional level. Called the Roads Alliance, this program encourages local governments to join with peers with mutual interest in the road network to identify and assign priorities to roads of regional significance.²⁸ Regional road groups (the term used to describe this peer committee) have been formed in all 15 regions. Main Roads participates in these road groups, which now include 125 of the 126 local councils. Local governments and Main Roads contribute investment funds to a regional pot of money to spend on roads of regional significance.

By 2005/2006, the regional road groups are expected to develop 5-year investment programs that will be incorporated into the Main Roads Improvement Program. These investment programs will include a 4-year fixed schedule of investment along

with one indicative year. Other conditions are that at least 80 percent of Main Roads' funds must be allocated to the state road network, no group member is required to spend its funding outside of its jurisdictional boundaries, and all routine maintenance is the responsibility of the road owner. Preliminary experience with this structure has suggested that local governments understand the need for a regional perspective on asset management and, in some cases, have allocated their own funds to support projects outside of their jurisdictions.

Another benefit of the Roads Alliance is that it has developed joint purchasing and resource-sharing practices. These practices range from improved project-scheduling procedures to better methods of identifying risks. A Roads Alliance Road and Bridge Asset Management Kit has been developed that lays out the key steps in asset management practice. The Roads Alliance also sponsors workshops and training sessions on tools and techniques to improve the productivity of public works employees.

Decisionmaking Approach

Main Roads relies on plans and decision support systems to support policy development and organizational decision-making. For example, Roads Connecting Queenslanders is the overall statement of vision and strategy for a cost-effective road investment program in Queensland.²⁹ This plan, referenced in all asset management documents, establishes the overall framework for Main Roads' activities in asset management.

A Road Asset Maintenance Policy and Strategy (RAMPS) was published in September 1999 with the goal of fostering a whole-of-life performance approach to Main Roads' investments in maintenance.³⁰ It also defined maintenance performance standards, and recommended that an analysis-based planning approach be used to support decisions. Such a decision support system should exhibit the following desirable functions:

- Support planning, programming, preparation, and policy research functions.
- Present relevant, reliable, and up-to-date information.
- Predict future impacts on the transport system and its users.
- Compare competing investment or policy choices.
- Consider both the infrastructure and the community.

²⁷ Nonfeasance can be defined as the failure of an agent (employee) to perform a task he/she has agreed to do for his/her principal (employer).

²⁸ For the latest progress report on the Roads Alliance, see: <http://www.mainroads.qld.gov.au/mrweb/prod/Content.nsf/fbadb90201547b374a2569e700071c81/d514e8ed960961904a256bc100802eb1!OpenDocument>.

²⁹ Main Roads, *Roads Connecting Queenslanders, A Strategic, Long-term Direction for the Queensland Road System and Main Roads*, Brisbane, QL, May 2002, see: [http://www.mainroads.qld.gov.au/mrweb/prod/Content.nsf/fbadb90201547b374a2569e700071c81/7ceb01526342d9a84a256bc6008394e3/\\$FILE/MR%20RCQ%20Report1.pdf](http://www.mainroads.qld.gov.au/mrweb/prod/Content.nsf/fbadb90201547b374a2569e700071c81/7ceb01526342d9a84a256bc6008394e3/$FILE/MR%20RCQ%20Report1.pdf).

³⁰ Main Roads, *Asset Maintenance Policy and Strategy*, Brisbane, QL, Aug. 2002, see: [http://www.mainroads.qld.gov.au/mrweb/prod/Content.nsf/fbadb90201547b374a2569e700071c81/a9b38e68267717d14a256c4d00171fb7/\\$FILE/Part1.pdf](http://www.mainroads.qld.gov.au/mrweb/prod/Content.nsf/fbadb90201547b374a2569e700071c81/a9b38e68267717d14a256c4d00171fb7/$FILE/Part1.pdf).



Figure 20. *Similar to other Australian states, Queensland has numerous timber bridges that present important challenges to its asset management program.*

- Allow for new work, maintenance, and upgrading.
- Provide a reliable calibrated modeling capability.
- Assess investment impacts over life cycles.
- Provide monetary and nonmonetary measures of investment effectiveness.

In *RAMPS*, Main Roads defined the relationship among the many different components of a road system management program, including the role for asset management. Figure 21 shows where road asset management and maintenance fit into this broader scheme. The concept of road system management has been recently reinforced with the development of a strategic framework for asset management that links different asset management functions to decisionmaking (based on Austroad's Integrated Asset Management Framework). This framework is called the Road System Manager, whose purpose is to provide "a consistent state-wide understanding of how Main Roads conducts its business" and a "high level view of Main Roads' end-to-end processes and key deliverables in meeting Government priorities and community outcomes, thus providing an environment for decisionmaking, policy development and support."

Note that the word "asset" is not in the term "road system manager." Main Roads officials believed that because of confusion about what asset management might entail (maintenance? preservation? rehabilitation?) it was best to keep asset out of the term. The specific objectives of the road system manager framework are the following:

- Provide relevant decisions for Queenslanders by maximizing benefits and minimizing risks on the road network, making investment decisions context sensitive and "fit for purpose," and providing a legally defensible

rationale for such decisions.

- Promote coordinated program delivery for capability by providing a unified and easy-to-understand view of Main Roads' business and by linking the different business units within the agency into one networked "organization of capabilities."
- Guide the development of quality tools to support Main Roads business by providing access to basic business-related information and by maintaining organizational capability.

Figure 22 (see page 50) shows the strategic framework for road system management. As noted by Main Roads' officials, this framework also represents a subconscious change in organizational mindset. Even though

changes in performance-oriented business practices in the agency had been tried, funding allocations had still been done on a traditional basis and at levels similar to those of previous years. There was thus a sense that something more than just performance-based decisionmaking was necessary. The Road System Manager framework is attempting to evolve toward a road system performance perspective, strongly tied into budgeting.

Because of its importance in explaining the linkage between asset management and decisionmaking in Main Roads, the key components of this framework will be described below. The first set of framework phases—phases 1 to 4—was called "aligned decisionmaking." This meant the framework was intended to relate agency outputs to desired government outcomes, align prioritization of plans and programs with these desired outcomes, conduct sensitivity analyses with funding scenarios, and accommodate broad policy statements. It adopts a whole-of-government outcomes orientation and, when institutionalized, is expected to survive any change in government or administration.

Phase 1: Outcomes and Direction—Sensing and interpreting the external environment to provide tangible direction to Main Roads' outcomes and outputs. This phase uses government policies, community input, market research, and Main Roads' documents that outline the desired directions for the road network as a means of making sure Main Roads is following the direction desired by the public. Main Roads' strategic plan is a primary input into this phase.

Phase 2: Road System Planning and Stewardship (15-plus years)—Translating policy directions and strategic choic-

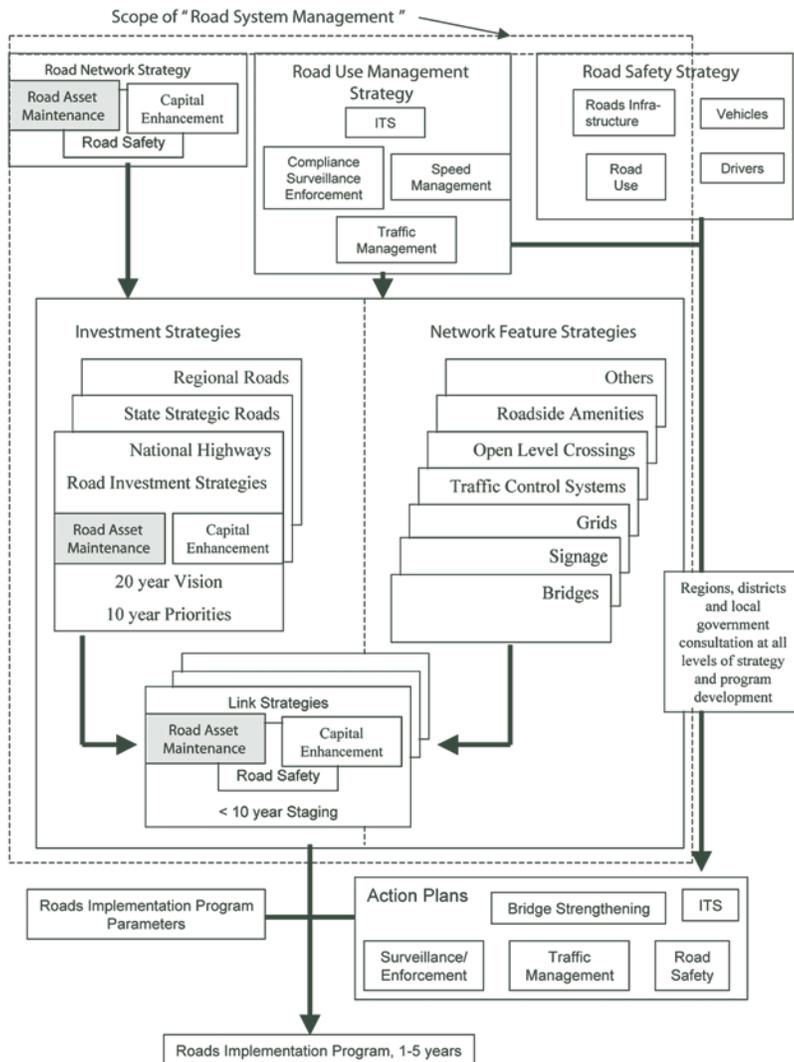


Figure 21. Road asset maintenance in the context of road system management in Queensland.

es/priorities into action plans. This phase includes modeling and other data-based analysis efforts to understand different aspects of road performance and to conduct investment analysis, including forecasting of future performance. The major output of this phase is a Road System Performance Plan that includes a financing plan, a priority network plan, identification of strategic asset metrics (such as condition measures), identification of 39 strategic delivery metrics (e.g., dollars per kilometer), and a network safety analysis.

Phase 3: Corridor Planning and Stewardship (less than 15 years)—Developing future-oriented plans and investment strategies for corridors, as well as stewardship of the current asset and operation conditions. The corridor plans should be multimodal and include consideration of land use and cultural

heritage. The term used to describe the types of actions to be considered is “fit-for-purpose” solutions. Main Roads regional directors must present proposed corridor investment plans to the deputy director-general of Main Roads for approval and final decision.

Phase 4: Program Development (less than 7 years)—Producing priorities for projects in maintenance, operations, and network enhancement. Weighting methodologies for seven elements have been developed and approved legislatively. The major result of this effort is a 5-year Roads Implementation Program (RIP) and production of road project concepts. Main Roads referred to this phase as “Doing the Right It!”

The next three phases were labeled “co-ordination of program, project and works management.” This meant that the Main Roads budget allocation process would be tied closely to the desired outcomes defined earlier, that all aspects of transportation system performance (including land use coordination) would be included in the Main Roads strategy, and that the community would be engaged in program development.

Phase 5: Program Delivery—Delivering the RIP, including the preliminary and detailed project designs, construction, and maintenance within road corridors. In essence, this phase includes all steps necessary to design, construct, operate, and maintain a road network. Main Roads referred to this phase as “Doing It Right!”

Phase 6: Program Finalization—Comparing completed projects and program delivery with baseline performance requirements. This phase compares actual performance with what was desired originally. In addition, investigations are conducted to determine what lessons can be learned from program and project experience. Main Roads referred to this phase as “Learning from Doing.”

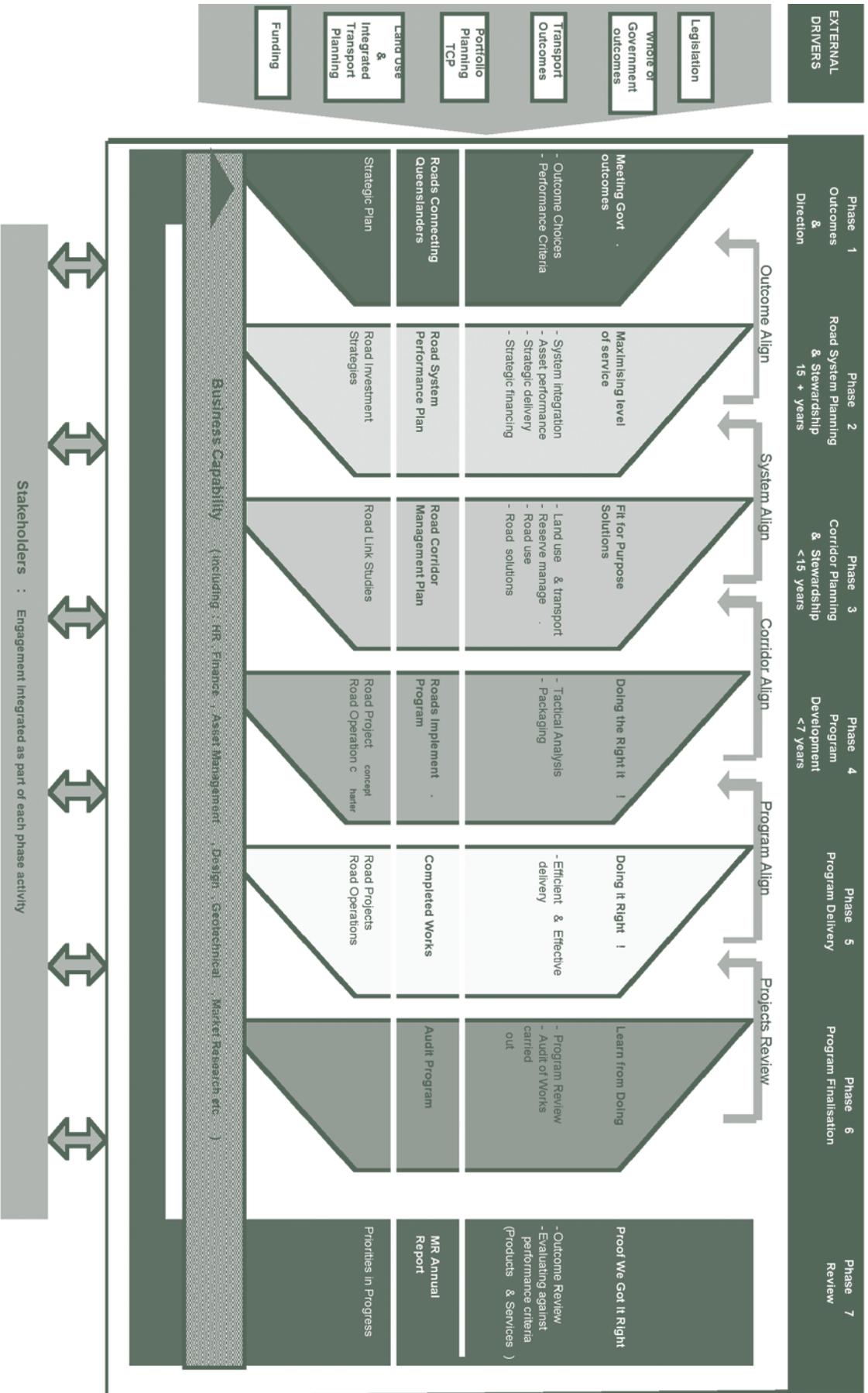


Figure 22. Strategic framework for road system management in Queensland.

Phase 7: Review—Measuring the actual outcomes against desired outcomes. This is the feedback loop to the decision-making process that informs future decisions. Main Roads referred to this phase as “Proof We Got It Right!” The band across the bottom of figure 22 represents the engagement of the community and key stakeholders throughout the decision-making process.

To identify a program of investments, the program is tailored to target whole-of-government outcomes, and to show increased accountability and transparency. However, Main Roads’ officials stated that over time this is becoming much more complex, especially considering the many factors outside of the transportation sector that now must be considered. With uncertainties surrounding a changing federal role in funding the national road network, programming of road investments is becoming even more uncertain.

Performance Measures

Enhancing transportation system performance and meeting

the government’s desired outcomes drive much of the investment decisionmaking in Main Roads. A distinction is made with the terms outcomes, outputs, and inputs, as shown in figure 23. As described earlier, *Roads Connecting Queenslanders* establishes the overall performance outcomes desired from the road network. Four outcome categories were identified in the report—efficient and effective transport to support industry competitiveness and growth, safer roads to support safer communities, fair access and amenity to support livable communities, and environmental management to support environmental conservation.

Main Roads’ strategic plan defines the relationship between these four outcome categories and agency outputs. These outputs were defined at different levels, including road system, road corridor, road operation, road project, and business capability. Specific deliverables and schedules were specified as well. In addition, this plan explains how Main Roads will meet government and customer expectations.

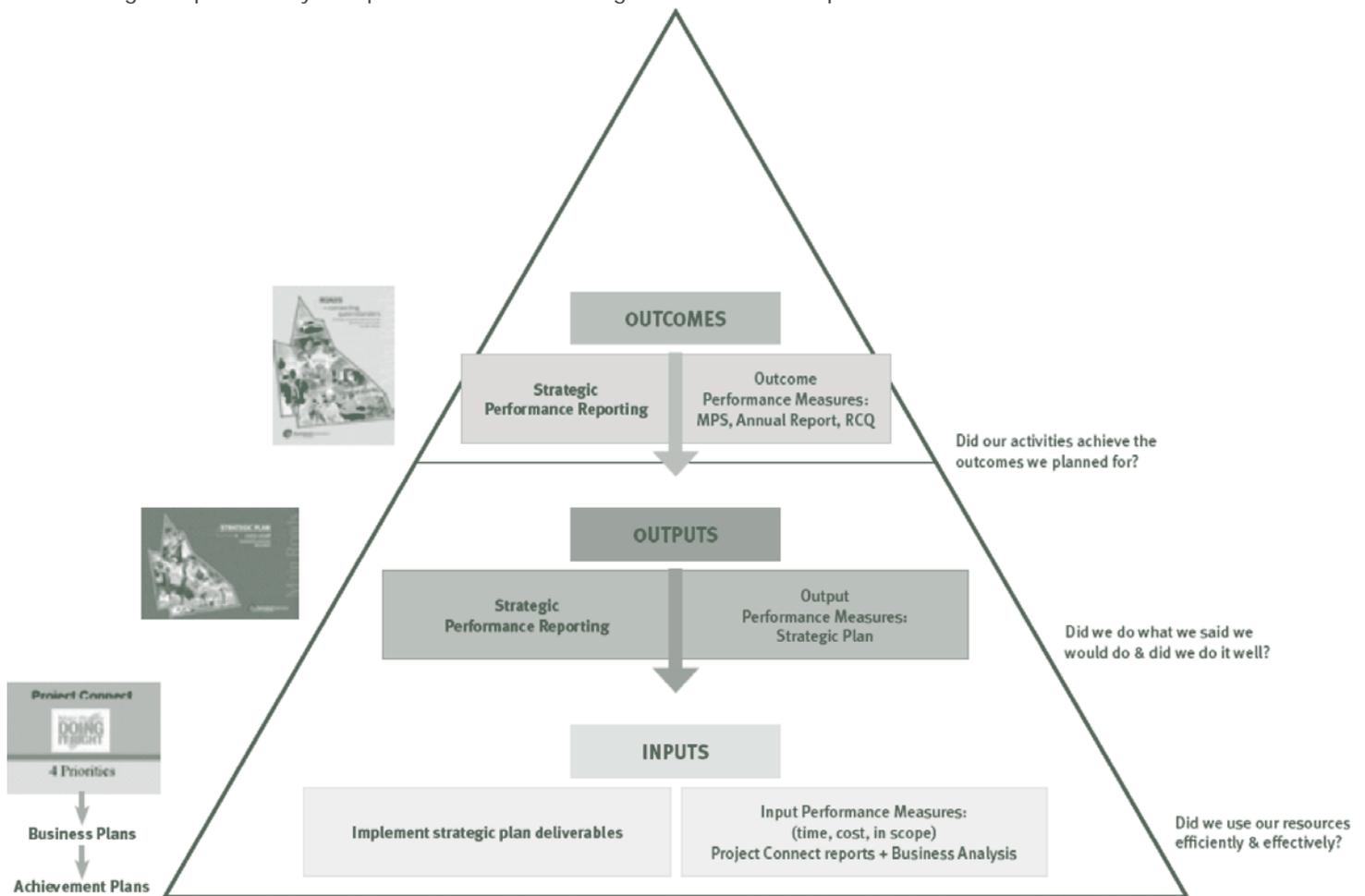


Figure 23. *Performance management at Main Roads in Queensland.*

Individual unit business plans specify the resources, time, and costs associated with putting in place the organizational capacity to deliver desired performance. Performance measures are defined at varying levels of specificity at each level of decisionmaking. At one time, Main Roads had a composite level of service measure for system performance, but the public and elected officials did not understand its meaning so Main Roads went back to travel time as the key measure.

Although the plans identified above provide general information on how the road network’s performance relates to broad performance goals, data on specific measures of interest to Main Roads’ management are also collected. For example, a recent Main Roads’ workshop on data and the relative importance of different data categories found that the desired data relating to network condition included, in order of preference, roughness and rutting, surface texture, field inspections, skid resistance, digital video records, pavement strength, and surface condition (e.g., cracking, patching, and edge break).

Asset Management Information Systems

The Queensland Treasury guidance on asset management stated that “a prerequisite of sound asset management is relevant, reliable and timely information about asset resources.”

According to the Treasury, this information, best provided in a structured way through asset management systems, is important for undertaking the following tasks:

- Assessing whether particular assets are being used in the manner that most effectively meets the goals and objectives of the organization
- Assessing whether assets controlled by the organization are properly maintained, enabling the agency to meet its current and future requirements
- Planning for the future replacement of assets
- Identifying and planning for the disposal of surplus or underused assets
- Effectively managing the risks associated with asset control
- Determining the cost of the outputs, products, and services the agency provides
- Assessing, where appropriate, the commercial competitiveness of the agency

Main Roads has been developing asset management systems since the 1990s, when both pavement and bridge asset management systems were first developed. Figure 24 shows the basic configuration of the road asset management system (RAMS) used today. As shown, RAMS uses data on finance, inventory, condition, traffic volumes, and policies/standards for the decision support function it provides. A variety of reports

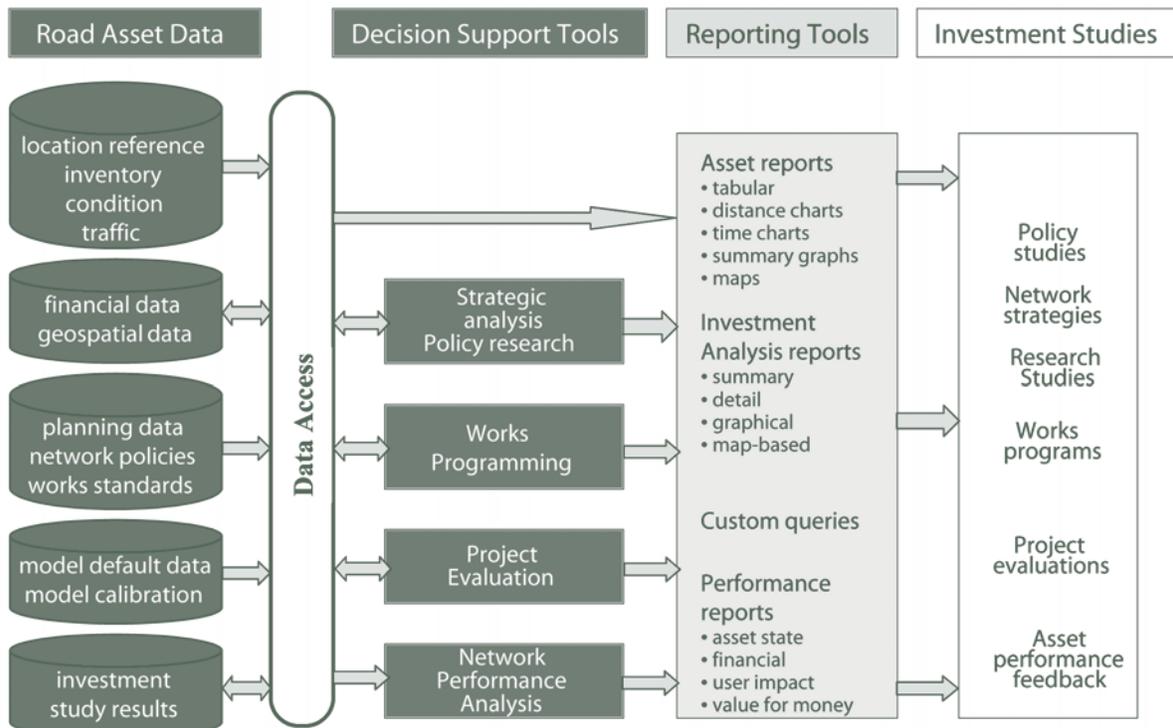


Figure 24. Road asset management system in Queensland.

can be generated on asset condition, network performance, and project investment.

A bridge asset management system (BAMS) was first developed in the late 1990s when senior managers wanted a better sense of the condition and performance of the approximately 2,700 bridges under state control. BAMS contains Main Roads' inventory of all bridges (including 560 timber bridges) and 20,000 major culverts, and allows the user to address the risks associated with defective structures (see figure 25 on next page). The management system includes not only the inventory, but also a prioritization method for assigning priorities for bridge maintenance (discussed below), and guidelines for the types of strategies appropriate for substandard and defective bridges. As noted in the BAMS description, BAMS produces "defensible maintenance programs from non-feasance and risk perspectives." Figure 26 (see page 55) illustrates the type of information BAMS can produce.

The comprehensive database available to Main Roads, called A Road Management Information System (ARMIS, see page 55), has several operational systems that allow Main Roads employees to manage road system data. These include a Road Reference/Road Inventory (RR/RI), Bridge Information System (BIS), Pavement Condition System (PAVCON), Traffic Analysis and Reporting System (TARS), Road Crash 2 System (RCRASH2), and a Road Maintenance Performance Contracts Management System (RMPC). For example, BIS produces the following types of asset management reports: progress against performance measures, trends in inspection, outstanding inspections, defective bridges by severity and trend, and heavy vehicle vulnerability maps. The PAVCON system provides information on such things as total district network status, relative status and priorities between road classes, detailed distribution of different types of road condition along a road section, and identification of project and maintenance priorities.

Data Collection

Main Roads began building a comprehensive database system in the early 1990s. This system has evolved into ARMIS. As shown in figure 27 (see page 55), ARMIS encompasses much of the data that a modern transportation agency needs for network management, including data on crashes, traffic volumes, pavement condition, road inventory and referencing systems, bridge condition, and road maintenance contracts. This database is linked to reporting systems such as the maintenance management system and the construction management system, allowing data to be updated when network changes occur. The data can be accessed via different media, both online as well as in print form. Those interviewed during the scan indicated that Main Roads is at a crossroads. Given that this database system has been in place about 20 years

and data-collection technologies have evolved since then, the question Main Roads faces is what is the most cost-effective way of getting, storing, and accessing the data necessary to support agency decisionmaking?

To begin answering this question, officials have given thought to what types of data should be collected. For business operations at the system level, desired data include maintenance of sealed road apparent defects, sealed road pavement surface deficiencies, pavement structural deficiencies, maintenance of unsealed road apparent defects, crash investigations, network-level crash analysis, hazardous grades, and intersection upgrading records based on high crash rates/potential. For business operations at the corridor level, desired data include management of roadside and surface delineation, fatigue management, skid resistance, and traffic-generated noise in urban areas. For bridge data, Main Roads has adopted a schedule for inspections, ranging from once every year to 8 years, depending on bridge type and the results of prior inspections. For roads, 20 percent of the kilometers on which data were collected are audited, (that is, data are collected again). The district road manager must sign off on the quality of the data collected.

According to Main Roads officials, video log data are by far the most actively used by both Main Roads engineers and consultants. On an average week, this video log Web site receives about 1,000 hits.

Analysis Procedures and Prioritization

One of the major products feeding into agency investment decisionmaking (and thus establishing an overall analysis framework) is the Road Network Investment Strategy. The purpose of this strategy is to 1) formulate a vision for the network based on industry and community demand, sound engineering principles, and realistic funding scenarios; 2) develop appropriate standards of performance and prioritize capital and maintenance dollars for each link in the network; and 3) assess benefits in terms of several criteria, including freight, efficient vehicle routing, safety, access for industry, benefit-cost ratio (BCR), community access to essential services, emergency access, environmental sustainability, and agency risk.

For bridge maintenance needs, Main Roads has developed a program called Whichbridge that assigns a numerical score to each bridge based on the risks attached to the condition of the bridge. The factors considered in this assessment process include condition of bridge components, effect of multiple defective components, significance of members to load-carrying capacity, global and local environmental impacts, component materials, currency of inspection data, obsolete design standards, and traffic volumes. The system, relying on Level 2 inspection reports, ranks structures based

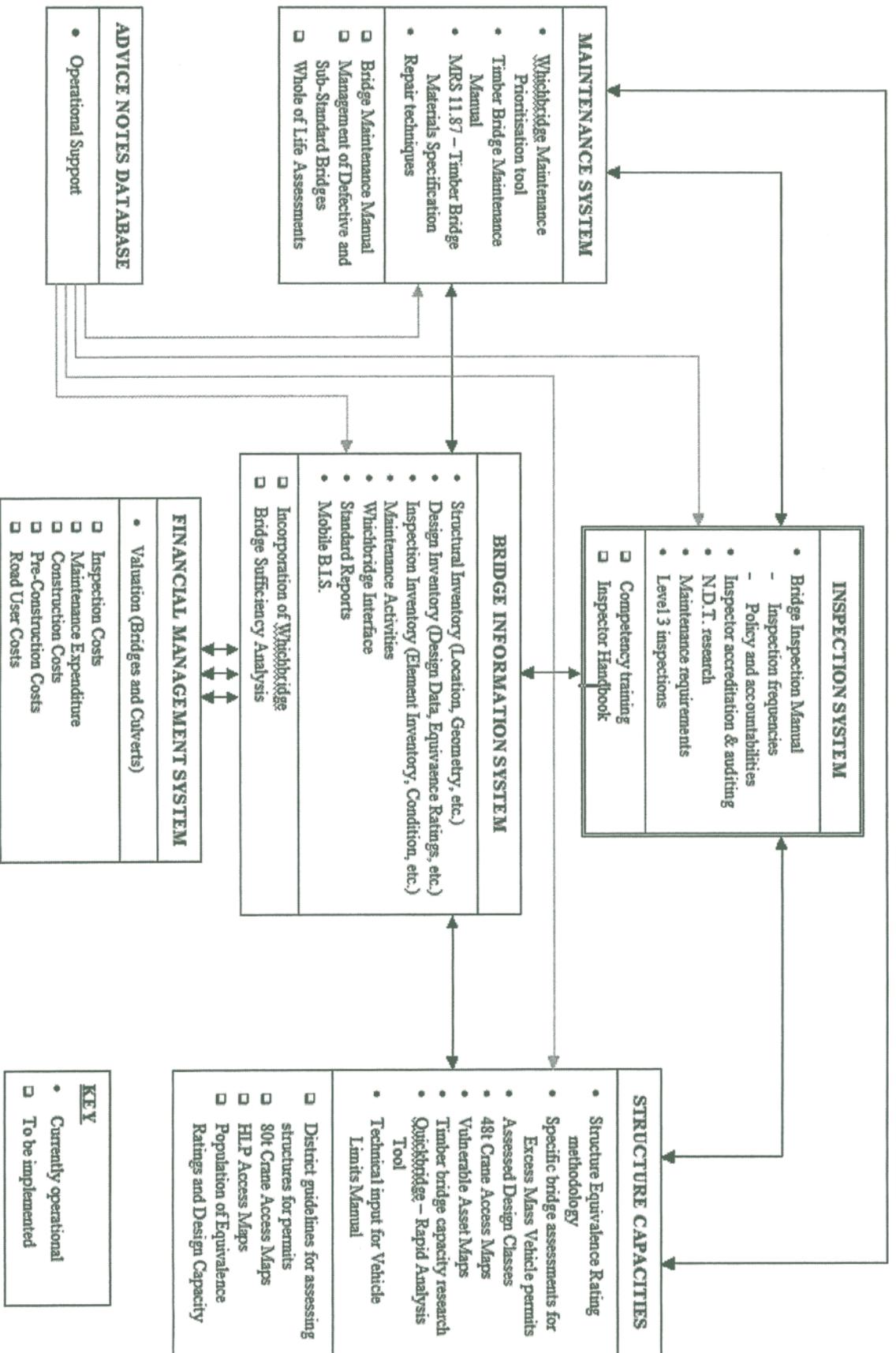


Figure 25. Bridge asset management system framework in Queensland.

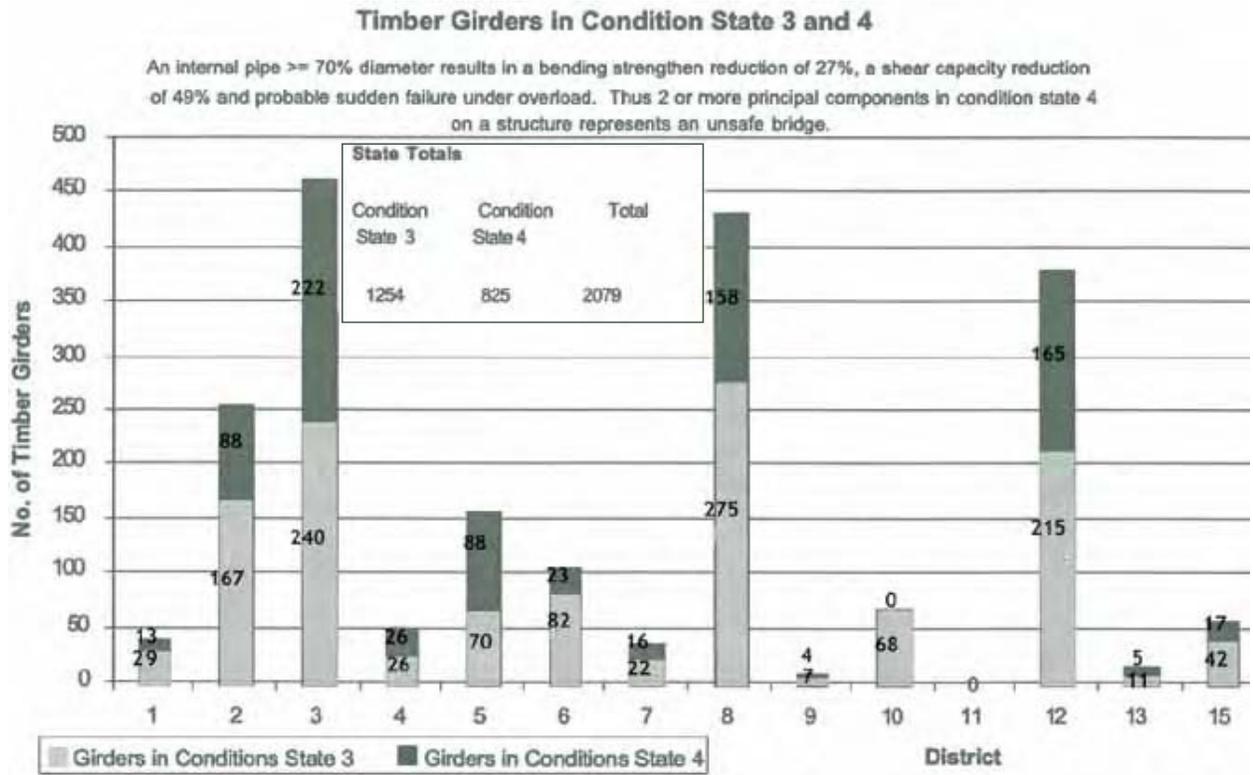


Figure 26. Condition of timber bridges in Queensland.

on risk exposure and safety considerations (a relative, not absolute, ranking). The probability of failure is multiplied by an assessment of the consequence of failure. The probability is expressed as a function of such things as loading, resistance, condition, inspection data, and exposure.

In this table, the current risk scores are related to the best possible scores for bridges in each region. The ratio of current to best scores gives managers a sense of which region faces the most severe bridge problem (the higher the number, the worse the problem). The use of risk measures in

Consequence is a surrogate for the costs of failure, which relate to such things as human factors, environmental, traffic access, economic, road significance, and industry access consequences. Figure 28 (see page 56) shows the input screen for Whichbridge and the types of factors that can influence the prioritization outputs.

Table 6 (see page 56) shows an example of the results presented to Main Roads' manage-

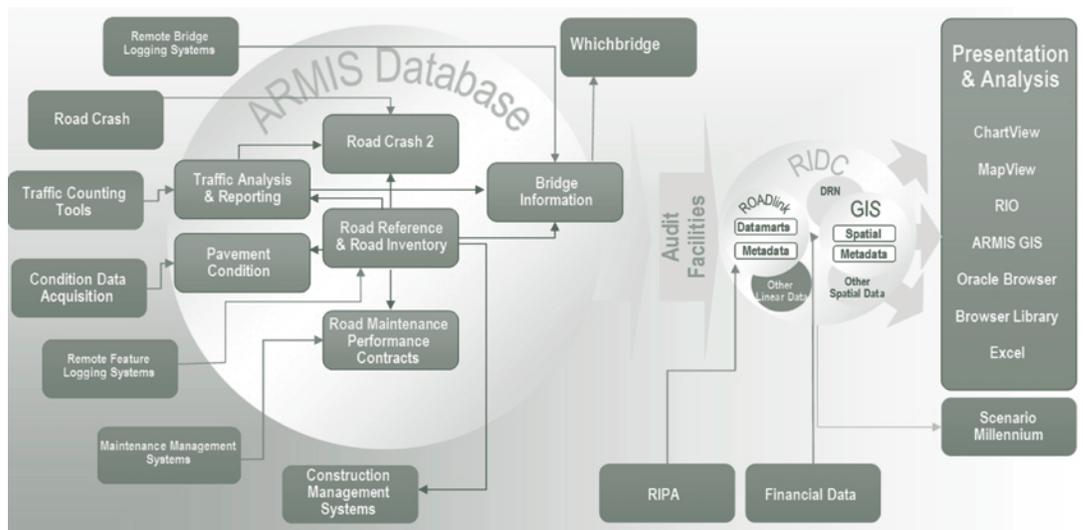


Figure 27. A Road Management Information System in Queensland.

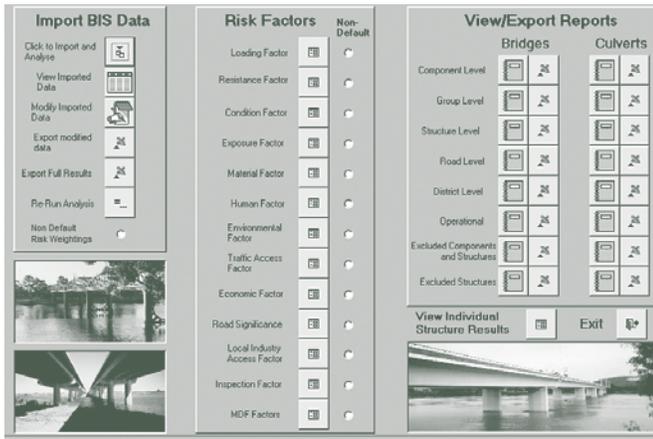


Figure 28. Bridge prioritization program in Queensland.

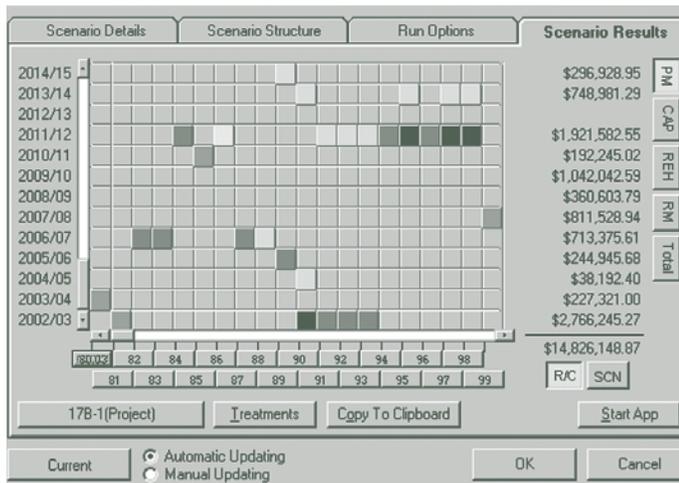


Figure 29. Illustrative results from a Main Roads SCENARIO analysis.

analysis and performance monitoring has also been a very useful strategy for getting the attention of elected officials. Some Main Roads officials believe that the concept of risk is one that elected officials can grasp easily, making them willing to consider funding allocations to reduce this risk.

Main Roads has impressive capabilities for conducting scenario analyses. A series of software programs allows Main Roads officials to understand the consequences on network performance of different input factors such as budget levels. One of these programs, called SCENARIO Millennium, is a rule-based decision support tool that assists in maintenance treatment programming by selecting treatments based on rules and conditions, calculating costs and benefits, making optimal treatment selections for road segments, and predicting condition according to deterioration models. The program examines each road segment in a typical group and produces suggested maintenance strategies and associated costs. The user can change input assumptions relating to such things as discount rate and unit costs. Figure 29 shows a typical SCENARIO output. The colored boxes in the middle of the figure represent different treatment strategies that occur on different road segments (on the x-axis) during different years (y-axis). The users of this tool can also change the scheduled activities (colored boxes) to different time periods and assess the resulting performance consequences.

Use of this tool has already resulted in significant policy-related findings. According to Main Roads officials, the analysis has shown the following:

- In aggregate, statewide programmed maintenance funding is insufficient to meet even the base case funding requirements.

Table 6. Comparative bridge risk scores across Main Roads' regions.

Category	State	Region				Comments
		Northern	Central	Southern	Southeast	
Bridge Risk Scores						
Risk-Current Condition	3,283,072	219,794	1,242,534	1,031,429	789,315	As calculated by Whichbridge
Theoretical Risk-Good Condition	836,023	171,367	268,767	175,048	220,841	Condition of all components set to state 2
Risk Index	3.93	1.28	4.62	5.89	3.57	Risk/Theoretical Risk
No. Bridges > 1,500	266	13	80	115	58	
No. Bridges > 3,000	179	6	60	79	34	

- To achieve the pure performance targets, twice the funding would be required for National Highways, and three times the funding would be required for other state roads.
- On a pure system performance basis, allocation of programmed maintenance funding between and within regions is inequitable.
- Performance equity can be improved by reviewing the allocation of existing budgets.

An interesting finding from the Queensland visit was the approach Main Roads has adopted for valuing its assets, which Treasury has approved. The original approach to this valuation, following the *Financial Management Standard 1997*, was fairly simple. Only four road network components were considered: bridges, surfacing, pavements, and formations. A straight-line depreciation method was used, as were standard useful lives and current replacement costs. Very small residuals (one-seventh to one-fortieth) were incorporated into the valuation. The valuation was based on road length and number of lanes, and there was very little linkage to the agency's asset management processes.

Given new Treasury guidelines, a reassessment of the valuation process was undertaken, resulting in 19 recommendations. The primary focus of the recommendations was to provide a stronger linkage to Main Roads' asset management processes. The most important recommendations for asset management were the following:

- Continue the internal audit of 20 percent of the data collected for ARMIS.
- Experiment with the use of equivalent single axles (ESAs) to quantify useful life and the use of condition to assess remaining useful life for pavements.
- Adopt square meters as the unit of measure for surfacings and pavement.
- Update procedure for calculating unit rates.
- Revise standard useful lives for formations and bridges.
- Adopt the established asset management useful lives for surfacings.
- Introduce residual values.

Main Roads adopted several of these recommendations. For formations, bridges, and surfaces, a residual value and a review of standard useful lives were introduced. Straight-line depreciation was retained for these assets because the consumption of the service potential of these assets was driven primarily by environmental factors (time) and commercial or technical obsolescence. For pavement depreciation, the rate of depreciation followed the consumption of future economic benefits (consumption of service potential), and the determination of where the asset is in its life cycle was based on the current asset management approach in Main Roads.

The effect of these changes on the discounted asset valuation was as follows:

- Using ESAs as a measure of economic benefits increased asset value by about 4 percent, or A\$700 million (US\$528.5 million).
- Using pavement management systems to determine remaining useful life had a net effect of increasing asset value by 2.5 percent, or A\$450 million (US\$340 million).
- Using square meters as a unit measure resulted in an A\$2 billion (US\$1.5 billion) reduction in discounted value.
- Adjustments to standard lives for surfacings resulted in an A\$240 million (US\$181 million) increase in asset value and an A\$30 million (US\$22.6 million) decrease in depreciation.
- Using residual values at the end of useful lives had the largest effect on asset value and depreciation. With other changes, it will result in an A\$2.1 billion (US\$1.6 billion) increase of asset value and an A\$120 million (US\$91 million) decrease in depreciation.

Observations

Queensland is one of the world's leading practitioners of asset management, in particular in the application of tools and techniques. Several aspects of Main Roads' asset management program stand out.

Similar to New Zealand, the level of asset management integration with agency activities was quite impressive. The asset management plan that was developed in the late 1990s was a very important point of departure for Queensland's asset management strategy. Decisions relating to asset preservation and maintenance, linked to this and other plans, rely heavily on the performance measures laid out in *Roads for Queenslanders*, Main Roads' strategic plan. The level of consistency among the different levels of plans and the linkage to performance measures were found to be two critical foundations for an effective asset management program.

The evolution away from asset management toward road system management seems a logical step in the evolution of asset stewardship. The RSM framework, in which asset strategies are aligned with decisionmaking and program delivery is coordinated among different agencies and linked to a variety of goals, is a useful approach to a broader concept of network management. The linkages between the different steps in this framework, and the logical relationship between planning, programming, and coordination, result in a good model of how to consider asset needs in agency decisionmaking in the most effective way.

Main Roads clearly had the most impressive analysis capability of all the sites visited. The Whichbridge program for prioritizing bridge maintenance and the SCENARIO

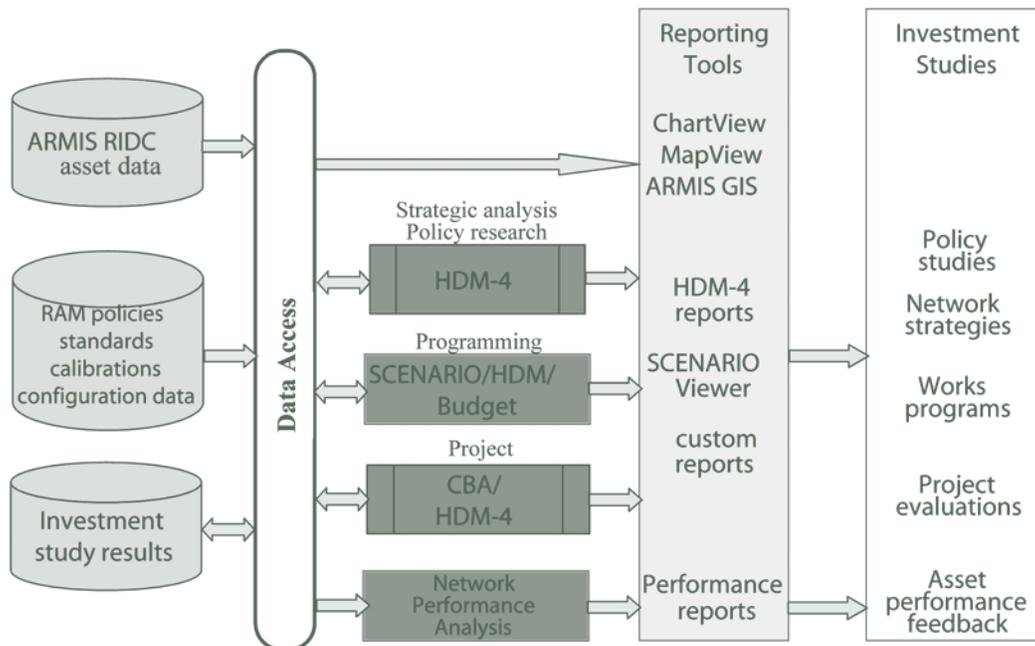


Figure 30. *Future asset management system at Main Roads.*

package for conducting scenario analysis are state of the art. In particular, the application of risk assessment in the Whichbridge program is an intriguing example of how risk can be incorporated into prioritization schemes. Both programs are excellent examples of how analysis can educate both decisionmakers and the public on the infrastructure needs facing a community.

Main Roads has been developing its road network database for the past 20 years. ARMIS is recognized as having served a very useful function in Main Roads, and in itself is a valuable resource to the agency. However, questions remain about what happens next in the development of an information support base for agency decisionmaking and road system management. Given Main Roads' reputation for being at the cutting edge of information-based decision support, it will be worth watching to see what it comes up with. Figure 30 shows the latest thinking on what Main Roads' future asset management system might look like.

An interesting aspect of Queensland's asset management approach is the direction it is heading in asset valuation. Unlike other cases, where straight-line depreciation is used as part of the valuation process, Main Roads has an agreement with the Treasury to use management system outputs in determining the remaining useful lives for pavements, thus producing a more realistic assessment of asset replacement value. The assessment that Main Roads went through in examining different assumptions underlying the valuation

process and determining what impact they have on net present value is an important learning experience for other transportation agencies.

Main Roads understands the human resource element of asset management as well. It provides training courses and publications on asset management aimed at increasing organizational capability in asset management practice.

Finally, the innovative, coalition-building approach seen in the Road Alliance is an excellent example of how to extend concern for asset management beyond a state's jurisdiction. Tying these activities to budget recommendations and developing an institutional structure that reinforces the mutual gain that comes from investments in asset preservation is a model to emulate for increasing the effectiveness of asset management efforts at state and local levels.

VICTORIA, AUSTRALIA

VicRoads— www.vicroads.vic.gov.au

Context

Victoria, about the size of Michigan, encompasses about 3 percent of Australia's area. However, with 5 million people (3.6 million in Melbourne), it is the most densely populated state in Australia. Victoria also has 4.1 million registered vehicles, representing about 33 percent of the Australian vehicle fleet, and

handles 25 percent of the country's road freight on its 155,000 km (96,315 mi) of roads.

VicRoads is the responsible authority for the road and traffic management of 22,000 km (13,671 mi) of the state's most important arterials, handling about 70 percent of the vehicle-kilometers travelled. The total value of the assets associated with this network is estimated at A\$11 billion (US\$8.3 billion). With annual program budgets of about A\$861 million (US\$650 million), maintenance budgets of A\$530 million (US\$400 million), and revenues just over A\$2.5 billion (US\$1.9 billion), VicRoads is one of the most capital-intensive and infrastructure-oriented agencies in Victorian government. The majority of funds for road improvements come from state government.

According to VicRoads officials, the major issues facing Victoria's road network are 1) increasing travel demand, 2) growing congestion in metropolitan road networks, 3) aging infrastructure, 4) rising environmental and community expectations, and 5) the challenge of optimizing system performance when individual travelers seek only to maximize their own utility. Asset management-related community expectations include ride quality and safe and efficient travel through work zones. VicRoads officials are particularly concerned about a national trend to allow larger trucks to use the highway network. Victorian pavements are much thinner than those in the United States, so with increasing truck mass limits, they are expected to deteriorate even faster.

Drivers for Asset Management

VicRoads officials identified several factors that led to increasing interest in asset management. First, there was a perception in the late 1990s and early 2000s that agency decisions historically had not adopted a system-wide perspective that led to the most cost-effective solutions. A comprehensive and system-wide perspective was desired, especially for to asset stewardship.

Second, VicRoads faced shrinking budgets in real terms, so it had to focus on the best use of its funds for accomplishing its mission. An asset management program based on life cycle costs was considered a major tool to support such decisions.

Third, the public, elected officials, and VicRoads officials became increasingly concerned about the risks associated with road performance (e.g., safety, skid resistance, etc.). Because of these concerns, a risk management approach was developed that evolved from the application of simple investment rules for reducing risk to comprehensive data collection

and deterioration modeling to predict future risks. It was clear to VicRoads officials that some agency activities (e.g., grass cutting) did not carry as much risk as others (e.g., slope stabilization), which led to some budget reallocation (e.g., cutbacks in mowing budgets).

Fourth, the Victorian government, in particular the Department of Treasury, has established principles and guidelines for asset management at the state and local levels. In a Treasury document entitled *Sustaining Our Assets*, the service

delivery model for the state emphasizes four main features:³¹

1. **Service delivery needs.** Regarded as the basis of all asset management decisions, service delivery needs address the social, environmental, and economic needs of all Victorians.
2. **Life cycle approach to asset management.** This approach evaluates operating and maintenance requirements, and the implications of eventual replacement or retirement of assets during acquisition decisionmaking. The planning process also includes evaluation of nonasset alternatives for the delivery of services.
3. **Integrated approach to asset management and service delivery,** across all assets and all governmental departments and agencies. This looks beyond stewardship of individual assets and examines the total asset base during decisionmaking. It also means achieving balance across government portfolios to optimize investment outcomes (see figure 31 on next page).
4. **Increased emphasis on accountability for asset investment.** This, in turn, requires greater transparency and quality in reporting arrangements.

The fifth, and most recent, driver for interest in asset management was the passage of the Road Management Act in 2004, which dramatically changed the legal liability of public agencies for road design and operations.³² Previously, government officials had immunity under the concept of nonfeasance. The Road Management Act

Transportation Infrastructure Managed

By VicRoads

- 22,000 km (13,671 mi) of paved road
- 5,000 bridges and major culverts
- 3500 traffic signals
- 170 CCTV cameras
- 800 help phones
- 350 freeway data collection stations

By local governments

- 133,000 km (82,645 mi) of roads
- 8,000 structures

³¹ For a complete list of Treasury documents on asset management see <http://www.dtf.vic.gov.au/dtf/rwp323.nsf/search/62EBFC40F8477C805256A9A00726104?opendocument&Expand=7.2&>.

³² See VicRoads, "Road Management Act, Regulations and Codes," <http://www.vicroads.vic.gov.au/vrne/vrne5nav.nsf/childdocs/>.

“It is fine to have asset management principles, but if you do not have an asset management mindset incorporated into your agency procedures and into service contracts, and data to determine what you are actually doing, you are kidding yourselves.”

—VICROADS OFFICIAL

changed this to require due diligence in designing, operating, and maintaining a road network, and having in place a process for reducing reasonable risks. A need existed to provide some legal surety on the level of maintenance deemed reasonable. This led VicRoads to rely more heavily on an asset management program to indicate the systematic process it was following for dealing with road risk.

The act requires a Register of Public Roads to indicate agency responsibility for roads in Victoria. The register must reference where responsibility for a road changes (e.g., transfers, delegation, Ministerial Directions, etc.). One result of this act is that VicRoads and 78 local councils must have

a Road Management Plan consisting of a statement of responsibility, a road infrastructure management system, and/or a statement of road maintenance standards. About 80 percent of the local councils have opted for a road infrastructure information system. The following language in the act indicates the basic components of a local asset management policy:

“As a minimum, councils need to have an asset management policy and strategy to provide direction and guidance for asset management planning. Asset management tactics translate the broad strategic goals to specific goals and objectives, generally through the development of asset management plans, which provide more detail and long-term projections. Operations comprise detailed action plans and information with a one to three year outlook to provide for the delivery of the defined level of service.”

VicRoads’ own Road Management Plan includes sections on overall policies and practices for processes relating to road infrastructure maintenance, and the responsibility of VicRoads road managers for road maintenance.³³

The scan team noted the issue of nonfeasance and legal liability for road condition and operation in other Australian states as well. However, many other states are waiting to see what happens in Victoria with legal challenges and the role of asset management in demonstrating due diligence.

Organization for Asset Management

At the state government level, an Infrastructure Planning Council and an Infrastructure Delivery Cabinet Committee have been established to guide the government’s infrastructure policies. In addition, the government has fostered public-private partnership arrangements through its Partnerships Victoria initiative (see section on toll road examples).



Figure 31. *An integrated perspective of asset management in Victoria.*

³³ VicRoads, Road Management Plan, Melbourne, VIC, Oct. 2004, see <http://www.vicroads.vic.gov.au/vrne/vrne5nav.nsf/8020?readform=&layout=VicRoads2005%7ESearch&query=Road+Management+Plan>.

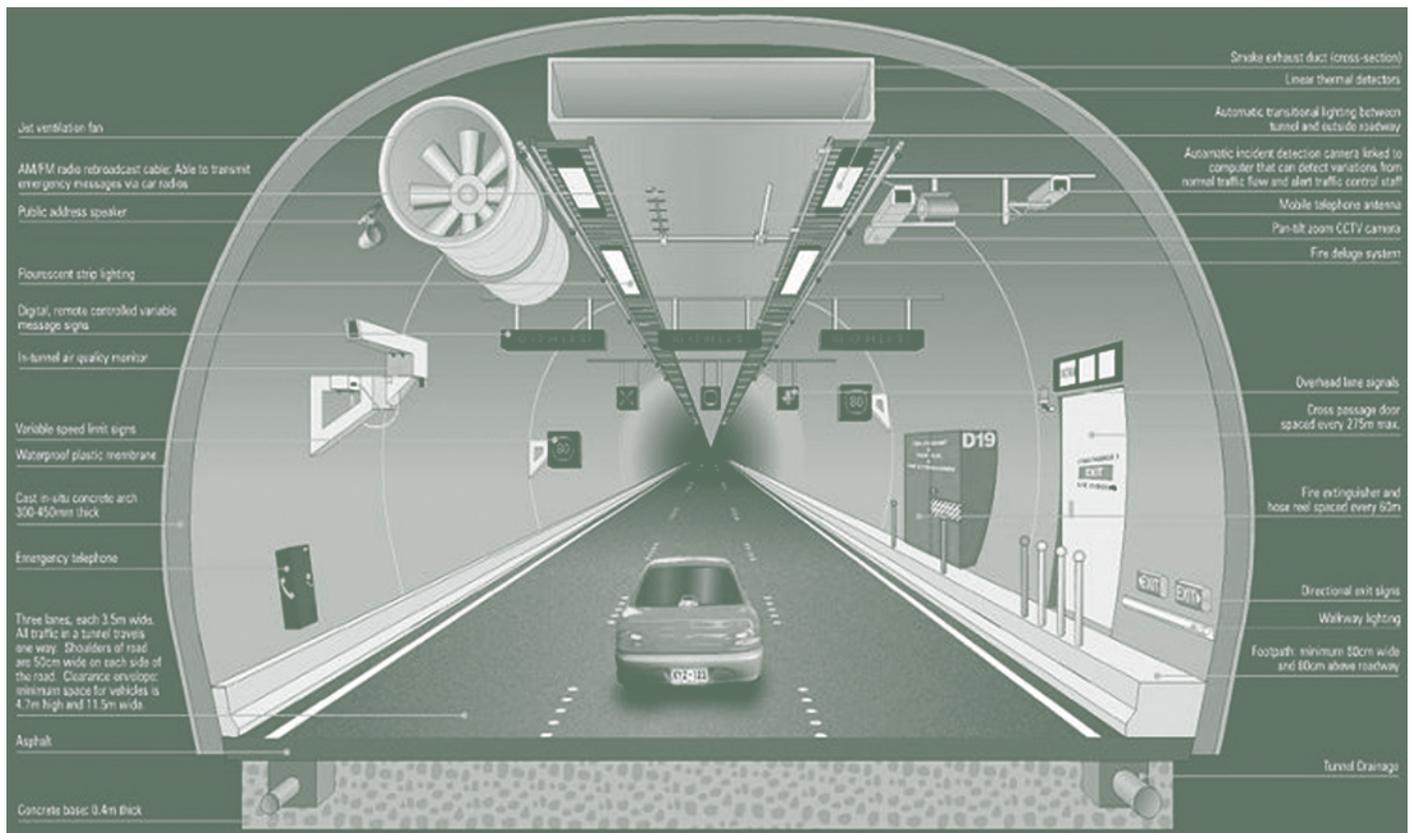


Figure 32. *Many Australian cities are building major new highways by tunneling under the city, making tunnels an important component of agency and private concessionaire asset management programs.*

VicRoads defines asset management as “a systematic process of maintaining, upgrading, and operating physical assets cost-effectively; which combines engineering principles with sound business practices and economic theory; that provides tools to facilitate a more organized, logical approach to decision-making; and that offers a framework for handling both short- and long-range planning.” As several VicRoads officials stated, however, an asset management approach to business is also very much an organizational culture issue.

The road system management group, one of VicRoads’ four core businesses, is responsible for asset management (the other core businesses are road safety, traffic and transport integration, and registration/licensing). About 35 equivalent full-time staff members are part of VicRoads’ asset management program statewide. A position of manager for asset management has been created in VicRoads with the following responsibilities:

- Develop strategies and programs for maintenance.
- Monitor condition of network.
- Recommend maintenance investment levels.
- Benchmark performance.

- Develop, maintain, and support management systems.
- Manage inventory systems.

In the early 1990s, VicRoads adopted a client/provider model as the major means of program delivery. This meant asset management strategies (e.g., maintenance) could be delivered either by private contractors or by VicRoads labor with service agreements (whichever won the job). Where contracts have been used, VicRoads has experimented with two types, contracting for a specific function (e.g., resurfacing) in a specific geographic area, or contracting for a function statewide. These contracts are performance based, which VicRoads officials stated makes an agency-wide asset management program even more critical.

VicRoads’ commitment to asset management has resulted in its funding of several research projects (about A\$1 million (US\$76,000) a year) on such topics as 1) getting better value from agency activities, 2) improving useful life from pavement treatments, 3) understanding network condition, 4) understanding the performance of treatments, and 5) improving the understanding of risks.

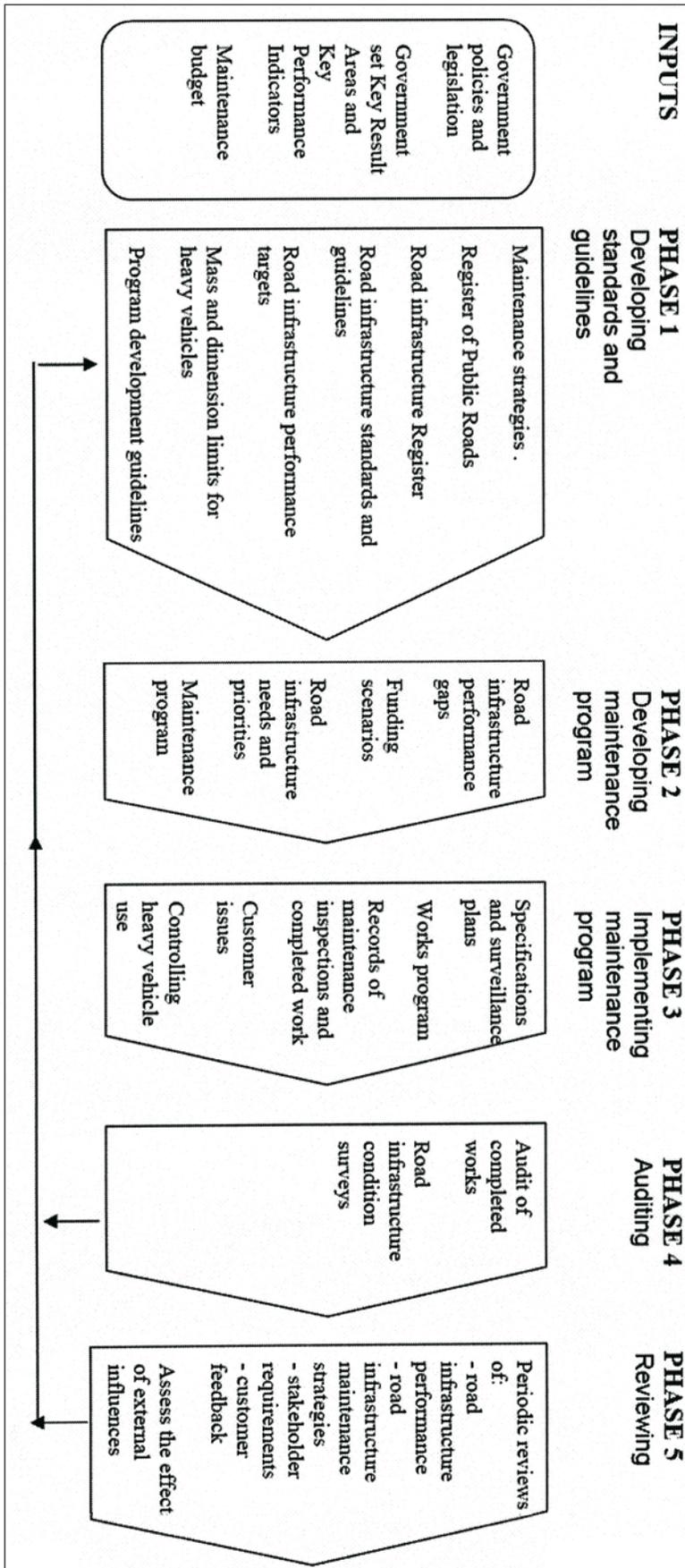


Figure 33. Road Infrastructure Management System at VicRoads.

Decisionmaking Approach

To a large extent, asset management's role in VicRoads' decisionmaking is closely linked to the Department of Treasury's concept of "optimal asset management." This concept states that this level of asset management is achieved by the following:

- Defining desired levels of services in consultation with the community, and matching these with assets that enable the services to be delivered
- Adopting a life cycle approach to planning asset investment and management decisions
- Balancing competing needs across all government functions and selecting options that best meet desired government outcomes
- Monitoring, evaluating, and improving service delivery
- Managing the risks of asset ownership and operation to ensure continuity of service
- Providing for present needs while sustaining resources for future generations
- Adopting a continuous improvement approach to asset management policies and practices

Since 2004, VicRoads has used a Road Infrastructure Management System (RIMS) that sets out the policies and procedures to achieve road maintenance standards. RIMS consists of five phases: developing standards and guidelines, developing a maintenance program, implementing a maintenance program, auditing, and reviewing. Figure 33 shows the flow of decisionmaking in RIMS.

RIMS targets deficiencies in roads and bridges through roughness, cracking, and seal width measures, and maintains the network in a fit-for-purpose condition. This is done by identifying effective and appropriate levels of low-cost treatments to avoid the need for more expensive treatments, and by applying rehabilitation treatments on roads road users assess as rough. Road maintenance standards are used to 1) identify defects with potentially hazardous consequences, 2) define the desired frequency of inspection, and 3) establish desired response times.

Examples of programs that have resulted from this process include the following:

*“The hardest thing in asset management is saying,
‘Great job on the 80 percent perfect solution!’”*

— VICROADS OFFICIAL IN RESPONSE TO A QUESTION ON HOW ROAD MAINTENANCE
AND REHABILITATION INVESTMENT COMPARES TO NEW CONSTRUCTION

Stitch in Time (A\$164 million (US\$124 million))—A strategy to deliver safe, user- acceptable, and economically efficient pavement conditions at the least cost to the community. It is based on target pavement conditions determined from user perceptions (pavement roughness for the general community, and rutting and cracking for road managers) and economic efficiency. The overall target was to resurface 10 percent of the network each year, a dramatic change from the 4 percent average before the program. The current program reaches 8 percent of the network. The program components of Stitch in Time include the following:

- Routine maintenance (A\$41 million (US\$31 million))— A strategy to ensure safe travel conditions and minimize pavement deterioration.
- Periodic maintenance (A\$56 million (US\$42 million))— A strategy to waterproof pavements and defer the need for rehabilitation.
- Pavement rehabilitation (A\$67 million (US\$51 million))— A strategy to minimize whole-of-life pavement costs, provide acceptable ride quality, and reduce user costs.

Victoria’s arterial bridges (A\$25 million (US\$18.9 million))— A strategy to rehabilitate bridges.

Roadside management (A\$35 million (US\$26.4 million))— A strategy to improve safety and condition of the roadsides.

VicRoads also uses highway management studies to identify and prioritize improvements on key arterial routes in Victoria. These studies look at the context of the route, its function and use, existing conditions, performance on standards, and critical transport issues, and make recommendations on appropriate strategies.

Asset management is also integrated into agency activities that link desired performance outcomes to the asset management framework. Figure 34, for example, shows VicRoads’ Roadside Management Strategy, which involves several stages:

- Establishing key outcome areas, in this case safety, environmental and cultural heritage values, and amenity/access
- Determining strategic performance objectives, which are the focus for program delivery as defined by the asset management framework
- Assessing risks, balancing competing objectives, and determining priorities through the asset management system
- Monitoring program delivery against the performance management system
- Measuring success by relating program results to stakeholder expectations

Figure 35 (see next page) shows a similar concept for arterial bridge management in Victoria.

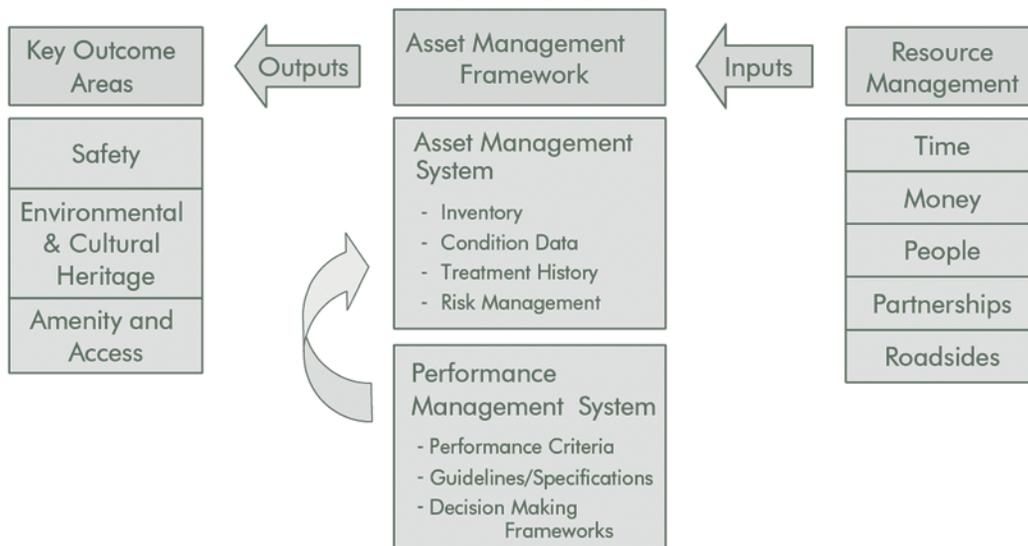


Figure 34. *Roadside management framework at VicRoads.*

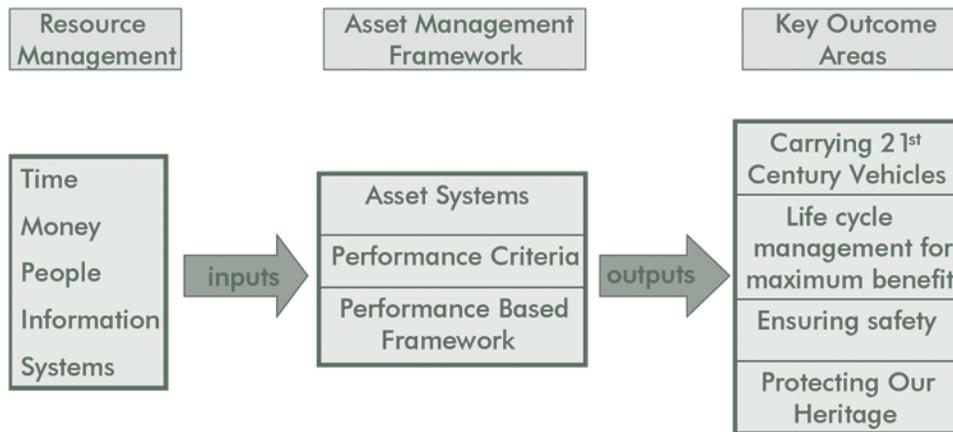


Figure 35. *Arterial bridge management and asset management at VicRoads.*

Performance Measures

VicRoads conducts standardized analyses to monitor network performance. For pavements, these include determining the following:

- Austroads performance indicators of smooth travel exposure (STE) on roads less than 110 and less than 140 national roughness measure (nrm)
- Road lengths of 500 m (547 yd) with average roughness over 140 nrm
- Percentage of rutting over 10 mm (0.39 in) and 25 mm (0.98 in)
- Surface inspection rating totals for seal and asphalt pavements
- Pavement condition using a road rating index (under development)

For bridges, analyses include the following:

- Bridge condition using a bridge rating number by road classification, principal corridors by regions, and by municipalities.
- Number of inadequate bridges because of higher mass limits
- Structures with Condition State 3 and/or 4 defects
- Query on bridge type and component number for different exposure classifications

Figure 36 shows the information produced in VicRoads and its relationship to corporate reports. Along with other Australian states, VicRoads has adopted a network condition indicator that is reported nationally to allow comparisons among the states—the Smooth Travel Exposure (STE). STE is defined as the proportion of travel undertaken each year on urban or rural roads with surface roughness at less-than-desired minimum levels of roughness (4.2 IRI). Target values are 93 percent of rural roads and 91 percent of urban roads meeting this threshold, and

99 percent of arterial roads accessible to legal vehicles.

The Victorian government has also adopted performance indicators for a variety of issues such as public transit patronage, road congestion, and freight modal share to the ports. Figure 37 (see next page) is an example of VicRoads' performance indicator monitoring.

VicRoads' strategy for managing the performance of bridges on the arterial system is also based on performance criteria. This strategy is divided into several themes, some defined with asset-related measures. They include the following:

Theme: Carrying 21st Century Vehicles *Performance Criteria*

- Number of bridges able to carry higher mass limit vehicles and 68-metric-ton double trailer trucks
- Number of existing bridges that meet height and width requirements
- Number of new bridges designed in accordance with the revised Australian Bridge Design Guide
- Adequacy of structure for flood conditions consistent with overall route
- Level of ride quality to reduce vehicle operating costs and adverse impact on structure

Theme: Life Cycle Management of Maximum Benefit *Performance Criteria*

- Using the most cost-effective maintenance regimes to ensure that bridges function satisfactorily for all road users and do not compromise load-carrying performance

Theme: Ensuring Safety *Performance Criteria*

- Bridge width appropriate to traffic volume

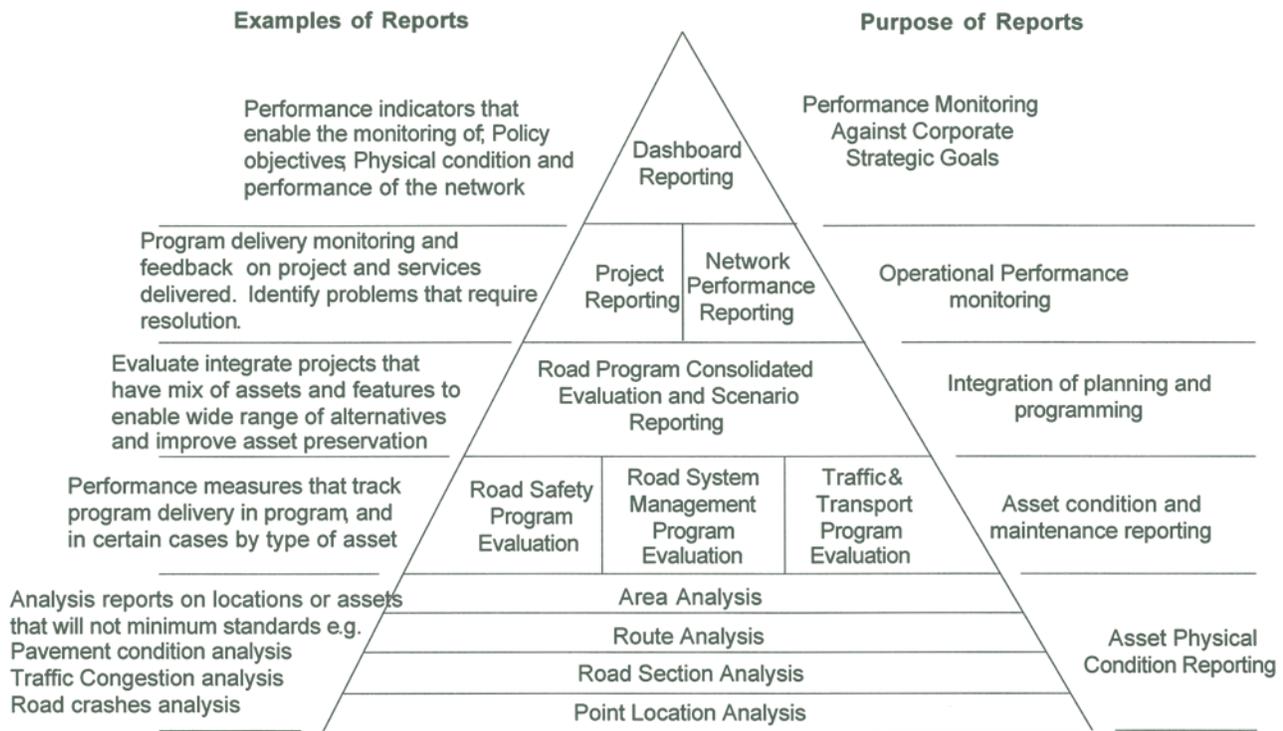


Figure 36. *Information reporting hierarchy at VicRoads.*

- Desirable minimum-height clearance
- Alignment consistent with safe travel speeds
- Barriers and guardrails maintained in operational condition

For road maintenance, specific standards are established that act as triggers for maintenance efforts. For pavement rehabilitation, for example, it is expected that between 0.5 to 1.5 per cent of the network will receive rehabilitation treatments each year. Roughness minimum requirement triggers for maintenance activity on different road types include the following:

- 3.6 International Roughness Index (IRI) on freeways
- IRI on arterials with speeds greater than 80 km/h
- 4.6 IRI on arterials with lower speeds
- The results of several years of performance monitoring of pavement roughness indicates that VicRoads has been successful in improving this measure.

Asset Management Information Systems

VicRoads uses asset data for a variety of purposes. At their most basic level, data are used to monitor road conditions and to report on performance indicators. The results of these efforts are used to develop policies aimed at correcting deficiencies and establish maintenance programs and targeted rehabilitation efforts. Data are also used to justify maintenance investment to elected officials and benchmark VicRoads' efforts with other Australian states.

Trends in Roughness for all Arterial Roads

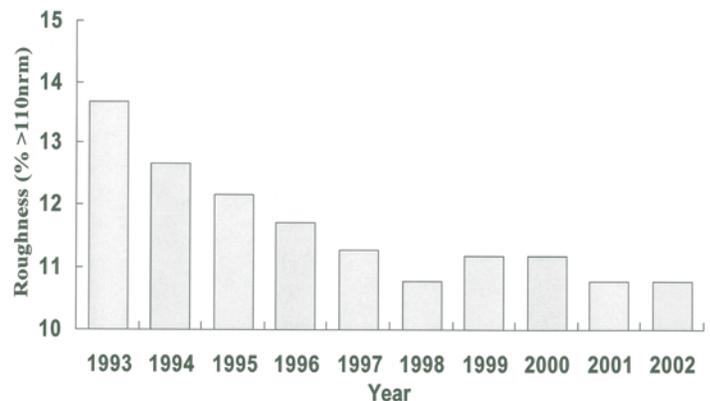


Figure 37. *Performance indicator reporting at VicRoads.*

VicRoads uses four primary asset systems to support its asset management program. A Road Asset System (RAS) provides basic information on pavement condition and performance, and retains a history of previous improvements. A Road Crash Information System (RCIS) includes data on crash records and road safety history. A traffic database compiles traffic volumes and characteristics. A financial system (PARMS) keeps track of costs and budgetary items. The systems are linked by

“Those consuming infrastructure today are responsible for its replacement.”

— VICROADS OFFICIAL

a State Road Referencing System (SRRS) so that data can be combined and referenced at identical locations.

Data on electrical systems are maintained in a central database that includes traffic signal inventory, phasing plans, traffic controllers, closed-circuit TV, incident detection devices, and street lighting. Maintenance records are also maintained in this database.

VicRoads is an international leader in the application of ITS technologies and has numerous ITS assets to keep in operating condition. The ITS inventory includes details on the asset (location, warranties, contractor, etc.), record of faults, corrective actions, special operating conditions, performance levels, and maintenance strategies.

Maintenance records are kept in a various forms, ranging from hard copy to databases. Selected maintenance treatments are also recorded in VicRoads' financial system and uploaded into RAS. VicRoads is reviewing these maintenance systems and procedures, and expects to restructure and centralize them.

Facilities and feature data (guardrails, sign type and location, and roadside facilities such as rest stops) are kept in a variety of database modes, including hardcopy records and spreadsheet databases.

Customer information consists of simply recording road asset defects identified by the public in a spreadsheet. VicRoads has developed a functional specification that will be used to create a more integrated customer information system that will at a minimum interface with a proposed maintenance system.

Figure 38 shows the direction that VicRoads is heading on an integrated asset management information system.

Data Collection

Data are collected on a variety of network and travel characteristics, using a range of data-collection tools. The primary data-collection activities relate to pavements, bridges and other structures, electrical systems, facilities and features, road use and performance, and customer information.

For pavements, video condition surveys are conducted primarily of roughness, cracking, and rutting characteristics for every 100 meters on the outer lane only. These data are col-

lected annually by private contractors on 50 percent of the network. A Surface Inspection Rating (SIR) procedure is used to collect pavement surface data on homogeneous road sections (seven seal and five asphalt parameters considered). About 33 percent of this network data are collected annually by private contractors. Deflection data for pavement design and skid resistance testing are conducted using a SCRIM vehicle (see New Zealand case for SCRIM description). The SCRIM vehicle is used in particular to test skid resistance at major intersections, where the safety risk is highest.

For bridges, the Road Asset System has a module that contains inventory and condition data for bridges, culverts, noise walls, and major gantries. The majority of bridges on the VicRoads network are subject to a four-level inspection and associated risk-based ranking system. Inspections consist of Level 1—routine (6 monthly), Level 2—condition assessment (2 to 5 a year), Level 3—structural safety assessment (when needed), and Level 4—load capacity assessment (on request).

VicRoads has established information technology system and data management principles to manage data as a resource. The intent of these principles is to develop a corporate-wide understanding of road asset information, improve information accessibility, reduce data management costs, and align data requirements with business goals and objectives. Guidelines have been developed for data maintenance to ensure integration and reduce duplication and redundancy.

Some of the principles guiding data management involve assuring data quality. VicRoads has established a rigorous set of guidelines and processes for assuring high-quality, reliable data. Historical records, cross verification with data collected or captured as part of other programs, comparison of treatment data with condition survey data, comparison of condition survey data with surface inspection data, rigorous specification requirements, and audits of data-collection processes are used to develop a high-quality database. For Level 2 bridge inspections, for example, 5 percent of inspected bridges are independently reinspected. For pavement surface inspection, 10 percent of the surveyed roads are reinspected.

For contracted data-collection efforts, the contractor's data collection and processing are calibrated and validated before a survey. After completing 3,000 km (2,806 mi) of data collection, the contractor is required to recalibrate the vehicle and drivers. Ten sites are selected with a roughness

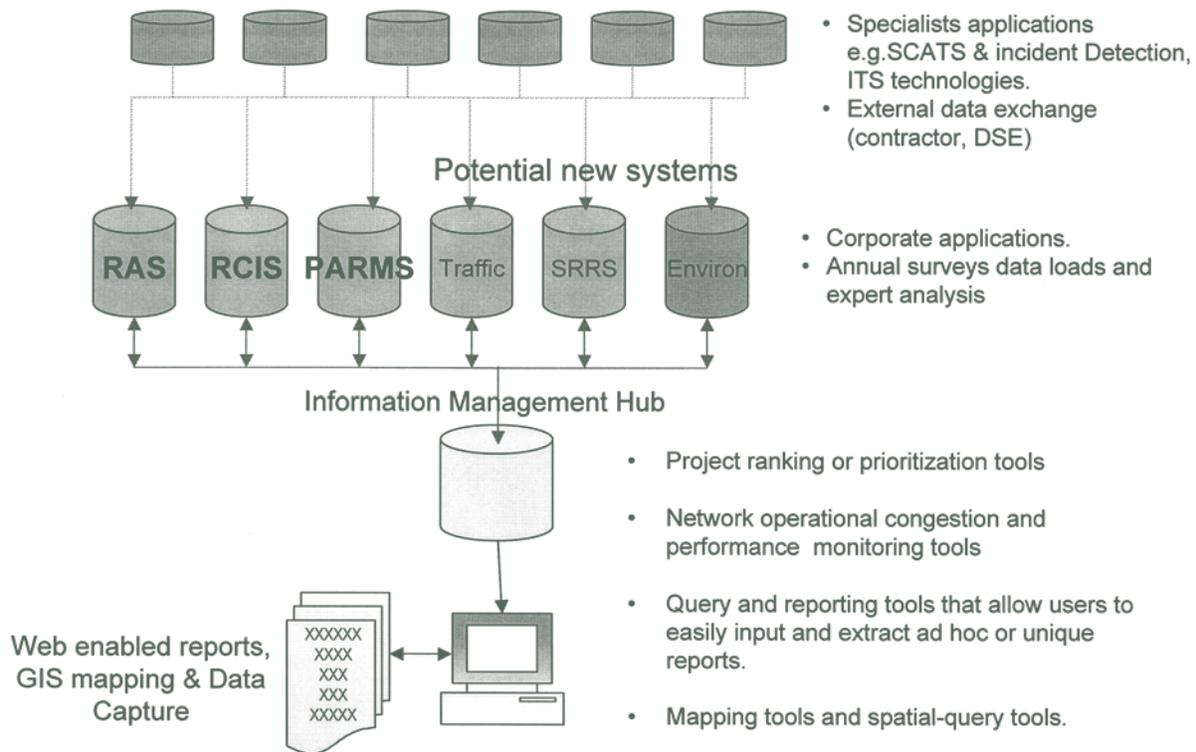


Figure 38. *Targeted road information management system at VicRoads.*

value range between 20 and 180 counts, with test surfaces including both chip seals and asphalt pavement. A minimum of five repeat measurements are taken at each site at nominal speeds of 25, 50, 75, and 100km/h (15.5, 31, 46.6, and 62 mi/h). Test results are required to meet 1) line of best fit falling between 0.95 and 1.05, 2) regression offset of the intercept of line of best fit within -0.25 and +0.25, and 3) an R^2 value of at least 0.95.

VicRoads is experimenting with different automated technologies for data collection. For example, it is using ground sensors to provide warnings on unstable slopes. It is also considering using such technologies on structures, as well as experimenting with advanced nondestructive testing methods.

Data-collection schedules for both network condition and performance are shown in table 7 on page 68.

A recent research project examined community expectations for asset management in relation to pavements, the roadside environment, and bridge maintenance. Researchers interviewed stakeholders, conducted focus groups, and conducted a conjoint analysis that enabled respondents to trade off varying levels of a service delivery within a specific budget level (see textbox on page 69).



Figure 39. *Scan team member Lacy Love (left) discusses use of the SCRIM machine to collect pavement data with a machine operator.*

Analysis Procedures and Prioritization

Asset management program priorities are driven by several key factors, including the following:

- Strategic monitoring/modeling of pavement network
- Reduction in roughness (ranking of rehabilitation projects)
- Preventive periodic maintenance treatments with priorities

Table 7. *VicRoads' data-collection strategy for network condition and performance.*

Network Condition Surveys			
Survey Type	Survey Method	Frequency	Supplier
Pavement Condition — roughness, rutting, cracking, texture, road geometry, video	Automated collection for roughness, rutting, and texture Cracking is visual inspection using high resolution video Video imagery of network is collected at the same time as the condition data	50% of network per year (12,000 km or 7,457 mi)	Contract
Surface Inspection	Visual inspection of road VicRoads provides the software application to record data in the field	About 33% of network per year (8,000 km or 4,971 mi)	Contract
Level 2 Bridge Inspections — length, width, structure components, construction type, construction materials, construction date, maintenance treatments and dates	Condition data collected based on a modified PONTIS system Level 3 condition inspection information	About 25% of structures per year	Contract
Level 3 Bridge Inspections	Visual and measurement survey	As identified by Level 2 inspection	Contract and internal resources
Network Performance Surveys			
Traffic Volume and Classification Data	Observation, automatic classification counters Traffic signal equipment	Rural—480 strategic sites	60% contract 40% internal
		Metropolitan Melbourne	80% contract 20% internal
Travel Time	Floating vehicle	Melbourne area 100% of freeways twice a year 15% of arterial network twice a year	Contract

based on surface inspection (cracking, rutting, age, etc.)

- Resurfacing at sites with low skid resistance
- Bridge condition monitoring and risk assessment
- Roadside inventory

VicRoads uses simple formulas to determine rankings of different types of projects for given budgets. Sensitivity testing is conducted by changing formula variables. For example, the following formula is used to score projects on the basis of skid resistance measures:

$$\text{Score} = \frac{K \times V \times S}{C \times \text{SFC}}$$

Where: V is volume exposed to hazard
S is speed zone in km/h

C is total estimated cost of the project

SFC is sideways force coefficient

K is:

- 3.0 for light-controlled intersections, school crossings, railway crossings, and roundabout approaches
- 2.5 for curves with radius < 250 meters and freeway on- and off-ramps
- 2.0 for intersections other than those above
- 1.5 for maneuver-free areas of undivided roads
- 1.0 for maneuver-free areas of divided roads

For conventional **rehabilitation projects**, the following formula is used:

“It is not appropriate for accounting practices (Australian Accounting Standards) to dictate asset management outcomes.”

— DEPARTMENT FOR VICTORIAN COMMUNITIES, 2003

Rehabilitation project score = $R * T * L * D / C$

Where: R is % roughness > target level (capped at 70%)

T is traffic volume

L is life of treatment

D is rate of deterioration

C is unit cost of treatment

For rural high-speed roads, VicRoads uses the following formula to determine rehabilitation priorities for **freight-related projects**:

Rehabilitation project score = $R_{\text{freight}} * AI * T * L / C$

Where: R_{freight} is % of sections where the difference in roughness is greater than 1.5 IRI

AI is the average roughness of the section being treated in IRI derived from the last two roughness surveys

T is the traffic volume (up to a maximum of 2,000 vehicles per day (vpd) rural)

C is the unit cost of treatment (\$ per m²)

L is the expected treatment life (years)

VicRoads has a social equity formula that gives the highest priority to roads where 30 percent or more of the individual length to be treated has an average roughness greater than 110 nrm and traffic volumes are less than 500 vpd. Social equity in this case means making sure that low-volume roads do not deteriorate to unacceptable levels simply because they can never reach a volume threshold. The ranking formula for **social equity projects** is as follows:

Rehabilitation project score = $R_{\text{improvement}} * D * T * L / C$

Where: $R_{\text{improvement}}$ is improvement in roughness from the current value to the estimated final roughness.

D is the rate of change of roughness derived from three successive roughness surveys that have been aligned, but limited to between 1 and 5.

T is the traffic volume (up to a maximum of 500 vpd rural)

C is the unit cost of treatment (\$ per m²)

L is the expected treatment life (years)

VicRoads officials expressed a word of caution about using such formulas. Once those responsible for obtaining maintenance budgets for their district or region know what is in the formula, the formula can be gamed and the data manipulated to show a greater need than actually exists.

Public Preferences on Maintenance Priorities

VicRoads conducted a conjoint analysis to determine public preferences among different maintenance strategies. A total of 360 interviews were conducted in Melbourne of a representative sample of the population. Participants were asked to trade off sums of money among four different maintenance strategies:

- Road surface (pavement) long-term maintenance
- Road surface routine maintenance
- Roadside maintenance
- Bridge maintenance

Four distinct responses were obtained. About 33 percent of respondents favored increased funding for long-term pavement maintenance, 28 percent favored increased funding for routine maintenance at the expense of other strategies, 19 percent favored both increased routine pavement maintenance and increased roadside maintenance, and 19 percent favored increased routine pavement maintenance and increased bridge maintenance.

Turning these desires into utilities for each class of expenditure suggested to VicRoads that an optimum expenditure (from the community's perspective) would be \$1 million less on periodic pavement maintenance, \$3 million less on roadside maintenance, \$2 million less on bridge maintenance, and \$6 million more on routine pavement maintenance.

For pavement maintenance, respondents preferred expenditures on filling potholes and cracks over other strategies. For roadside maintenance, the top preference was maintenance on signs, guardrails, and footpaths. This was followed by grass mowing and guardrail upgrades.

Fifty-five percent of respondents said that Victoria spends “about the right amount” on road maintenance, 42 percent said it did not spend enough, and 2 percent said it spends too much.

Numerous project characteristics are considered when bridge projects are prioritized. These include the strategic importance of the route, functioning of the bridge for all users, freight volume, condition and rate of deterioration, capacity and performance, availability of alternative routes, assessed risks, feedback from users and local communities, cost-benefit ratios, and fit with other strategies and business plans. Asset management is an important part of the process of establishing priorities and is based on a risk management approach. This means projects are assessed in light of competing demands for resources, an understanding of the consequences of not investing in the project, and a prioritized program created to obtain a balanced allocation across all asset needs.

For maintenance, VicRoads' Road Management Plan outlines the process for developing a program. The first step is to conduct a gaps analysis, which entails comparing the latest road condition surveys to maintenance standards and performance targets. A network-level analysis is then conducted to identify appropriate types of strategies that can be applied on the network to fill these gaps. The next step is to develop initial maintenance program targets that reflect likely funding and any changes in road management strategies. The final step is to prepare the maintenance program, which gives priority to routine maintenance, followed by periodic maintenance and rehabilitation. VicRoads' pavement management system provides input into this analysis process.

Roadside maintenance projects are prioritized by first meeting statutory responsibilities, then preserving the integrity of the roadside, and finally meeting environmental goals. VicRoads has experimented with pavement deterioration models (dTIMS and HDM-4) in examining combinations of strategic investment and system use scenarios. These experiments were conducted primarily in regional offices to develop regional investment programs. The results of these efforts suggested that the scenario analysis application in the regional offices was time consuming, complex, and difficult to understand. Thus, these tools are now used primarily in the central office as a strategic tool for examining network-level trends.

VicRoads also conducts benchmark studies to compare its program to other Australian states, as well as to examine differences in productivity with different models of service delivery. For example, a comparison was done between contract maintenance versus work done with its own commercialized maintenance group. Costs appeared to be cheaper initially for contract maintenance, but have gone up in recent years. In addition, quality of service could not be benchmarked, although there is a perception that the quality of service is not as good as that provided by VicRoads staff (this could not be verified independently during the scan team's study).

Public-Private Partnerships and Asset Management

The Victoria government has participated in two major public-private partnerships (PPP) for toll roads over the past 10 years. The experience with these initiatives has been most instructive to the responsible authorities, especially on the role and use of asset management principles and tools in the concessionaire's day-to-day activities.

The first PPP project in Melbourne, the CityLink project, consisted of 19.3 km (12 mi) of new urban freeways including tunnels, elevated roads, and bridges. It was constructed from 1996 to 2000 for A\$2.2 billion (US\$1.7 billion). Fully dependent on electronic tolling (transponder and video imaging), the CityLink project generates about A\$250 million (US\$189 million) a year. A concessionaire won the bid to construct, operate, and maintain this project for 34 years. There are more than 950,000 registered e-TAG users, with 750,000 daily transactions. Toll violations are less than 1 percent of daily users.

This project consists of a variety of infrastructure assets, many with very different life cycle characteristics. For example, structural assets have long lives (often 30 years plus), mechanical and electrical systems usually fall into the 10-to-30-year useful life range, and electronic tolling instrumentation has a fairly short useful life, from 3 to 10 years. CityLink estimates that 50 percent of the total life cycle costs of the project are related to repair and maintenance.

CityLink is organized into several divisions or groups, one of which—the Infrastructure Group—is responsible for the owner's (Victoria's) interests and for monitoring performance. These interests were defined as providing travel-time benefits, reliability, and a better road; producing a showpiece asset; maintaining sustained asset performance; assuring an acceptable return on asset investment; assuring safety for users, staff, and contractors; and complying with governance, corporate, and social responsibility mandates. Operations and maintenance activities are outsourced, with about A\$20 million (US\$15.1 million) spent for both (40 percent for operations and 60 percent for maintenance).

The concessionaire's deed mandates certain maintenance requirements, such as maintaining and repairing promptly, reporting to VicRoads, and responding to notifications of maintenance deficiencies. Maintenance standards are specified for pavements, road markings, lighting, signs, and landscape. The concessionaire is also responsible for meeting handover requirements on facility condition when the road is turned over to VicRoads at the end of the concession deed. For example, the following hand-back conditions illustrate the type of asset requirements that were in the concession deed:

- Bridge and tunnels—remaining structural life = at least 80 years at hand back

- Road pavement—remaining structural life = 20 years average at hand back
- Road surface—remaining operational life = 5 years average at hand back
- Major electrical/mechanical—remaining operational life = 20 years minimum at hand back
- Tunnel finishes—remaining operational life = 50 percent of product life at hand back
- Communications and control systems—remaining operational life = 10 years at hand back
- Renewable items—reasonable life at hand back, not less than 50 percent of operational life as agreed with the state

A maintenance plan was part of the concession bid, as was a requirement to show how maintenance management would be undertaken. In the case of CityLink, a computerized maintenance management system (CMMS) was proposed to guide maintenance planning and work allocations, report defects, provide quality assurance reporting, and act as a stores/spares inventory system. Even with these maintenance requirements, the original bid specifications said little about asset management.

To meet the technical requirements and still achieve a desired return on investment over the life of the project, the concessionaire developed a business plan based on risk management. The approach identified the most critical risks to meeting the concession agreement's requirements, designing out defects and inherent faults, replacing worn or troublesome assets that continually fail or cause problems, replacing assets that reduce risk and improve infrastructure investment, replacing assets that are energy inefficient or environmentally unfriendly, and ensuring compliance to the concession deed including meeting specified hand-back requirements. One issue CityLink faced early on was a major failure of a concrete slab in a tunnel because of water filtration. Because the concessionaire accepted facility responsibility as built, the cost of fixing this failure produced a deficit of A\$200 million (US\$151 million) to the concessionaire at the very beginning of revenue service.

CityLink is now focusing on business-critical systems. According to CityLink officials, the asset management lessons learned from their initial experience with this project include the following:

- 1) design out defects and faults as much as they are known in the design phase,
- 2) reduce risk wherever possi-

ble, 3) reduce energy consumption, 4) maintain the facility as an evergreen site (that is, do preventive maintenance), and 5) replace troublesome assets as soon as possible. Figures 40 and 41 show how asset management concepts have been incorporated into the business operations of CityLink.

Transportation officials learned a great deal from the CityLink experience, especially about asset management. The most recent PPP project, called EastLink, incorporated asset management requirements more comprehensively in the initial bid requirements. The EastLink project consists of 45 km (28 mi) of freeways (39 km (24 mi) tolled) with twin 1.5-km (0.9-mile), three-lane tunnels. The project has a long history of controversy and public discourse, ending up with substantial commitments to environmental mitigation, which were incorporated into the project costs (and, in the process, extending the concession time frame to 38 years to recover these additional costs). Unlike CityLink, a special authority called the Southern and Eastern Integrated Transport Authority (SEITA) was established to oversee this US\$2 billion project.

EastLink consists of 17 interchanges, 103 structures (86 bridges), 3 railway crossings, 7 million m³ (9.2 yd³) of earthworks, 2 million m² (2.4 million yd²) of pavement (asphalt), 150,000 m² (179,000 yd²) of noise wall face, and 4.7 million plants. Similar to CityLink, the concession assigned risks to several characteristics of the project. The concessionaire was required to maintain, operate, and promptly repair; minimize disruption; and use best practice and continuous improvement strategies. Condition inspections and a requirement of no defects were incorporated into the handover specifications. The concessionaire was required to report residual design life

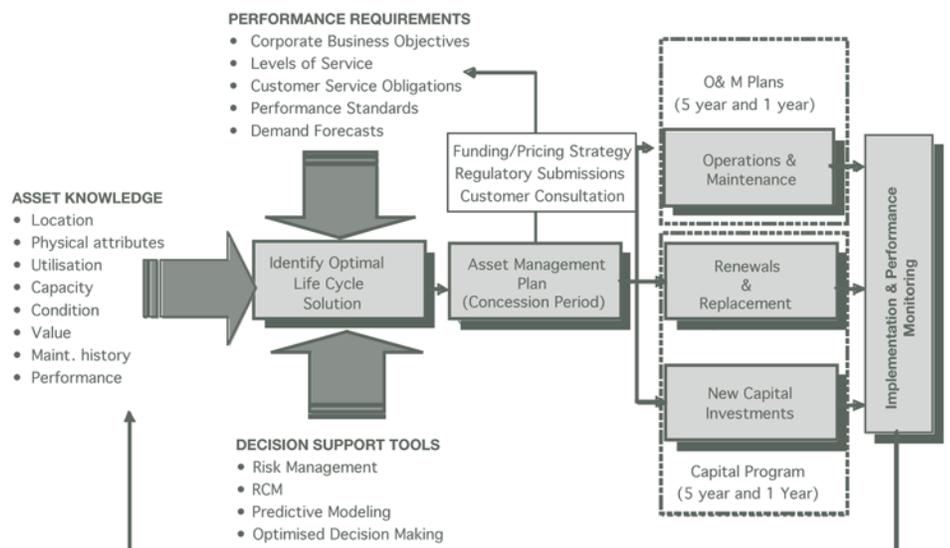


Figure 40. *Asset management approach for toll roads in Melbourne.*

for key assets, and had maintenance obligations for 1) routine maintenance, 2) planned refurbishment, 3) unplanned intervention and repair, 4) inspections, 5) an asset management system and adopted code of maintenance standards, and 6) keeping records and meeting reporting schedules. For operations and maintenance, performance-based terms and conditions were incorporated into the deed. The deed includes for all assets an extensive code of maintenance standards that must be achieved during the life of the concession.

A bid bond of A\$10 million (US\$7.5 million) was required for the bid phase, an A\$87.5 million (US\$66.1 million) bond for the construction phase, and an A\$5 million (US\$3.8 million) bond building to A\$20 million (US\$15.1 million) with increasing volumes for the operations phase. A hand-back bond is required that will be agreed to 3 years before the road being is turned back to VicRoads.

The concessionaire must report on a performance indicator regime relating to several performance categories—customer service, road condition, landscaping and features, tolling accuracy, and environmental quality. A monthly scoresheet and a quarterly report on key performance measures are submitted to SEITA. In the event of noncompliance, an A\$15 million (US\$11.3 million) credit could be provided to road users.

Observations

Several aspects of the VicRoads' experience with asset management are noteworthy. The first relates to the recent change in legal nonfeasance that has spurred greater interest in

developing a defensible decisionmaking process that the courts would consider reasonable. This legislative change has resulted in activities not only at the state level, but also at the local government level. The fact that more than 60 local governments have opted to have a road information system in place as part of their "reasonable decisionmaking process" gives an indication of the importance liability has in motivating greater concern for asset management.

Victoria, similar to other Australian states, has given much thought to the relationship between performance measures and their role in different levels of decisionmaking in the transportation agency. Performance measures influence everything from strategic decisions to day-to-day maintenance. This consistency in focus provides an important capability showing compatibility with service outcomes and government policies and goals.

Of all the sites visited, VicRoads was probably the most interested in advancing the state of practice in data-collection technologies. Not only has VicRoads adopted high-speed data-collection capabilities, but it is experimenting with smart technologies for collecting data on difficult asset types (e.g., slopes) or in remote locations.

VicRoads has developed several quantitative approaches (formulas) to identify priorities among different maintenance strategies. Only in New Zealand did the scan team observe anything similar. In particular, the team noted that the maintenance rankings included projects oriented toward freight

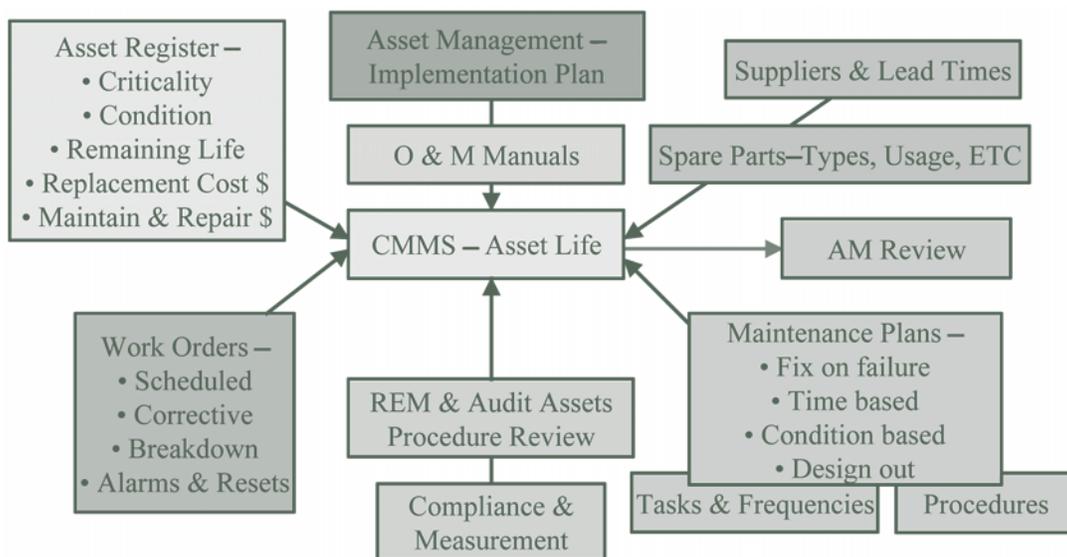


Figure 41. *Asset management tools for toll roads in Melbourne.*

roads and social equity. Although the use of formulas appeared to provide some rigor to the prioritization of work activities, it was noted that the potential for gaming of the formula could lead to inefficient budget allocations.

One of the most interesting observations in Victoria related to the role of asset management in PPP projects. Because Victoria has had several years of experience with PPP projects, lessons learned from this experience can be important for others contemplating this direction for infrastructure investment. Put simply, great care should be given to making sure that the concessionaire becomes committed to asset management as part of the business decisionmaking process. The first project in Melbourne did not include asset management in its specifications as much as the second project has. This was the direct result of the learning process that transport officials went through in both projects.

BRISBANE,
QUEENSLAND,
AUSTRALIA

EDMONTON,
ALBERTA, CANADA

LONDON,
ENGLAND

Chapter 4: Local Experience With Asset Management

Three of the sites visited represented asset management experience at the local government level. Such governments, more than those at other levels, have many types of assets to care for, so the scan team was particularly interested in learning how tradeoffs were made among these different categories, if at all. Three local government experiences with asset management included those for Brisbane, Edmonton, and London.

BRISBANE, QUEENSLAND, AUSTRALIA
www.brisbane.qld.gov.au

Context

With a population close to 900,000 and an area of 1,327 km² (512 mi²), Brisbane is the largest local government authority in Australia. As such, it is responsible for providing a large number of public services, ranging from water and sewerage to public transit. Not surprisingly, the Brisbane City Council considers infrastructure delivery and asset management one of its major responsibilities. Since 1994, given the growth in population, the amount of paved road surface (measured in square meters) has grown 2.4 percent per year. With Brisbane expected to be one of the fastest-growing cities in Australia in the next several decades, road surface and public transit infrastructure are likely to continue to grow at a fast rate.

Brisbane's transportation plan emphasizes not only efficient management of the road network, but also renewed investment in public transportation and the use of demand management strategies to reduce transport demand. Similar to other Australian cities, Brisbane is placing greater emphasis on tolls or user charges for major investments in the transportation network. The preferred model is privately owned toll roads under a 30-year franchise. If a suitable project offer does not emerge from the tender process, the proposed ownership model is reviewed. An example of a proposed public-private partnership is TransApex, a plan for major investment in new river crossings, connecting major arterials with new roads and tunnels, and enhancing public transportation services developed in response to several transportation challenges facing Brisbane. Increasing congestion, limited general revenue funding, public perceptions

of little or no progress in solving transportation problem, and aging of the infrastructure have led city officials to consider innovative funding strategies and develop a comprehensive asset management approach to city assets.

Drivers for Asset Management

Several factors have led Brisbane officials to embrace asset management as part of their stewardship of city resources. First, as noted in the Queensland case, state government has adopted asset management principles as part of its basic approach to infrastructure provision, and has expected (and for some activities required) local authorities to do the same. Second, Brisbane is proud of its innovative and cutting-edge image among Australian and world cities. Indeed, Brisbane actively markets many of its services to other cities as part of its governmental business plan. The asset management approach in Brisbane, which has received national awards, is part of the general philosophy of governmental stewardship of city resources. It is viewed as a natural evolution toward effective and efficient provision of services.

The defined purposes of asset management in Brisbane perhaps best explain this philosophy and the driving influence behind its adoption in city government. According to city officials, asset management does the following:

- Provides a strategic direction and corporately consistent planning framework for the city's physical asset and property management
- Ensures that facilities and assets are adequate to meet assessed needs (community service expectations)
- Improves use of the City Council's asset portfolio
- Optimizes preservation of all retained assets at the lowest life cycle cost

Transportation Infrastructure Managed

- 5,400 km (3,355 mi) of roads
- 803 traffic signals
- 230 road bridges/414 path bridges
- 906 culverts
- 5 tunnels
- 690 buses
- 0 ferries/25 ferry terminals

- Identifies surplus assets and maximizes the return, in both revenue and benefit, from the disposal process

In essence, asset management is considered part of good government. Finally, officials pointed to the rapid growth in population and employment as strains on the city's infrastructure and budgets. Asset management was viewed as a way to provide the best value in infrastructure improvement for the limited funds available.

Organization for Asset Management

Brisbane created an asset steering committee in 1998 under the direction of the mayor and other top division managers that coordinates the provision and preservation of infrastructure in the city. About 10 people serve on this committee, including the key asset management officials in four major city divisions—urban management, community and economic development, city governance, and information technology. According to Brisbane officials, the focus of this committee has evolved from asset management as a financial accounting technique to asset management as a stewardship strategy.

The Transport and Traffic Program in city government is responsible for the road network, and is a major player in the city's asset management program.

Decisionmaking Approach

The adopted vision for Brisbane's asset management effort is "enhancing community outcomes through excellence in physical asset management." According to this vision, expected to be accomplished by 2010, the city's assets will 1) be financially, environmentally, and socially sustainable, and 2) enable the delivery of agreed-on services at optimal cost. The vision statement also says that "in 2010, Brisbane's asset management will be a paragon for local government throughout the region and the world; and be innovative, collaborative, flexible and fully integrated with other city functions." The strategy on how Brisbane plans to develop this asset management approach shows quite well how asset management links to decisionmaking. The themes associated with the steps in this strategy include the following:

Step 1: The community is a key stakeholder and valued participant in strategic decisionmaking. Involvement will occur by educating, collaborating, building relationships, and formulating a community plan for asset management.

Step 2: Asset management solutions are based on a best-for-region approach. The city will continue to work with a Southeast Queensland working group on infrastructure coordination, help develop a regional asset management

plan (especially for shared services), and use a whole-of-government approach.

Step 3: Asset strategic plans provide a reliable basis for effective planning and service delivery. An integrated approach for related assets will be developed with stakeholder participation. Scenario planning will examine service-level tradeoffs.

Step 4: Agreed service standards define the composition of the asset portfolio. This might entail looking at just-in-time asset creation, flexible assets, nonasset solutions, and ownership options.

Step 5: Financial, environmental, and social responsibility will be the foundation of asset management. Stable funding, positive environmental impacts, and assets that help build social capital will be major objectives of the management approach.

Step 6: Enhanced organizational capability is critical for successful asset management. This will entail appropriate assignment of responsibilities, the most efficient arrangements for asset management, and assumed leadership.

Step 7: High-quality outcomes will be achieved in an environment of continuous improvement. Basic characteristics of achievement will include quality assurance efforts, research and development, improved skills and manager knowledge, and public-private partnerships.

Step 8: An asset management program will be streamlined, cost effective, and based on a low-risk information support network. This will require clear organizational rules, accessible and complete information, and integrated support systems. Infrastructure provision, preservation, and maintenance decisions are strongly founded on several plans developed to guide these decisions (see figure 42).

Asset strategic plans have been developed for all major asset classes, varying in time horizons depending on the useful life of the asset. Information technologies, for example, have very short time horizons, while road pavement surfacing is assumed to last between 10 to 20 years and bridges more than 100 years. The asset management plan for roads and streets is typical of how these plans are organized and the types of information needed to support decisionmaking. The asset management plan includes sections on levels of service, future demand, condition assessment, life cycle management, asset risk management, a financial summary, asset management practices, and plan improvement/monitoring.



Figure 42. *Asset management model in Brisbane.*

The table of contents for the traffic signals and electronic control devices asset management plan provides another illustration of what is included in such a plan. The plan is organized in the following manner:

■ INTRODUCTION

— *Background*

- Purpose of the plan
- Asset included in the plan
- Relationship with other planning documents
- Key stakeholders in the plan
- Organization structure

— *Goals and objectives of ownership*

— *Plan framework*

■ LEVELS OF SERVICE

- *Customer research and expectation*
- *Legislative requirements*
- *Strategic and Corporate goals*
- *Current levels of service*
- *Desired level of service*

■ FUTURE DEMAND

- *Demand forecast*
- *Changes in technology*
- *Demand management plan*

■ LIFE CYCLE MANAGEMENT PLAN

— *Background data*

- Physical parameters
- Asset conditions
- Asset valuations

— *Routine asset maintenance*

— *Renewal replacement plan*

— *Asset creation*

— *Asset disposal*

■ ASSET RISK MANAGEMENT

■ FINANCIAL SUMMARY

— *Financial statements and projections*

- Maintenance
- Renewal
- Capital
- Valuations

■ ASSET MANAGEMENT PRACTICES

— *Accounting/financial systems*

— *Asset management systems*

■ PLAN IMPROVEMENT AND MONITORING

— *Improvements*

— *Monitoring*

“We have evolved away from a focus on financial accounting to a more central role for asset management.”

—BRISBANE CITY OFFICIAL

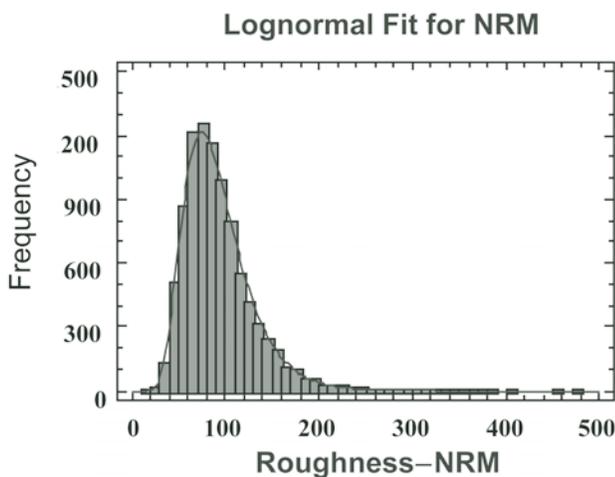
The 10-year asset management plans are part of the strategic-planning process and focus on operations, maintenance, and rehabilitation needs. Key considerations in the plans (described as key challenges in any asset management effort) included the consideration of desired-versus-actual (measured) standards of service, how to reduce the level of backlog, planned-versus-reactive maintenance, how to anticipate growth in demand and unit costs, changes in technology, and alternative service delivery options (i.e., demand management). Asset needs are matched to city infrastructure strategies, which are to invest, maintain, or divest.³⁴

The importance of having an asset management plan to support decisionmaking was illustrated in a recent example where the City Council rejected a requested budget for city traffic signals maintenance because a strategic asset management plan for signals did not exist.

Performance Measures

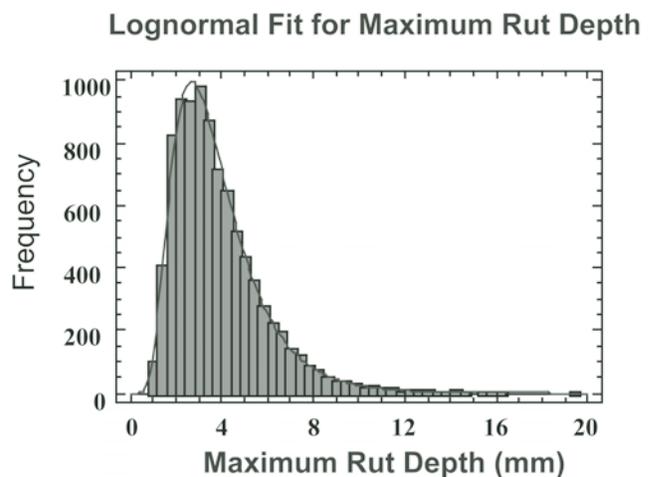
Road infrastructure managers monitor measures of pavement condition and quality. In addition, given the challenges of growing transportation demand, they monitor and report measures relating to congestion/delay and public transportation system performance. The annual report of the Transport and Traffic Program to the City Council best indicates the asset management-related performance measures that elected officials consider most important:

- Amount of road pavement resurfaced
- Amount of improved or reconstructed footpaths and bikeways
- Number of upgraded storm water gullies
- Tons of asphalt manufactured at city sites
- Number of service agreements with internal suppliers and customers to ensure value for money and best-for-Brisbane outcomes



Confidence Levels

- Below 80: 41.95%
- Below 120: 81.16%
- Below 140: 90.27%
- Below 180: 97.56%



Confidence Levels

- Below 2.5mm: 26.10%
- Below 5.0mm: 78.68%
- Below 7.5mm: 94.90%
- Below 10.0mm: 98.72%
- Below 12.5mm: 99.65%

Figure 43. Rutting and roughness data for Brisbane.

³⁴ One issue the city council faces is a recent recommendation from a management consultant to divest its fleet resources and three other asset groups.

- Percentage of customer satisfaction
- Number of lost-time injuries

Given the concern about congestion and public transportation, other measures relating to road level of service and transit ridership are also reported.

Brisbane City Council tested other performance measures to see if they would be more appropriate than what is used now. Figure 43, for example, shows results of a survey of major roads to determine if rutting and roughness data provided better decisionmaking information. It was concluded that they were appropriate at a project diagnostic level, but not at a programmatic level.

Brisbane officials also identified bridge durability and heritage designation as important concerns for those involved with structures.

Asset Management Information Systems

The foundation for Brisbane's transportation asset management program is the Total Asset Management (TAM) system (see figure 44), based on 16 classes of assets. The TAM framework, available on Brisbane's Web site, is an asset planning tool that can examine asset performance over variable time horizons, including annually, 10-plus years, and 30-plus years. TAM supports decisions on capital investment

Brisbane's South East Busway

The Queensland government decided in 1996 to plan a busway network for the Brisbane metropolitan area. The first part of the network, the South East Busway that opened in 2000, now extends for 16.5 km (10.3 mi), with a planned overall length of 72 km (45 mi). Brisbane Transport operates many of the bus services on the busway, with a 2- to 3-minute headway during peak periods and 7- to 8-minute headways during offpeak periods. On an average day, about 3,300 bus trips occur on the busway, serving just over 60,000 passengers. The government viewed the busway as a showcase for the application of ITS technologies, both for vehicle operations and passenger information. The control center houses staff from Brisbane Transport, Main Roads, and police agencies.

Queensland Transport has had responsibility for the maintenance and capital renewal of the busway, but it has agreed to transfer this responsibility to Main Roads because of its experience in maintaining roads. Queensland has entered into a level-of-service agreement with Main Roads that will provide a ride quality and pavement condition equal to the best motorway under its jurisdiction. However, maintenance and upgrading of ITS technologies will remain with the transit agency because transit officials believe they have a better understanding of the service needs of the technology applications.

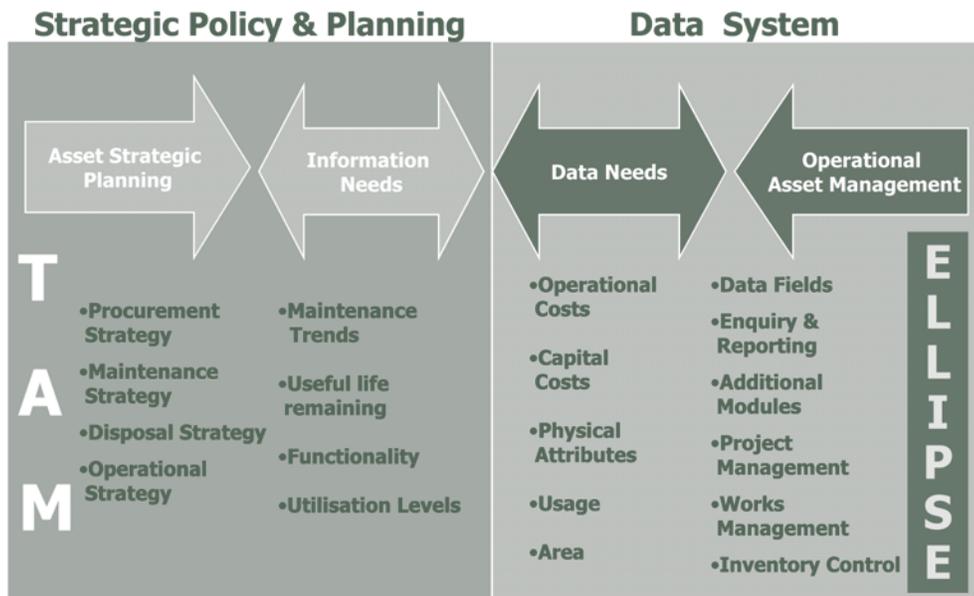


Figure 44. Asset management systems in Brisbane.

planning, strategic and operational planning, maintenance planning, and disposal planning. According to Brisbane officials, top elected officials are very interested in TAM and how it leads to the most cost-effective budget decisions for the city. As a result, TAM has a lot of political support for its use.

According to city guidelines, TAM should provide several functionalities in its role as a decision support system. In particular, it should do the following:

- Be based on life cycle costing
- Provide basic information management
- Allow users to conduct value management
- Include the capability to examine demand-management strategies
- Provide risk management analysis

- Provide economic appraisal capabilities
- Allow asset accounting
- Provide functional assessment capabilities
- Feed into performance measurement
- Keep track of heritage assessments
- Link to environmental management processes
- Conduct condition assessment

The value of pavement is determined through the use of the pavement management system, which uses a condition-based methodology, while all other assets use a straight-line depreciation approach.

Data Collection

Brisbane has developed a pavement classification system manual that defines the approach for collecting data on

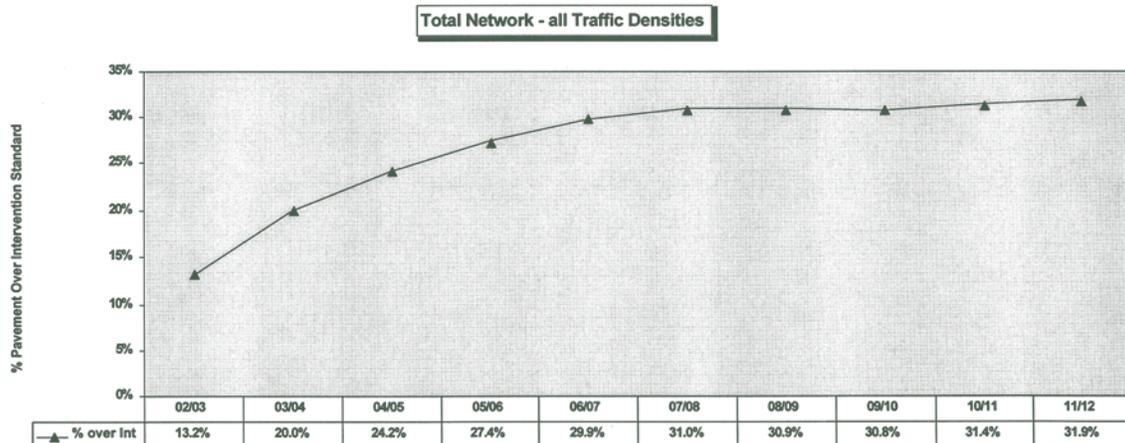
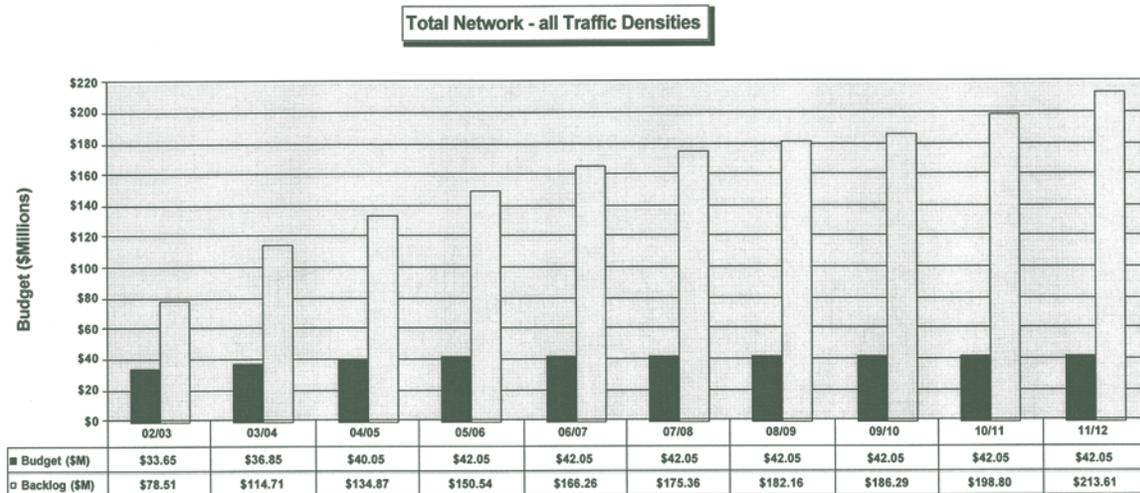


Figure 45. Scenario analysis in Brisbane.

roads, medians, curbs, and footpaths. The data collection strategy uses primarily visual observation to collect data on surface condition. Three teams of two people each collect data on the entire system, usually taking about 4 years to complete the entire road network. Data are collected on major roads every 2 to 3 years and on residential roads every 3 to 5 years.

Analysis Procedures and Prioritization

The asset management approach in Brisbane is based on whole-of-life costing with special attention given to asset durability. The asset preservation program, which includes maintenance and rehabilitation options, is based on standards of service, expected future needs, and identification of risk. Pavement degradation curves calibrated to Brisbane data are used to determine future condition. Risk assessment and comparing current asset condition to engineering standards are the primary means of identifying priorities.

A pavement management system is used to conduct scenario analysis on such policy questions as the following: What is the condition of the road network if the city continues spending at existing funding levels? What amount of funding is necessary if the city wants to maintain today's network condition? Figure 45 illustrates this scenario approach. This figure shows what would happen if 2005/2006 funding levels were continued for 10 years. Network condition (denoted on the y-axis as percentage of pavement network area over intervention standard) not unexpectedly would deteriorate.

This scenario approach was used to develop a 4-year funding program for operations, maintenance, and rehabilitation requirements for all of the city's assets. Assets were considered by class, and funding categories for operations, maintenance, and rehabilitation were defined. This was the first time maintenance and rehabilitation had been included in such an analysis as separate funding categories. In the final analysis, funding for transportation and traffic had the highest budget allocation, A\$229 million (US\$173 million) out of a proposed A\$593 million (US\$448 million) budget.

Some of the issues faced in this analysis were typical of those found elsewhere. They included considering desired levels of service versus actual levels of service, defining the magnitude of maintenance backlog, estimating planned versus reactive maintenance, considering changes in technology, and identifying alternative service delivery options and the costs associated with them.

To value Brisbane's pavement assets, the concepts of useful life, remaining life, replacement cost, and depreciation are used. The estimated replacement cost of the road network is



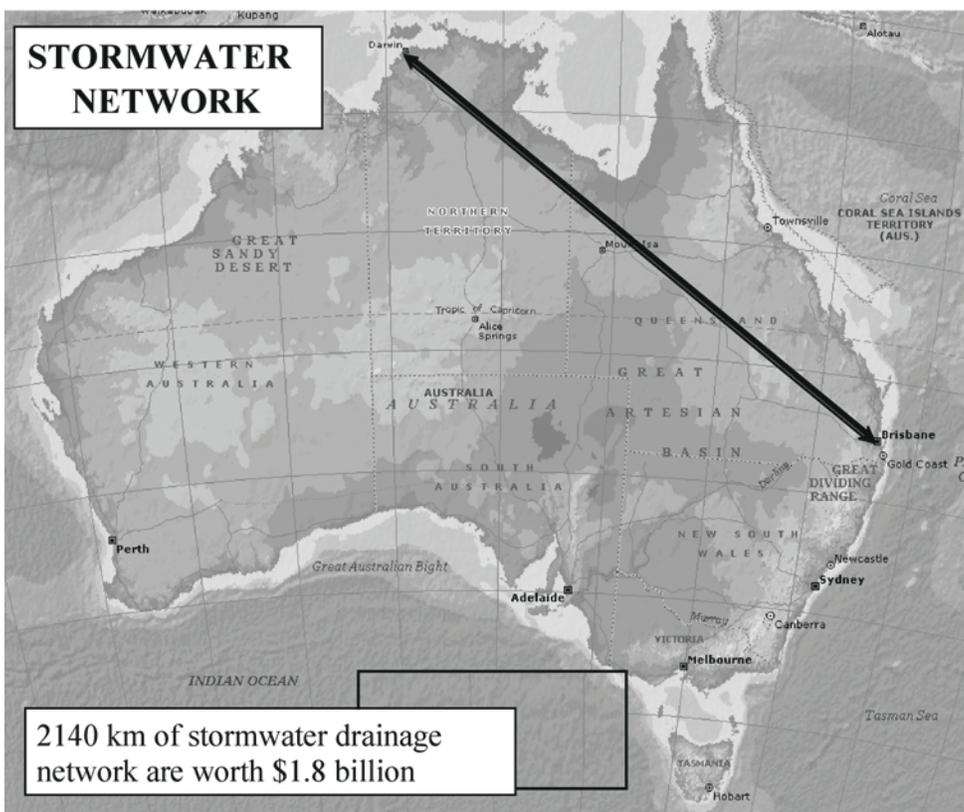
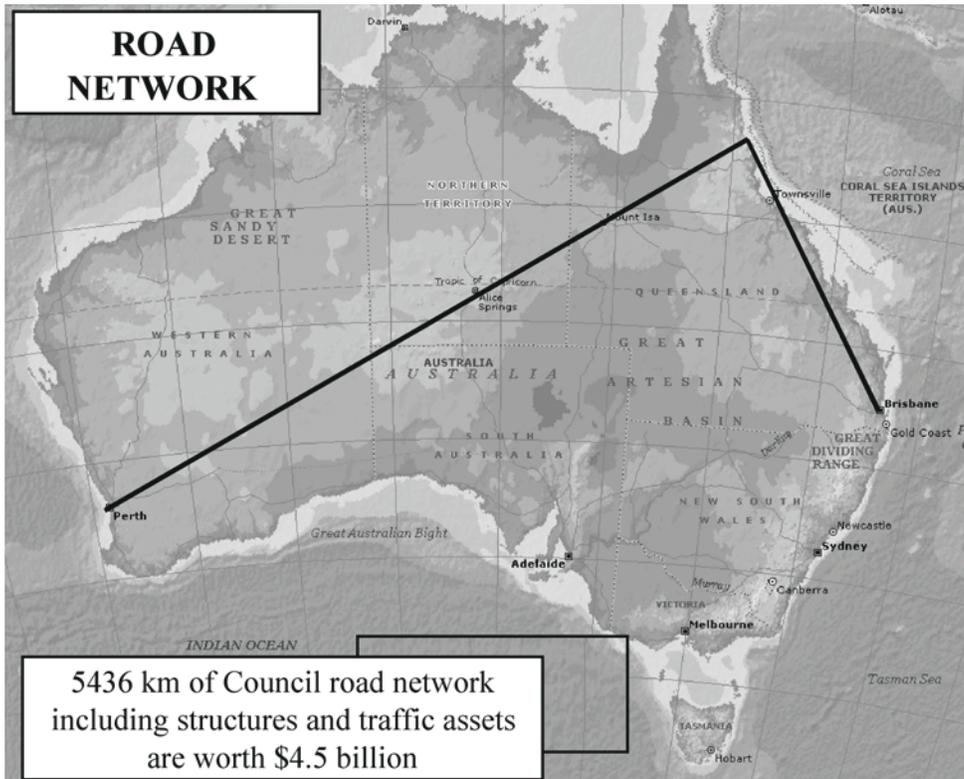
Figure 46. *Brisbane has devoted considerable resources to an asset management program for its sidewalks.*

A\$2.47 billion (US\$1.87 billion). Budget recommendations are based on life cycle cost projections.

The types of atypical road asset management strategies considered as part of the city's program include improving asphalt-laying tolerances, developing advanced asphalt mixes, implementing alternative rehabilitation methodologies, improving materials and techniques, developing alternative uses for road pavement, developing light-emitting strips, and using fiber-reinforced concrete curb and channel.

Observations

Brisbane is a good example of a fast-growing city that gives attention not only to expansion of the transportation network (which it is doing in a dramatic and impressive way), but also to preserving the massive investment that has already occurred in the transportation system. Its award-winning total asset management (TAM) approach has laid the groundwork



for making the most cost-effective decisions possible given budget constraints. Several aspects of the asset management approach in Brisbane are noteworthy.

Asset strategic plans have been prepared for all asset categories. These plans have not only laid out the technical aspects of asset management for each type of asset, but they have also become important decision-support tools—a good example being the Brisbane City Council’s refusal to pass a budget request for traffic signals because no signal asset management plan existed. These plans are an important part of the institutional decision-making process and guide technical analysis and prioritization.

Brisbane’s asset management program leads to a process of prioritization based on tradeoff analysis. This analysis relies on risk assessments and deficiency analysis for desired levels of service. Although still in its infancy, the approach Brisbane adopted appears to provide sufficient information for city officials to determine the right mix of investment across all of its assets. In particular, the approach has promoted the importance of assets that often do not receive much attention, such as signs, signals, and markings, or what was called the “winks-and-blinks” appurtenances. The credence of this approach is enhanced by having an asset steering committee that provides overall guidance to this process.

Given the very public process of transportation planning in Brisbane, city officials have structured the asset management program to be informed by public input. Public presentations and focus groups have been used to seek input from

Figure 47. Portrayal of the extent of the infrastructure challenge in Brisbane.

the public on its desires on system condition and performance.

Similar to Edmonton (see next case), Brisbane has thought carefully about how to portray asset management issues in an easy-to-understand manner. Brisbane staff used figure 47, for example, to convey to elected officials and the general public the extent of the infrastructure challenge facing the city. If nothing else, the equivalent straight line kilometer-to-kilometer extent of Brisbane's road and storm water network conveys the scale of the asset stewardship challenge.

EDMONTON, ALBERTA, CANADA

www.edmonton.ca

Context

The city of Edmonton, Alberta's capital, has just over 700,000 people in a metropolitan area of about 1 million. Strategically located to serve the natural resources industry, Edmonton is expected to capture a large share of future investment in the province. For example, Can\$13 billion (US\$10.4 billion) of the Can\$100 billion (US\$80 billion) in construction announced or underway in the province is occurring in Edmonton. Growth in population and employment is expected to place tremendous pressure on the 12 asset areas for which the city is responsible.

Edmonton defines the replacement value of its assets as the cost of infrastructure if it were replaced in today's dollars (estimated at Can\$19.2 billion (US\$15.4 billion)). The second-largest component of this estimate is transportation and streets, with a nearly Can\$7.5 billion (US\$6 billion) replacement value.

Roads constitute 38 percent of the city's total unfunded needs. About 60 percent of the road investment (Can\$311 million (US\$235 million)) and 54 percent of the transit investment (Can\$123 million (US\$93 million)) are targeted at maintenance and rehabilitation needs. Major funding sources for transportation include debt, tax levies, a provincial fuel tax (5 cents/liter—one of the few in Canada), and developer fees.

According to officials, the critical issues facing the city's transportation system include a significant backlog of necessary work and inadequate funding. The overall physical

condition of transportation infrastructure is considered fair, but problems exist in collector and residential roads (in mature neighborhoods), alleys (in mature neighborhoods), street lighting, traffic signals, traffic signs, the light rail transit (LRT) fleet, bus terminals, transit fare-collection equipment, and transit bus and LRT communications equipment.

Of interest to this scan, Edmonton's experience in asset planning and management led to the development of Canada's *National Guide to Sustainable Infrastructure (InfraGuide) Best Practice on "Managing Infrastructure Assets."*³⁵ In addition, Edmonton has played a lead role in the development of InfraGuide's new *Managing Infrastructure Assets Knowledge Product*, released in June 2005.

Drivers for Asset Management

Edmonton's adopted Infrastructure Strategy (1998) was based on a goal of ensuring that Edmonton's infrastructure is "in a good state of repair, and rehabilitation and development programs are adequately funded on an ongoing basis, and are as efficient and effective as possible."³⁶ This strategy was founded on concerns over many years of deferred maintenance caused primarily by an economic downturn and corresponding funding shortfalls.

Edmonton officials noted the following major drivers for asset management:

- Need to optimize investment decisions in light of significant funding shortfalls
- Need to quantify asset value and operational status of the infrastructure
- Need to demonstrate clearly the linkage between funding and service levels to the city council
- Need for a mechanism to compare investments between different asset classes
- Need for a mechanism to compare investment products between growth and investment infrastructure

City officials described these drivers in general terms as leading to Edmonton becoming a "knowledgeable owner."

Transportation Infrastructure Managed

- 4,395 km (2,731 mi) of paved road
- 142 bridges/culverts
- 4,334 km (2,693 mi) of sidewalks
- 69,000 streetlights
- 822 traffic signals
- 123,000 traffic signs
- 19,526 posts/bollards
- 3,370 parking meters
- 757 diesel buses/37 light rail vehicles/63 trolleys
- 10 light rail transit stations

³⁵ See www.infraguide.ca.

³⁶ City of Edmonton, *Thinking Outside the Gap, Opportunities to Address Edmonton's Infrastructure Needs, Infrastructure Strategy Report 2004*, Edmonton, Alberta, see: <http://www.edmonton.ca/InfraPlan/Infra/City%20Docs/Infrastructure%202004%20v3.pdf>.

No legislative mandates for asset management have come from the federal or provincial level, but city officials stated that funding programs from these sources increasingly require evidence of asset stewardship before funding will be awarded. They think this will become more prevalent in the future, so an asset management program could become strongly tied to the city's ability to obtain funding support.

Organization for Asset Management

After adopting the Infrastructure Strategy, the City Council created an Office of Infrastructure in March 2000 (see figure 48). Three departments, Asset Management and Public Works, Transportation and Streets, and Community Services, form the majority of the city's asset base and contribute an apportioned share of the office's consulting budget. The office's mandate is to report the state of the city's infrastructure, and implement strategies and tactics to address the gap between capital needs and available funding. The office updates the city's infrastructure inventory and investment needs annually and submits a formal update of the Infrastructure Strategy to the City Council every 2 years.

The office is also responsible for monitoring strategy recommendations and conducting corporate life cycle costing and a risk assessment to identify the risk associated with deteriorating infrastructure. The role of the office is as a strategic coor-

dinator; implementing recommendations falls primarily to city departments. In this way, the office and city departments operate as a cross-functional corporate team. The Office of Infrastructure has four employees.

The city of Edmonton's director of infrastructure planning oversees the Office of Infrastructure (OIT). Responsible for managing OIT, the position's primary mandate is to monitor, implement, and update strategies to address the growing disparity between the city's infrastructure capital needs and available funding. An Infrastructure Working Team (IWT), representing city departments with an asset management role, assists OIT in collecting data and preparing information. A Capital Infrastructure Committee (CIC), composed of nine managers from key civic departments, provides general guidance in implementing the Infrastructure Strategy.

An Infrastructure Technical Advisory Committee (ITAC) has also been created to provide an opportunity to consult with 20 external professional and technical organizations. The ITAC mandate is to 1) provide advice to the city as it improves and validates strategies, processes, and planning tools, 2) provide a broad scope review of infrastructure issues, and 3) foster two-way communications between the city and key stakeholders. According to Edmonton officials, ITAC members benefit from their participation by the following:

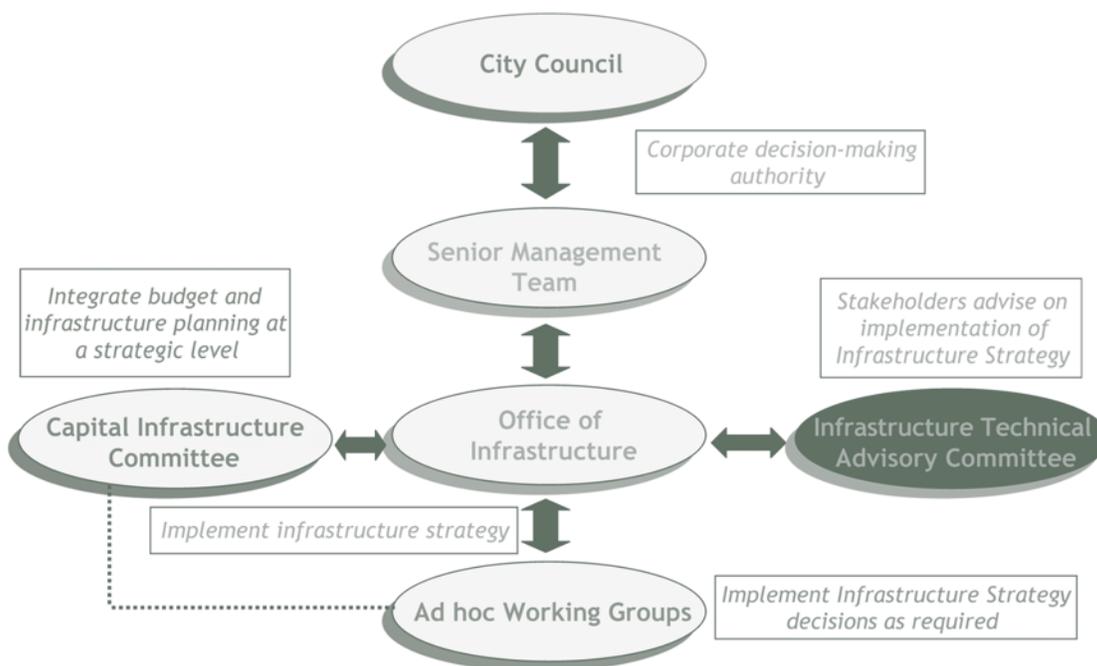


Figure 48. Asset management organization in Edmonton.

“Pay me now, or pay me later . . . and it will cost much more later!”

—EDMONTON CITY OFFICIAL IN RESPONSE TO A QUESTION ON WHAT THE ASSET MANAGEMENT MESSAGE SHOULD BE TO ELECTED OFFICIALS

- Receiving and disseminating to their appointing organizations information on the city's overall infrastructure investment and management practices
- Accessing media reports that help them monitor developments in other municipalities and measure public opinion on municipal infrastructure
- Meeting to discuss infrastructure issues with other interested parties
- Having opportunities to see Edmonton management practices firsthand and to influence program development

The Office of Infrastructure reports to the Senior Management Team monthly, providing updates of work undertaken and reporting on any new information that has come to the attention of office staff. The office is required to report to the City Council every 2 years on the state and condition of the city's infrastructure. This report includes the inventory and investment needs of the city, as well as investment options and revenue opportunities.

According to officials, the most important role of the Office of Infrastructure has been its validation of the infrastructure gap, and its identification of the rehabilitation and growth requirements of the city's infrastructure. In identifying these needs, the office has also created tools to help determine the critical areas that require immediate attention. For example, a risk assessment of the city's assets determined an increased risk with the city's service connections (pipes that provide sanitary and/or storm sewer connections to the sewer mains). As a result, this was taken into consideration in the budgeting process, removed from the operating budget, and repositioned in the capital program.

The agency with direct responsibility for road asset management is the Transportation and Streets Department. The department designs, builds, operates, and maintains Edmonton's roads, and is organized around strategic planning, street engineering (including design, construction, maintenance, and services), traffic operations, and transit. Maintenance is primarily “clean it and fix it,” while rehabilitation is considered a capital project. The department maintains a core expertise for asset management and contracts out rehabilitation/reconstruction work, but does maintenance work primarily in-house.

Part of the organization for asset management is the linkage among asset managers, elected officials, and the general pub-

lic. City officials have produced a very impressive document called Thinking Outside the Gap, Infrastructure Strategy Report 2004, a biennial infrastructure strategy update report to the City Council. This report identifies strategies for dealing with the infrastructure challenge facing the city. This update included strategies on maximizing use of existing infrastructure, continuing to develop a comprehensive asset management system (including risk assessment and life cycle costing), achieving sustainable levels of service, and promoting shared services among communities.

Decisionmaking Approach

Each year since 1998, the city of Edmonton has developed a 10-year long-range financial plan (LRFP) to meet forecasted needs. The LRFP presents funded and unfunded categories, with the unfunded portion constituting the infrastructure gap. A Transportation Master Plan (TMP) broadly outlines allocation targets for road-versus-transit projects and growth-versus-rehabilitation projects. This plan also outlines a series of 10-year priorities.

At the city level, a business case must be prepared for each project and is taken under advisement by the CIC, which ranks projects from highest to lowest priority. Several key factors are considered in this prioritization, including deterioration of infrastructure, service needs, and regulatory requirements; the impact of investment on safety, quality of service, quality of life, and economic growth; infrastructure condition; expected infrastructure performance; return on investment; and demonstrated benefits.

One of the major constraints on the city's transportation funding is the eligibility of the fuel tax rebate revenues from the Province. The fuel tax rebate can only be used for the arterial roadway system (both rehabilitation and growth-related projects) and for major transit system investments (both rehabilitation and growth-related projects). The Province also requires that the physical condition of the arterial roadway infrastructure be maintained, which has resulted in maintenance set-asides for this purpose. Thus, city officials believe that programmatic requirements of funding sources drive rehabilitation priorities.

For pavement maintenance decisions, the city's pavement management system is used as a first-cut identification of the most critical needs that enter into the city's 5-year program. Different levels of service are determined corresponding to different budget assumptions.

After the infrastructure gap was verified, the City Council amended its debt policy to permit borrowing of Can\$50 million (US\$40 million) per year over 5 years to pay for large, high-priority capital projects. The borrowed funds are paid for by a 1 per cent increase in property tax and are allocated to projects that would otherwise be unfunded, including interchanges, road rehabilitation, and road improvements.

According to city policy, debt-financed projects must be in the range of Can\$10 million (US\$8 million), have an asset life of at least 15 years, and must fit into approved capital plans.

Having committed \$100 million in debt financing for key infrastructure projects in 2003 and 2004, Edmonton has already made significant strides in dealing with key infrastructure issues.

Performance Measures

Edmonton uses system performance measures of condition, functionality, and demand capacity for all asset categories. These are the primary measures it uses to determine if its infrastructure is performing at desired levels. The degree to which infrastructure spending is meeting (or not meeting) the infrastructure gap is also considered an important measure.

An infrastructure report card is prepared annually that reports on various asset characteristics. Departments provide data on the following infrastructure characteristics: replacement value, quantity and unit of measure, average age, expected asset life, physical condition rating, demand/capacity rating, functionality rating, capital budget for rehabilitation, growth, other projects (past 3 years), other projects (current year), operating budget for operations and maintenance (current year), sources of financing, funded and unfunded 10-year needs for rehabilitation, growth, and other projects (taken from the 10-year Long-Range Financial Plan).

Besides the usual condition and ride quality measures found in almost every asset management program, Edmonton uses a pavement quality index (PQI), which is a composite of a visual condition index, road condition index, and structural adequacy index. PQI is based on a mathematical relationship developed by relating experts' visual ratings to instrumented values for the same sections. A separate PQI formula exists for different combinations of indices.

Officials are also conducting a pilot project to determine public desires on service levels. This effort reflects a basic philosophy that performance measures should relate to public willingness to pay, as well as to the implications of failing to achieve desired service levels.

Asset Management Information Systems

The physical assets monitored in various asset management systems include the following:

1. Roads (primary highways, trunk arterials, nontrunk arterials, residential streets, industrial roads, collectors, locals, and alleys)
2. Sidewalks (suburban neighborhoods, mature neighborhoods, and special treatments)
3. Bridges (major/custom design, standard design, and culverts)
4. Auxiliary structures (distinct and continuous)
5. Streetlights (arterial poles, residential poles, decorative poles, and arterial high-mast poles)
6. Traffic signals (cabinets, poles, closed-circuit TV camera poles, and cameras)
7. Electronic parking meters
8. Traffic signs (overhead guide sign supports, overhead signs, ground mount signs, and ground general signs)

Edmonton began using the Municipal Pavement Management Application (MPMA) in 1986. MPMA defines a network pavement rehabilitation strategy, optimizes the selection of individual road sections, and recommends a 5-year capital investment program. City officials view MPMA as having several beneficial characteristics, including decision trees that are easy to customize, output that is based on cost effectiveness, deterioration models that allow local parameters to be input, good network analysis capabilities, and good communications/graphics modules.

Data Collection

The Transportation and Streets Department collects the following types of data: For pavements, surface distress is defined by a visual condition index (VCI, collected manually using the APWA Paver method), roughness is defined by a riding comfort index (RCI, collected with a profilometer), and structural capacity is defined by a structural adequacy index (SAI). Rutting is collected by a vehicle-mounted rut bar integrated into the data-collection process for surface distress. For sidewalks, surface distress (the only condition data collected) is collected electronically. For bridges, all individual structures are rated manually.

The Transportation and Streets Department collects arterial, collector road, and sidewalk data biennially. Local streets are surveyed every 4 years, but structural capacity data is collected when needed. Twelve temporary staff, three permanent staff, and one supervisor collect data for pavements and sidewalks. Data-collection costs are about Can\$500,000 (US\$400,000) per year.

Analysis Procedures and Prioritization

Edmonton is responsible for 12 infrastructure areas ranging from roads to affordable housing. To provide a fair comparison across all infrastructure categories, the Office of Infrastructure has devised a ranking system that rates the physical condi-

tion, demand/capacity, and functionality of individual infrastructure elements. *Plan Edmonton*, the city's municipal development plan, identifies the following areas as being most important for city investment: safety and public health, growth, environment, preservation of infrastructure, and service to people.

City departments worked together closely to develop a consistent ranking methodology, which established a common vision for a corporate-wide strategic asset management approach. The Transportation and Streets Department traditionally kept good data on its needs, but many other infrastructure areas did not have the same level of information and had to conduct data-gathering activities to reach parity with the road asset database. This effort has facilitated the comparison of disparate infrastructure types, and has set the stage for the corporate risk assessment and life cycle costing processes.

The Transportation and Streets Department uses its own measures, primarily the pavement quality index (PQI), to determine its recommended priorities. The department also uses deterioration curves to determine the change in PQI based on assumed budgets. For example, the 2004 *Transportation and Streets Infrastructure Report* presented the following PQI performance with an assumed continuation of current funding:

Roadway Type	Current PQI (2003)	Year 2008 PQI
Primary highway	7.0	6.9
Arterials	5.7	5.3
Collectors	5.1	4.5
Locals	5.2	4.7
Alleys	3.3	2.8

Other assets, such as streetlights, transit equipment, traffic signs, and parking meters, are rated as being in good, fair, or poor condition.

Figure 49 shows how the rating scheme works for Edmonton's roads. This approach borrows from the report card format used by the American Society of Civil Engineers (ASCE) when rating U.S. infrastructure. By using such an approach to analysis, Edmonton officials are able to determine the level of unfunded infrastructure needs in the city (14 percent in poor condition and Can\$4.1 billion (US\$3.1 billion) investment needed from 2005 to 2014). The condition rating varies by road classification; 5 percent of major arterial roads and 50 percent of alleys are in poor condition. This information, along with the amount of infrastructure considered in poor or very poor condition and the percentage of the replacement value allocated each year for asset preservation, is used to determine whether the level of infrastructure investment is adequate. National experts have recommended that annual

What is its Condition?

- Physical Condition**

– condition of the physical infrastructure that allows it to meet the intended service level

- Functionality**

– the ability of the physical infrastructure to meet program delivery needs

- Demand/Capacity**

– the ability of the physical infrastructure to meet service needs



These ratings are applied to each classification

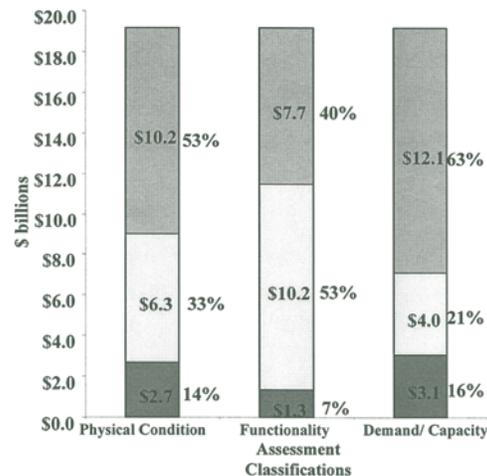


Figure 49. Rating Edmonton's roads by condition, functionality, and demand.

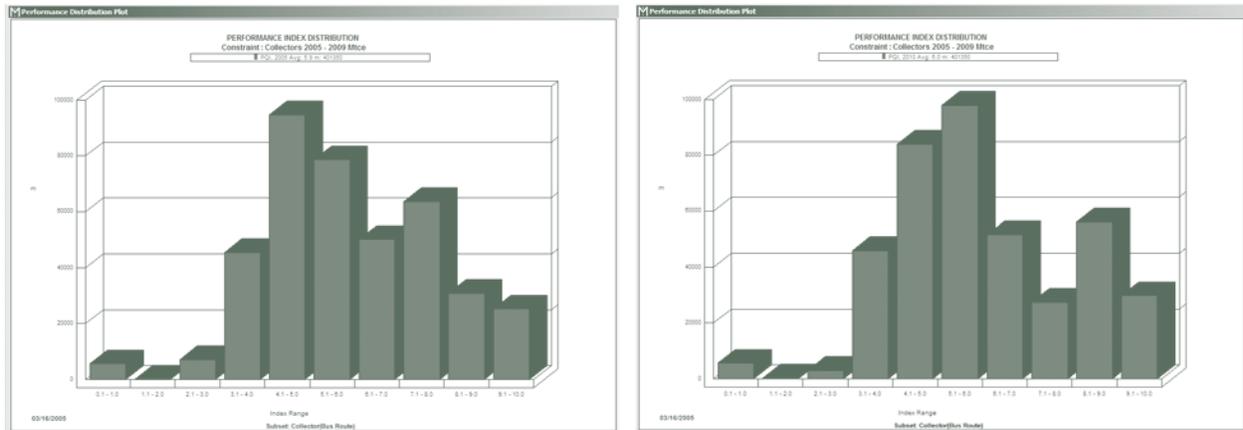


Figure 50. Scenario analysis in Edmonton showing different condition time streams.

investment in the city's assets be 2 to 4 percent of the replacement value. The city spends Can\$178 million (US\$134.4 million) each year on infrastructure rehabilitation, compared to a recommended 2 percent of replacement value of Can\$383 million (US\$289 million).

The Municipal Pavement Management Application is used to analyze different performance and budgetary scenarios. For example, Edmonton officials can look at cost minimization and maximum performance scenarios or combinations of the two. Figure 50 shows how MPMA can be used to examine the dis-

tribution of pavement condition (the x-axis) given different budget allocations.

Edmonton was one of the few sites using a formal risk assessment process to evaluate the impact of failure for a given element of infrastructure. The first step in the risk analysis process was to segment infrastructure assets into logical groupings based on common characteristics. For each segment (e.g., one road kilometer), data were collected describing the inventory, state, and condition, and the 10-year rehabilitation financial estimates for that asset. The condition of an asset was categorized using Edmonton's standardized rating system. Conditions were assessed by reviewing the assets within a given department through a combination of workshops and independent analysis. Failure was assumed to occur in two ways, either suddenly and unexpectedly, or gradually and expectedly. The approach uses 155 different deterioration curves and probabilities to determine expected failure.

Figure 51 is an example of the type of analysis that can result from this effort. In this figure, the severity of an asset failure is compared to its replacement value. Those assets found in the upper tier and farthest to the right are considered greater priorities.

The Office of Infrastructure has been promoting the use of corporate-wide life cycle costing in infrastructure management, although the Mobile Equipment Services (Fleet) Department is the only one that has fully implemented such a system. Eventually, life cycle costing is expected to be applied at the strategic, network, and project levels. A life cycle costing approach was used in assessing the status of Edmonton's sidewalks (a Can\$500 million (US\$400 million) asset). In

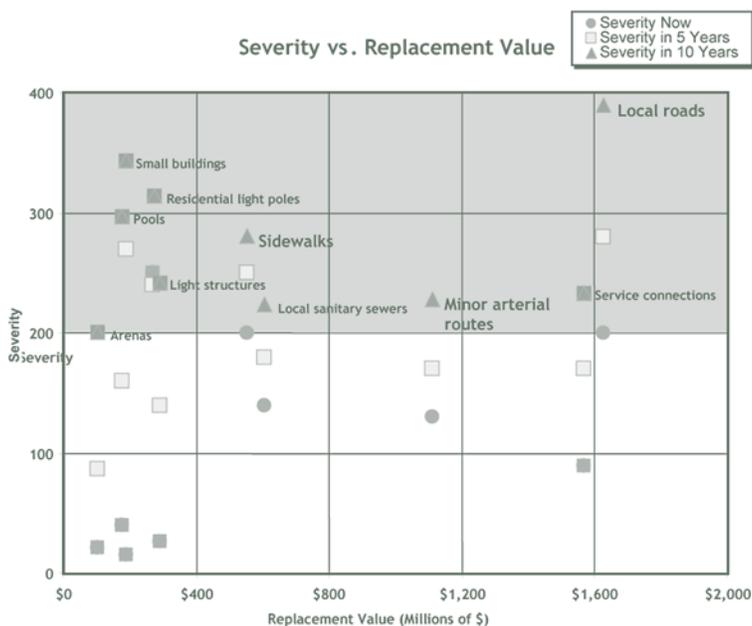


Figure 51. Example of risk assessment in Edmonton.

addition, Edmonton officials have used life cycle costing to examine the possibility of increasing service lives of assets through initial design concepts. A recent decision to use a granular base for new and reconstructed roads was based on the finding that it would increase overall useful life, compared to the use of full-depth asphalt and cement-treated bases.

The city's finance group is also looking at an integrated capital and operating budget to get a better sense of life cycle cost estimates. The Office of Infrastructure is examining criteria that could be used in such an integrated budget concept to provide an improved balance among renewal, upgrades, and capacity expansion.

Observations

In establishing an Infrastructure Strategy and undertaking an investment needs analysis, Edmonton's Office of Infrastructure has achieved a high level of credibility in the asset management process. The approach of assessing different assets and portraying the assessments in tabular and graphical form has allowed elected officials and the public to understand both the importance of the city's assets and the need to support them financially. Through its asset management efforts, Edmonton has demonstrated to others in government that municipalities require additional funding to keep infrastructure in reasonable condition.

Edmonton was one of the few cases the scan team observed in which tradeoff analyses among different asset categories were conducted. Edmonton does not use models or formulas to conduct a rigorous tradeoff assessment. However, by using common criteria—condition, functionality, and demand/capacity—officials are able to get some sense of the benefit to the city of funding different asset types. The use of an infrastructure scorecard, similar to that used by ASCE, is a good way to illustrate to the general public the status of the city's infrastructure. In the pavements area, the use of the PQI measure and scenario analysis also allows officials to gauge the tradeoffs in system performance associated with different budget strategies.

One innovative characteristic of Edmonton's approach to asset management was the creation of an infrastructure technical advisory group. Not only is this advisory group critical for educating key constituencies on the importance of infrastructure, but it also provides a sounding board for finance and policy proposals that can lead to greater public and political attention to the asset challenge facing the city. This advisory group is part of a much larger communications strategy that has surrounded the city's asset management program. Public dialogue around asset needs, and the adoption of a "made-in-Edmonton" solution, is widely understood and endorsed by the citizens.

Finally, Edmonton is way ahead of other similar municipalities in considering risk part of its prioritization process. The combination of the risk of failure and the level of severity associated with such a failure allows city officials to give greater attention to assets critical to the economy and quality of life in Edmonton. The scan team did not see anything like the approach Edmonton takes in any other sites it studied.

LONDON, ENGLAND

www.tfl.gov.uk

Context

Just over 27 million trips are made in greater London every day, 8.5 million on public transport, 11 million by car or motorcycle, 7 million on foot, and 0.3 million by bicycle. Transport for London (TfL), created in 2000, is the agency responsible for much of the transportation system used by these 27 million trips. Transport for London manages London's buses, subway system, Docklands Light Railway (DLR), and London Trams. It also runs London River Services, Victoria Coach Station, and London's Transport Museum. Only TfL's Street Management Division participated in the presentations during this scanning study, so the team's observations focus on road assets rather than TfL's considerable public transit assets.

Road Infrastructure Managed

- 580 km (360 mi) of primary roads
- 4,600 traffic signals
- 900 bridges
- 10 tunnels

The backbone of the Street Management Division's responsibilities is the 580-km (360-mi) road network known as the Transport for London Road Network (TLRN), also designated as the "Red Routes." The stated aim of TfL is to improve the Red Routes for pedestrians, motor and pedal cyclists, bus passengers, people with disabilities, drivers, and freight movement. Because of their strategic role in London's street network and their concentration of traffic control and safety devices, these routes consist of just over 1 million assets. London's 33 local boroughs manage the remaining roads in London, except for those under the responsibility of England's Highways Agency.

Given the size of the metropolitan area (more than 9 million people), it is not surprising that the stated transportation challenges range from congestion relief (resulting in London's innovative road congestion pricing scheme) to safe pedestrian and bicycling environments. In fact, TfL's business plan and

performance monitoring scorecards show that the great majority of the performance indicators relate to the performance of the Underground (subway). In the business plan, Transport for London lists the following as the most immediate priorities:

1. Reducing the number of people killed and injured on London's roads
2. Improving the bus network
3. Bringing assets such as bridges and the road network into a state of good repair

Transport for London committed a substantial amount of funding to TLRN to reduce the backlog of maintenance needs, which it inherited when TfL was created. This investment has resulted in a decrease in the percentage of roads needing repair from 14.2 to 11.5 percent over a 2-year period.

Drivers for Asset Management

Transport for London has been committed to asset management for many years. The most important driver for asset management in its early years was a desire to know what assets were TfL's responsibility and the condition of those assets. The national and London governments have also adopted a policy of reducing the road maintenance backlog that had built up over many years, and they consider an asset management program the most effective way to manage such a program. More recently, as was discussed in the England case, the national requirement for whole-of-government accounting procedures, the opportunities for public borrowing of funds for transportation investment, and the national requirement to prepare local transport plans that included a highway asset management plan have led to increased interest in an effective asset management program.

Decisionmaking Approach

Transport for London's asset management program identifies critical asset needs in the city, determines the most cost-effective strategy for dealing with these needs, and conveys progress to elected officials by relating the results to Best-Value Performance Indicators (BVPIs). In addition, asset management information has been used to value assets and redistribute capital maintenance funds among the different boroughs of London. The following statement from TfL's 5-year business plan in the streets management area shows the importance of asset management:³⁷

"The funding level for capital road renewal in the Plan means a re-evaluation of priorities. The total 5-Year Investment Program will be focused on striving to meet the government 2010 deadline for clearance of the 'backlog'. However, the funding

levels under this Business Plan means that there is a significant risk to meeting the 2010 target."

The risk mentioned in this statement is expected to be reduced with the application of asset management principles.

Performance Measures

Transport for London focuses its attention on several performance measures, not only for technical analysis, but also for conveying network status to elected officials. The most important of these measures are called Best-Value Performance Indicators (BVPIs), which relate to those network characteristics that are considered most critical and that have the highest value in terms of network effectiveness. London, along with other local authorities, report on the BVPIs mandated by England's Department for Transport. For example, for road network operations, four indicators are considered most important: 1) percentage of working streetlights, 2) dangerous defects made safe or repaired within 24 hours, 3) days of temporary traffic controls, and 4) traffic signals operating effectively. Figure 52 shows condition data on streetlights (ranging from no defects to unsafe). The scan team noted a difference in overall condition between light columns in the first two districts of the city versus the other three. This was explained as primarily the result of data collection by two different contractors, each with a different concept of what was meant by "minor" or "no defects" (a lesson on data consistency when more than one entity is collecting data).

One of the most important government goals for TfL was to reduce the backlog in maintenance needs. This has become an important program performance measure. The following information comes from the annual report for TfL that shows progress toward this goal.

Maintain Strategic Road Network, Change Between 2000 and 2010	Measure	Target	Progress
	Proportion of network in need of maintenance	Between 7 and 8%	Substantial improvement
	Halt deterioration of local road network	Halt by 2004 End backlog by 2010	Substantial improvement

For principal roads not controlled by TfL and the Highways Agency, the London boroughs have pooled their resources and chosen one borough, Hammersmith and Fulham Council, to collect data on these roads. The primary measure (BVPI) for these roads is a pavement structural condition index.

³⁷ Transport for London, *Business Plan, 2005/06-2009/10*, Office of the Mayor of London, undated, see: <http://www.tfl.gov.uk/tfl/downloads/pdf/business-plan/2005/business-plan-05.pdf>.

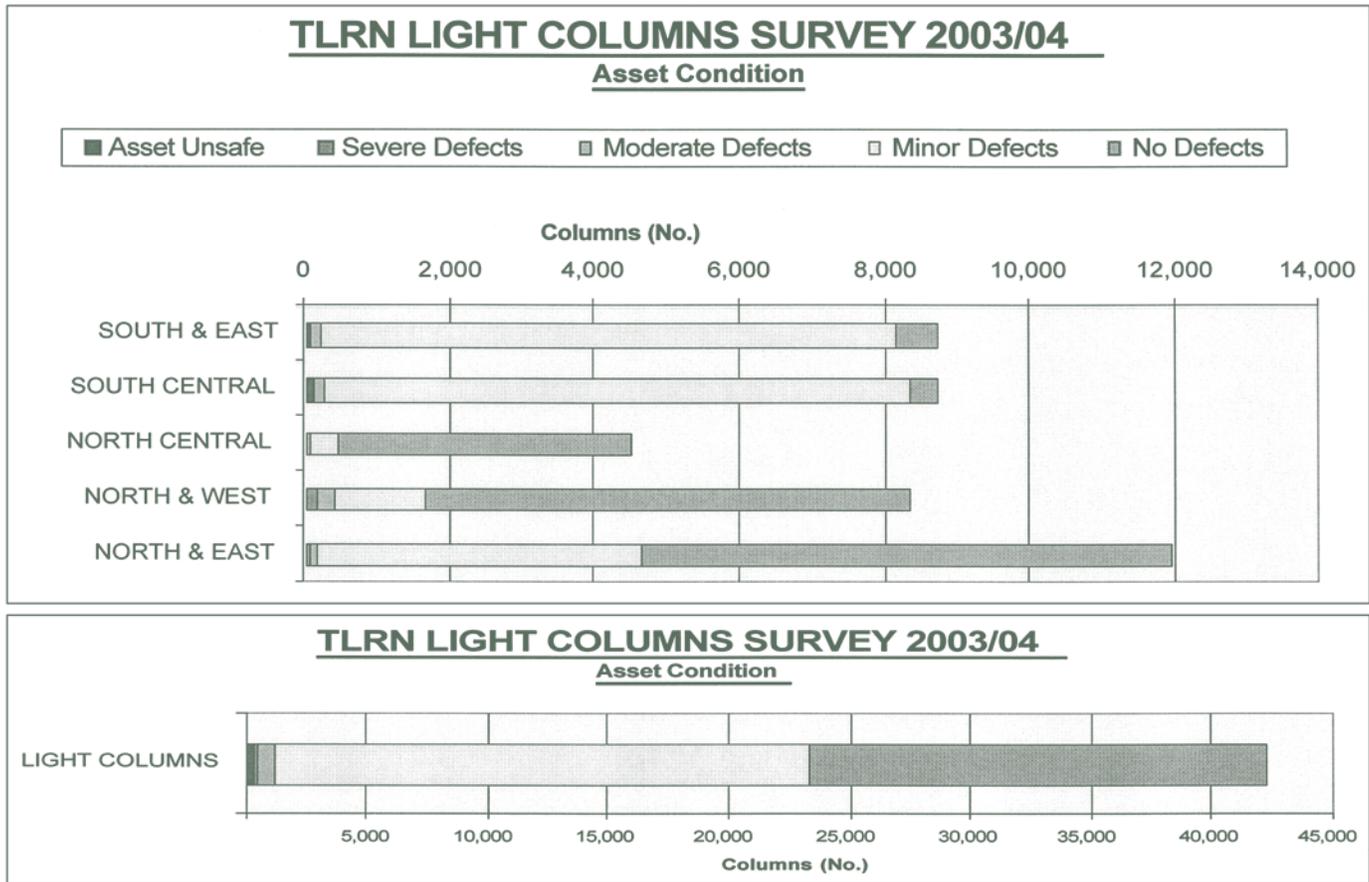


Figure 52. Streetlight inventory and condition assessment in London.

Asset Management Information Systems

The major asset management system for Transport for London is called the Asset Inventory and Management System (AIMS), part of the geographic information system (GIS) platform used for numerous city planning and management activities. The basic structure for AIMS is consistent with and reflects the functionalities of the United Kingdom Pavement Management System (UKPMS), discussed earlier in the case description of England.

The basic data found in AIMS includes network description (including highway boundaries and road hierarchy and data by lane), 59 different asset types with about 10 to 15 attributes per asset type, condition data, and crash data. The spatial accuracy of the data is 1 meter. In addition, Transport for London employs numerous live video cameras, so the AIMS data includes not only historic data, but also live feeds from cameras on the street network. Figure 53 shows two types of representations available in AIMS. The first one reports the location, geometric characteristics, and condition of a particular asset (in this case, dropped curb). The second shows a real-time feed from a camera that indicates several different

assets (bus stop, sign, and information kiosk) and their relationship to what is indicated on plans.

Data Collection

London's approach to pavement condition data collection is based on the Detailed Visual Inspection (DVI) regime of UKPMS. This is carried out in London by walking the network. Forms are coded for visually determined condition (defects and their extent) characteristics. This information is used to report the Best-Value Performance Indicators (BVPI) condition for footways. In the case of roads, this is converted to equivalent Coarse Visual Inspection (CVI) values as required by the Department for Transport, so that BVPI comparisons can be made. Most rural (county) authorities use only CVI condition collection from a slow-moving vehicle.

Transport for London relies on four inspectors and one supervisor to collect data. TfL officials expressed a high level of confidence in the quality of this data because of the ability to maintain direct control of the survey and defect identification. This has been confirmed by the close correlation between prediction from its modeled and actual condition results. TfL

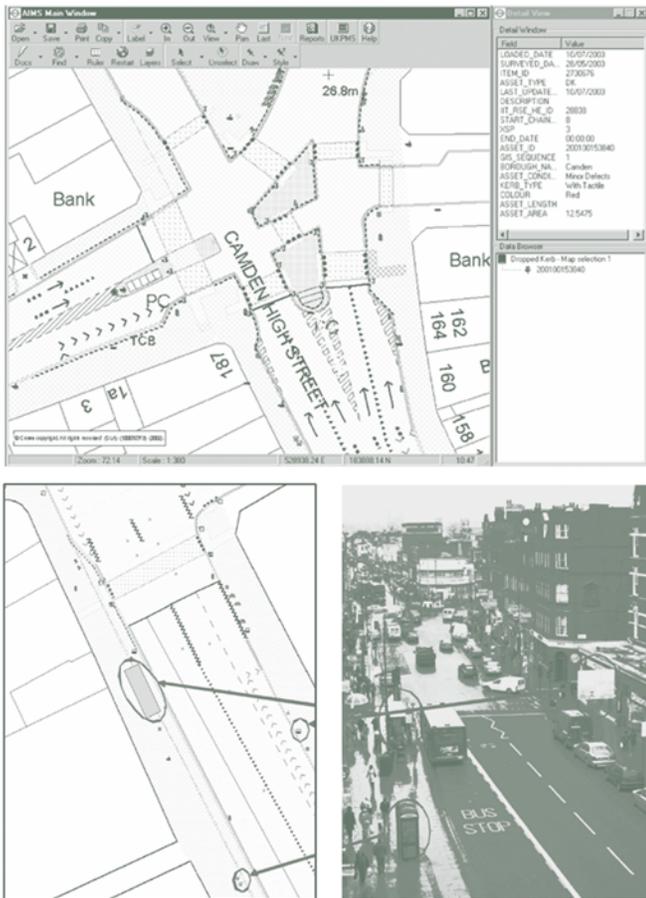


Figure 53. Asset Inventory and Management System in London.

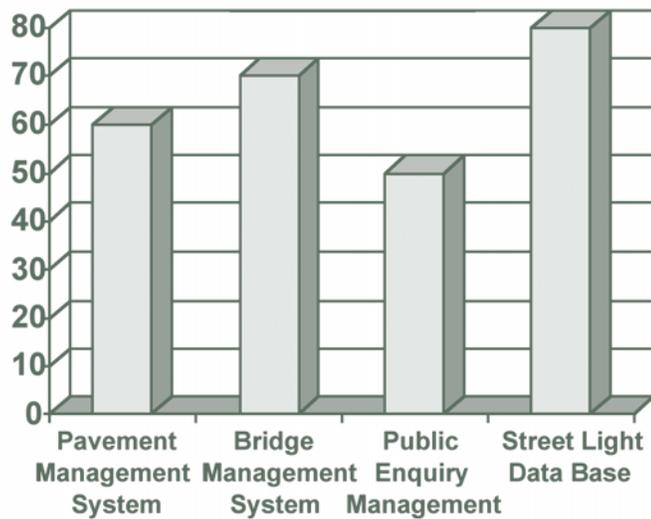


Figure 54. Percentage of local governments using asset management systems in England.

also uses the SCANNER or TRACS machine inspection method for road condition data collection, a relatively new methodology for England. TfL plans to work with national and local authorities to develop correlation between the two survey methodologies so that in the future SCANNER information can be used in its pavement model.

Analysis Procedures and Prioritization

Transport for London uses condition index ratings to establish project priorities for both roads and sidewalks. The condition of the asset is rated on a scale of 0 to 100; the bigger the value of the indicator, the worse the condition. Any asset receiving 70 or above is considered in “poor” condition. The “percentage of roads with ratings of 70 or above” is a national BVPI. Transport for London officials have concluded from the experience with this approach that treating pavements with condition index scores of 50 to 70 is the most cost-effective way to prolong pavement life.

A pavement deterioration model has been developed to examine the future performance of roads and develop a 15-to-20-year investment program. For lighting standards, which appears to be a much bigger asset management issue in England than in the United States, a model is under development to produce similar results. For bridges, a model based on current bridge deterioration data in London is used; a second phase of tying this into benefit-cost analysis is under development.

Transport for London uses the pavement model to test different expenditure scenarios: How much funding is needed to clear the maintenance backlog by 2011? How much funding is necessary to keep road pavement in a steady state of good repair and retain it at this level? What are the optimal funding levels to provide the most cost-effective life cycle investment program? The assumptions that enter into analysis for each condition index range include the appropriate type of treatment for roads and sidewalks, average costs of treated roads/sidewalks, proportion of funds spent, and life cycle of the roads and sidewalks with assumed rates of deterioration.

Other Local Governments

During the course of the scan team’s discussions in England, several other local government experiences with asset management were described as best-practice examples. The following sections provide brief descriptions of these efforts. In addition, the scan team heard from maintenance contractors and an asset management consultant on their experiences and thoughts on local government asset management practice in England. These observations are presented here as well.

Figure 54 shows the percent of local governments with some form of asset management system in place. Many systems are

quite simple, while others have been developed by consultants in response to asset management guidance from the national government. An asset management consultant noted that the response of local authorities to this guidance falls into three categories: local authorities that have initiated an effort to develop an asset management plan, local authorities that have formed coalitions with other local governments to develop a generic asset management plan that can be applied in member jurisdictions, and local governments that are not doing anything.

For those making some effort to develop an asset management plan, the steps are straightforward. They include a review of the state of the infrastructure, a gap analysis, assessment of condition data, preparation of an asset management plan, and development of an implementation strategy. According to the consultant, the experience to date with local governments is the following:

- Asset management planning is making local authorities think about managing their assets.
- Few examples of demonstrable benefit exist, simply because of the short time that has transpired since the first program was put in place.
- Many see a major benefit in highlighting funding needs in a repeatable and defensible manner.
- An enlightened few recognize that better planning will provide better value (more productive use of scarce resources).

Several issues common to local authority experiences were also identified. The quality of data varies widely; tools and models do not have a good ability to predict future conditions, especially for nonroad assets; the degree of influence over resource allocation has yet to be determined; an internal commitment to changing mindsets and possibly decisionmaking processes is often lacking; funding is insufficient; comprehensive performance measurement and prediction tools are absent; and processes to deal with customer preferences for desired service levels need to be established.

A maintenance contractor presented an interesting overview of the evolving roles of contractors, consultants, and local authority clients over the past several years. In this evolution, the relationships have evolved along the following path:

- Client, consultant, and contractor role done in-house (traditional government role) to—
- Client and consultant in-house, external contractor to—
- Client and contractor in-house, external consultant to—
- Consultant and contractor external, and report independently to client to—
- Consultant and contractor in partnership, and report jointly to client to—
- Client, consultant, and contractor in partnership to—
- Consultant and contractor in joint venture

The consultant's tasks are primarily to do the following:

- Feasibility studies
- Pavement and site investigation
- Major road schemes design
- Maintenance schemes design
- Supervision of works
- Inspection of structures
- Advice on contract documentation, specifications, etc.
- Street lighting
- Environmental issues
- Transportation studies
- Noise studies

The contractor's tasks are primarily to do the following:

- General reactive ad hoc maintenance, such as emergency repairs, debris collection, and drain clearance
- Winter maintenance
- Grass cutting and verge maintenance
- Surface dressing and resurfacing
- Road marking
- Gully cleaning
- Structures

Two examples illustrate the local government experience with asset management program development.

Hampshire County Council

The Hampshire County Council has developed a *Highway Maintenance Management Plan* (HMMP) that is integrated into the council's service plan, business plan, and quality procedures. The adopted highway maintenance strategy is intended to do the following:

- Provide a clear statement of highway maintenance policies and procedures.
- Provide a defined network hierarchy that will meet the reasonable demands of all highway users.
- Maintain a systematic approach to decisionmaking within a consistent framework.
- Provide a common basis for assessing maintenance needs, resource requirements, and implications.
- Assist in the effective allocation of resources.
- Regularly review policies, standards, and the effectiveness of maintenance programs.

The plan defines the working procedures and codes of practice to be adopted by all those involved in highway maintenance.

As an illustration, the key objectives and strategies for bridges were defined as follows:

- Complete the strengthening of bridges subject to temporary weight limits over a 2-year period.
- Complete the strengthening of substandard bridge decks

- identified by the assessment program over a 5-year period.
- Complete the strengthening of substandard bridge deck roadside areas identified by the assessment program over a 10-year period.
- Eliminate the backlog of structural maintenance items in which safety is the main criterion over a 5-year period.
- Eliminate the list of structural repairs where further neglect would threaten stability, result in capacity reductions, or create disproportionate future costs over a 10-year period.

Strategies to be used to accomplish the bridge objectives included the following:

- Complete the majority of the assessment program on the remaining rail bridges where three-dimensional nonlinear analyses are required.
- Explore in detail the social, environmental, and economic benefits and disbenefits of permanent weight restrictions on all substandard bridges.
- Implement permanent weight restrictions where acceptable.
- Strengthen to appropriate levels all substandard bridges not suitable for permanent weight restrictions, in accordance with Hampshire's priority system.
- Program essential maintenance and necessary preventive maintenance schemes outlined in this submission.
- Ensure that feasibility studies, including design and documentation, for strengthening and maintenance are prepared in the year preceding the planned works.

Gloucestershire

Gloucestershire was one of the first local authorities to begin the process of implementing an asset management strategy in light of governmental directives to tie transportation plans and asset management together. It has adopted the *Framework for Asset Management* developed by the County Surveyor's Society (see Chapter 5) for application in the United Kingdom. The County Council has established an asset working group, which has produced several point-of-departure products, including a statement of objectives, a list of desired outcomes, definition of asset resources, and the identification of risks associated with asset condition.

The council's core assets were identified as follows:

- Roadway
- Street lighting
- Bridges and structures
- Trees
- Gullies
- Pedestrian guardrails
- Traffic signals
- Road markings/studs
- Urban sidewalks and paths
- Signs and bollards
- Urban bike paths
- Bus stops and shelters
- Roadsides
- Traffic data
- Associated drainage data
- Real-time passenger information

A gap analysis identified the infrastructure difference between current and desired levels of service, and the cost of closing

this gap. In addition, this analysis examined the benefits to the citizens of Gloucestershire. An implementation plan is being prepared that identifies priorities and needed resources.

Observations

In many ways, the London and other local government examples show asset management practice in its infancy. Many local governments are just now beginning to develop an asset management plan in response to national legislation. Much of the data collected are visual condition data, although in some cases these data are augmented by instrumented vehicle inspections. Nonetheless, it is impressive that a large number of local authorities have some form of asset management system that produces information for decisionmaking. Some interesting characteristics of this experience include the following.

London and other local government asset management activities are guided by the national Best-Value Performance Indicators that relate not only to transportation, but also to other service areas. The use of such national indicators provides consistency in data reporting and comparison, as well as economies of scale in terms of data-collection technologies and programs. This consistency (along with a common asset management framework) has allowed several local authorities to form working groups that are developing a generic asset management program for use in member jurisdictions.

Transport for London conducts scenario analyses to understand better the consequences of varying budgets on the performance and condition of the road network. Similar capabilities are being developed for streetlights and bridges.

London's geographic information system (GIS) platform has provided Transport for London with an impressive ability to display and work with the asset database. Not only can engineers and planners look at as-built plans, but in many cases, video links provide the ability to see the asset in real time. In addition, the GIS platform is used to convey information to public officials on both the current status of infrastructure and on the progress being made.

The use of contractors and consultants to provide asset management services appears to be widespread among local governments. This capability provides a level of consistency in asset management applications. The advocacy of these contractors and consultants for asset management is an important catalyst for pushing advances in asset management practice. One challenge of using different contractors for different asset management tasks was seen in the London case, where the condition of streetlights from one district to another was dramatically different presumably because two data-collection contractors had different interpretations of what was meant by good or poor condition.

Chapter 5: Associations and Support Groups for Asset Management

The active promotion and support of asset management by professional associations and local transportation officials were important factors in the success of asset management in many of the sites the scan team studied. This support included not only advocacy on changes in laws and guidance, but also development of technical materials that define the overall framework for asset management in the countries. Some of the publications prepared by these groups have become standard reading in asset management. Two groups, in particular, stood out as being significantly involved in asset management, one in New Zealand and another in England.

Austrroads

Austrroads, an association of Australian and New Zealand road and traffic authorities, has provided important leadership in asset management for its member institutions. Austrroads defines asset management in the following way:

“Road asset management is a structured approach to the delivery of community benefits through the management of road networks.”

Asset management is one of the five strategic priorities Austrroads members have selected, along with addressing the future freight task, optimizing the use of the road network, enhancing the security and integrity of information, and improving road safety. The asset management priority objective is to develop and deliver a research program that will assist road and transport agencies in their efforts to minimize the whole-of-life cost of road infrastructure assets. Four key themes are part of this objective: 1) determining optimal levels of service, 2) identifying road-user requirements, 3) monitoring and reporting performance, and 4) capital investment. Austrroads is developing an extensive series of technical publications on asset management that will examine the technical challenges facing those interested in establishing an asset management program. For example, publications on the following topics are or will soon be available:

- Stakeholder/community requirements (outcomes)
- Asset strategies
- Program development and implementation

- Asset performance
- Asset valuation and audit

The Austrroads asset management Web site is at www.austrroads.com.au/asset/index.html.

National Asset Management Steering Group

The National Asset Management Steering (NAMS) Group was formed in 1995 to further asset management best practice and knowledge in local governments in New Zealand. The group consists of the top infrastructure-related associations in the country:

- INGENIUM—Association of Local Government Engineering
- SOLGM—Society of Local Government Managers
- Local Government New Zealand
- Office of the Auditor-General
- New Zealand Water and Wastes Association
- New Zealand Recreation Association
- Association of Local Government Information Managers

NAMS has defined asset management as the process to “plan, create, acquire, maintain, operate, rehabilitate, replace, and dispose of assets in the most cost effective (sustainable) manner required to meet present and future corporate objectives and demands for service levels.” The impetus for the formation of NAMS was a 1993 report of the Office of the Auditor-General of New Zealand on the weak financial condition of local authorities, along with a local government task force recommendation to adopt a nationwide asset software package. This initial motivation to create NAMS was confirmed in 1996 when a law was passed requiring local authorities to prepare 10-year asset management plans. Given infrastructure’s significant role in a local authority’s responsibilities (between 60 and 80 percent of the budget), NAMS decided to take a more proactive role in fostering nationwide consistency in asset management planning. Today, NAMS helps local authorities move beyond the basic plans developed in response to the 1996 law to more advanced concepts in asset management. In addition, it encourages communities to apply asset management techniques to asset-based activities outside the core (i.e., transportation and water infrastructure) of a community.

The major vehicle for asset management at the local level is the 10-year Long-Term Council Community Plan (LTCCP), which each of the 86 local authorities must prepare every 3 years. The LTCCP must describe desired community outcomes, identify activities that will be undertaken to assure these outcomes, adopt a long-term focus, and provide for public input and participation. As an interesting linkage between asset management and community planning, the Office of the Auditor-General of New Zealand is required to audit the LTCCPs, and determine if the plans are indeed concerned about total resource use in the public sector and the processes described for dealing with the challenges are sound. The auditor-general is a strong supporter of asset management in the context of a community's strategic planning effort.

As a sister organization to NAMS, a Road Information Management Systems (RIMS) Group has implemented dTIMS for deterioration modeling and RAMMS inventory software in all New Zealand councils. This ensures that road information is collected and stored in the same format throughout the country. RIMS continues to develop the software in conjunction with New Zealand users and programmers to enhance the quality and usability of the systems.

NAMS organizes many technical seminars and workshops on a variety of asset management topics. Perhaps most important for developing consistent approaches to asset management are the internationally recognized manuals NAMS publishes on asset management. For example, NAMS manuals on *International Infrastructure Management*, *Optimized Decision Making Guidelines*, *Creating Customer Value from Community Assets*, and *Asset Valuation and Depreciation Guidelines* are important contributions to the theory and practice of asset management. The *International Infrastructure Management* manual is undergoing a significant review and the new edition will include U.S., Canadian, and U.K. -specific sections, and several U.S./Canadian case studies. The manual on *Asset Valuation and Depreciation Guidelines* is also being reviewed to align with the new international accounting standards.

The NAMS Web site is at www.nams.org.nz.

County Surveyors' Society

The County Surveyors' Society (CSS) was established in England in 1885 as an organization aimed at supporting local governments in their responsibilities for infrastructure and service provision. It represents the local authority chief officers from across the United Kingdom with responsibility for strategic planning, transportation, the environment, waste management, and economic development. The authorities that belong to CSS represent 68 percent of the road network, 79 percent of the land area, and 50 percent of the population.

CSS became involved in asset management because its government members faced increasing community demands on limited infrastructure, but did not have the necessary tools to deal with the challenge. In addition, national legislation for best value, asset valuation, developing local transportation plans, and privatizing service delivery suggested to CSS officials that some effort to provide its members with tools to deal with asset management was warranted.

CSS defines asset management as follows:

"Asset management is a strategic approach that identifies the optimal allocation of resources for the management, operation, preservation and enhancement of the highway infrastructure that meets the needs of current and future customers."

The benefits of such an approach are defined as reducing life cycle costs; allowing officials to define levels of service for infrastructure and track performance against these variables; improving transparency in decisionmaking; providing staff with the ability to estimate the consequences of budget changes; reducing the risks associated with financial uncertainty, operational unreliability, and legal challenges; and meeting government requirements for reporting.

Perhaps the greatest contribution CSS has made to asset management in the United Kingdom is the publication of *Framework for Highway Asset Management* in 2004. The intent of this manual was to provide a framework for implementing asset management at the local level, with specific steps to take governments from concepts to a working asset management process. Figure 55 shows the asset management framework recommended in this manual.

The manual has been used in many instances to frame the approach taken for implementing an asset management program in a local authority. A number of authorities have appointed asset managers and assigned them responsibility for developing an asset management plan. Others have hired consultants for a similar purpose.

In addition to developing the asset management framework, CSS conducts workshops and offers guidance through its Web site. It has held numerous conferences on specific technical aspects of asset management. Perhaps the most important activity now underway is development of a manual on asset valuation. This manual is intended to meet the requirements of whole-of-government accounting and resource accounting and budgeting (RAB) requirements of the national government (see England case). The manual will show how to value the highway network in direct support of the *Framework for Highway Asset Management*. Guidance will be provided on condition and performance data that need to

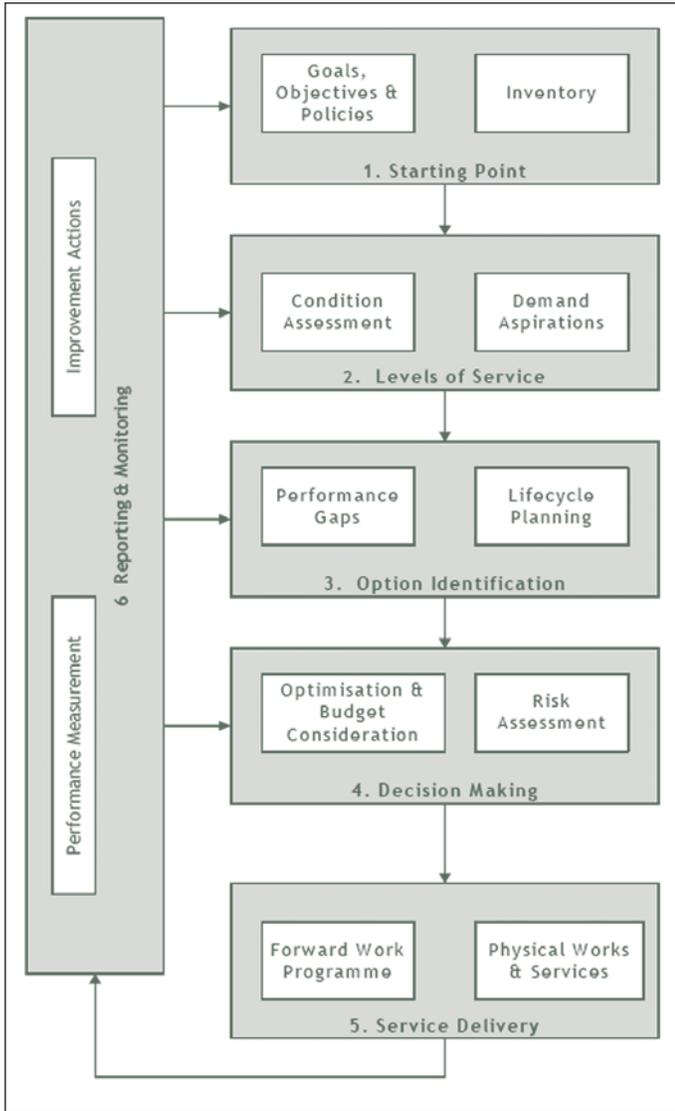


Figure 55. Asset management framework recommended by the County Surveyors' Society in England.

be collected to show the linkage between budgets, performance targets, and asset valuation. This will be a timely addition to the reference library that CSS is providing the profession.

The CSS Web site is at www.cssnet.org.uk.

Chapter 6: General Observations

The scan team has identified 31 observations of interest to transportation officials in the United States. These observations are organized in five major categories—asset management’s role in decisionmaking, leadership and organizational structure, asset management technical activities, program delivery, and human resources.

Leadership and Organization

- 1. Top-level agency commitment (at the very highest levels) in support of asset management was apparent in every case.** Asset management was viewed by the chief executive officer/chief operating officer of the agency as an important tool for managing the agency’s portfolio and for maintaining credibility with the agency’s constituencies. Part of obtaining this high-level commitment was showing how asset management could produce more cost-effective program results.
- 2. In almost all cases, changing the organizational culture to think of asset management as a key business area** was pointed to as the key challenge. The evolution in the use of asset management was viewed as changing the culture of the organization.
- 3. Each agency had a management position or office responsible for asset management.** This focal point for asset management provided guidance to other units in the organization and acted as a filter for asset information directed to different decisionmakers in the agency. In addition, this office usually acted as a major participant in national or state efforts to enhance asset management activities more broadly.
- 4. One of the most important aspects of the observed asset management programs was the bringing together of agency resources and capabilities for undertaking asset management and creating an asset management culture in the organization.** Although many different units in an organization collected data and produced information on asset performance and condition, in several cases this information was synthesized at key decision points in the agency.

Asset Management’s Role in Decisionmaking

- 5. Each site visited has made a commitment to, and allocated resources for, developing an asset**

management program, although the approaches varied in scope and content. Although the scan team found no common, integrated asset management model in the sites visited, the basic components of each asset management effort were the same. Importantly, asset management approaches were found in situations where maintenance outsourcing was a major part of program delivery, as well as where program delivery was done primarily with an agency’s own staff.

- 6. In all of the sites visited, the agencies competed for resources across all government programs** (such as education, public safety, community services, etc.). Few agencies had access to transportation-specific revenue sources, so they had to compete as “whole-of-government.” Several examples where **good data on infrastructure needs provided justification for additional funds** to be put into transportation infrastructure programs showed asset management’s role in such a decisionmaking context.
- 7. Continuity in government has assured a stable environment for asset management to evolve.** Top government transportation officials have held their positions for a long time (in U.S. terms). Once these individuals were convinced of the value of an asset management approach, they supported continuing asset management efforts.
- 8. Several major drivers were identified for adopting an asset management approach.** Similar to the United States, increasing numbers of trucks using the road network, aging infrastructure, and congested road networks have created pressures on infrastructure owners. This has resulted in a need to better manage an important asset base with limited resources. It has also resulted in providing this management responsibility with a limited number of staff (in some cases, staff cutbacks) while at the same time maintaining staff capability. Finally, linking asset management to broader community and agency goals and conducting tradeoffs among asset categories were mentioned as important characteristics of individual asset management efforts. In several cases, asset management was adopted during hard economic times, so it was viewed as a way to provide the most cost-efficient program delivery.
- 9. In some cases, national or state legislation has been an important catalyst to view asset management in a different way** (e.g., New Zealand’s sustainability law and

Victoria's Road Management Act). In Australia, in particular, recent changes in liability laws have been important factors for developing (Victoria) or stimulating thinking about (Queensland and New South Wales) a more systematic approach to asset management. In England, national laws requiring the development of local transport plans and the legal mandate to maintain a community's asset base have led to better integration of asset management into local planning and decisionmaking. In many cases, changing governmental accounting rules have also motivated a closer examination of how to assign value to assets.

10. **A good asset management program conveyed to elected officials strong stewardship of transportation assets**, and has been an important consideration in increasing funding for transportation. In other words, agencies have been able to demonstrate the need for additional support, the link between investment and system performance, and the effect on the community of investing in infrastructure (Alberta, New Zealand, and VicRoads, in particular, illustrate this).
11. **Statements of intent tie an agency's vision and key goals to levels of service or performance measures, providing important vision and accountability points of departure for asset management.** These performance measures, most of which do not deal with asset management, are used to assure that agency actions relate to government policies. In the case of asset management, performance measures on the condition, use, and functionality of the transportation asset have been used to monitor system performance trends and the overall effectiveness of investment programs. In England, for example, the asset management approach the national Department for Transport encourages for local governments is based on performance indicators and targets.

At the strategic or upper-management level, only the most important information needed for establishing funding policies by agency heads or for monitoring agency progress toward policy achievement was provided. The operating core of the agency often received and produced information on many different performance/condition measures.

12. **Asset management has been integrated into the many different corporate or agency planning and policy documents.** For example, the scan team found asset management incorporated into strategic policy statements/agency visions, performance measures, asset-specific plans (e.g., state highway plans), tactical operations (e.g., contract specifications for maintenance outsourcing), and job descriptions. Asset management was incorporated into multiyear planning efforts, often in 1-year, 5-year, 10-year and 25-year plans. The total asset

management approach suggests consistency in agency directions and activities.

13. **Some advanced examples of asset management have also begun to integrate asset management principles and activities into a range of agency activities and products not specifically focused on asset management.** This reflects the fact that many agencies faced transportation problems similar to those in the United States (e.g., congestion, safety, system operations, environmental quality, etc.) and that many nonmajor asset-based solutions (such as operations strategies) are being considered. For example, Transit New Zealand is attempting to link asset management efforts to its environmental policy and at the local level to community quality of life. In England, asset management is supposed to be incorporated into local transportation plans that focus on many different aspects of transportation system performance.
14. **It was interesting to note the blurring of what is maintenance and how it relates to asset management for investment decisions.** In some cases, periodic maintenance was portrayed as the asset management program, rather than as just one component of such a strategy. New South Wales has incorporated capital renewal projects (which in some cases meant total replacement of existing structures or portions of roads) into its network infrastructure program, a program that focuses on infrastructure maintenance and rehabilitation. The justification for this was that such projects are acceptable as long as road capacity is not increased. Projects that significantly increased capacity were considered part of the formal project development process, often requiring environmental assessment studies.
15. **Consistency and cooperation were apparent in some cases among different levels of government in their approach to asset management.** National or state agencies worked with local governments to provide guidance and/or participate in user groups. This was especially true in Alberta, England, and New Zealand, and in some cases in Australia.

Technical Approaches and Data Use in Asset Management

16. **Life cycle costing (also known as whole-of-life costing) has been adopted** in each site as the basic approach to program and project costing. Importantly, data identification and collection were targeted to support this approach.
17. **In only a few cases was any effort made to conduct technical tradeoff assessments among asset categories, and these were heavily based on engineering judgment** Although the scan team looked for examples where tradeoff analysis occurred among

different asset categories or among different programs areas (such as maintenance, capital expansion, and capital renewal), it found very few. It was clear that all of the agencies were working toward such a capability.

18. **Many officials talked about “optimizing” decisions or “optimization approaches.”** In U.S. terms, this means using quantitative analysis techniques to produce the most economically efficient outcome. The scan team believes the term, as used, really meant providing a balanced investment portfolio that reflected community goals and policy desires.
19. **All of the agencies used risk assessment in their asset management program.** For example, the likelihood of disruption or failure of certain types of infrastructure was made a conscious part of the asset management analysis in New Zealand (subject to high levels of natural disruptions). In Edmonton, a risk or vulnerability measure has been developed and incorporated into the formal project assessment process. In New South Wales, the assessment of risk appeared to be a driving force in developing the network infrastructure program. In England, risk was used to help prioritize projects. Not surprisingly, the risk assessment associated with a concessionaire’s participation in a public-private partnership related to those factors that affected revenue generation, while that for public services tended to relate to safety, public support, and customer service factors.

It appeared that the risk assessment approach was also used as a way to educate and obtain asset management buy-in from elected officials. The scan team’s sense is that all of the sites visited have more formal risk applications and use them more in asset management applications than do agencies in the United States.

20. **Government accounting procedures were viewed in several cases as inappropriate for assigning value to assets and driving asset management decisions.** Based on experience in Queensland and England, asset management systems were viewed as much more appropriate to use for asset valuation than straight-line depreciation accounting rules.
21. **Defining core purposes of the agency and investment program and determining the necessary technical support structure** were considered important first steps in implementing asset management. Piecing together the supporting databases was described as critically important. In this construct, several agencies the team visited viewed data itself as an asset to be managed and replaced when it no longer served its function.
22. **All of the agencies visited are adopting the approach of developing locational referencing systems for database support for asset**

management. Instead of creating one comprehensive database for all assets under an agency’s responsibility, agencies are relying on existing databases (even when they have been developed with different formats and levels of comprehensiveness) to support their asset management programs. In addition, several agencies adopted quality-control procedures to make sure that the data collected was high quality. In one example, 30 percent of the lane kilometers were resampled every year to check the consistency, accuracy, and uniformity of the original data collection. In some cases, agencies are beginning to question the range of data collected and to assess the data’s usefulness in supporting the decisionmaking process.

An impressive aspect of the database systems was the wide extent to which the data was available within an agency. Many said that if you have a computer on your desk, you can access the asset management database.

23. **Data-collection approaches and technologies are not that different from those used in the United States.** The team saw on national networks pavement condition measuring vehicles (SCRIM), falling weight deflectometers, ITS collection of traffic data, use of GIS and GPS, use of the International Road Index (IRI), etc. Somewhat different from the United States, much more data is typically collected on a range of characteristics (e.g., skid resistance data). VicRoads is exploring the use of on-ground sensors, early warning systems, and non-destructive testing technologies as part of its data-collection efforts. At the other end of the technology spectrum, annual visual inspections of asset condition are conducted in London using clipboards.
24. **The experience with deterioration modeling is not uniform** across the agencies visited, and in many cases was quite limited. For example, no common definition exists for remaining service life for different assets, and in some cases agency officials questioned what this concept really meant. The experience with deterioration modeling ranges from commonly used software programs to reliance on experience and expertise in determining the most critical investments for preserving or enhancing future system performance.

Program Delivery

25. **One of the most important observations from this scan is the importance of incorporating strong asset management principles in public-private partnership (PPP) agreements when such projects are considered.** This was especially true in Victoria and New South Wales, where agency officials described the learning process they went through in subsequent PPP projects to have a better asset management provision incorporated into the concessionaire’s agreement or deed. The model

that appears to have been adopted in the sites visited was the use of input-output performance criteria as part of the concessionaire's deed that, in essence, guided the asset management strategy for the project. The concessionaire's response was to provide adequate funding in its business model to provide the desired asset management program. This institutional learning process is an important experience for U.S. asset owners considering entering into such arrangements.

26. **In all of the sites visited, transportation agencies have used private contracts for delivering much, if not all, of their maintenance and minor capital construction programs.** Preventive and renewal maintenance are important parts of a comprehensive asset management program, so the relationship between how and when assets are maintained and the contractors' program responsibilities becomes an important consideration in determining the overall effectiveness of asset management efforts. The key approach was to **encourage contractor ownership of asset management in the delivered program.** For example, in a performance-based contracting regime, an agency must make sure that the structural integrity of pavements is maintained or addressed when contractors are making maintenance investment decisions. In some cases in which contracts were let before a system of performance management was in place, questions of service quality, asset condition, and price occurred.

Agencies in England, which has many years of experience with maintenance outsourcing, appear to be moving to a hybrid strategy of service provision by including owner agencies in service provision partnerships, and in some cases providing services themselves again.

27. **Agencies have made efforts to reach out to public officials and, in some cases, to the general public, to convey the importance of an asset management policy.** In Edmonton and New Zealand, for example, such outreach has been considered successful in developing support for agency funding. In all cases, the state ministers of transportation have bought into asset management as an important policy focus. In at least two cases (New Zealand and Victoria), focus groups were used to affirm the importance assigned to maintenance and capital renewal program investment. In other cases, focus groups were used to determine the attitudes and reactions of the general public toward the agency's priorities and resource allocation. In Edmonton, an infrastructure advisory committee consisting of important business and community leaders has been established.
28. **Australia, New Zealand, and England, in particular, have very active asset management professional associations and user groups, spearheaded by local**

officials, that have developed materials aimed at both public officials and practicing transportation professionals. The scanning team found impressive asset management outreach material in England and New Zealand. In both cases, the initiatives were spearheaded by local government associations or national working groups (or alliances as they were called). Austroads, Australia's equivalent to AASHTO, is in the process of putting together asset management material, much of which is found in separate reports.

Human Resources

29. **An effective asset management program has a strong human resource element.** In some cases, an asset management program (and usually private outsourcing of maintenance) was implemented at the same time staff cutbacks occurred. Every agency visited, however, noted that a good asset management program requires capabilities in understanding the data-collection process and what the data mean. When private concessions were used for data collection and maintenance efforts, the owner agencies needed capable staff to manage the contracts. In almost every case, agencies have added staff since their low points in the 1980s and 1990s. Training (see below) thus has become an important human resource support activity.
30. **Several agency personnel systems have created positions with asset management in the job responsibilities.** As officials in England noted, local government positions for asset management professionals, and civil engineers in general, are being advertised with only limited success in attracting qualified applicants.
31. **In many agencies the scan team visited, asset management training** has been an important aspect of their asset management strategy, not only for staff but also for other jurisdictions using asset management approaches. In Alberta, England, New Zealand, and Queensland, in particular, manuals and best-practice procedures have been developed to promote consistency in asset management applications.

Chapter 7: Lessons for the United States

The countries, states, provinces, and local governments the scan team visited during this study provided a rich experience in the challenges and benefits associated with asset management. It is not surprising, therefore, that a number of “lessons learned” for the United States have resulted from this scan.

- 1. Asset management practices and processes have been used successfully to obtain funding for transportation infrastructure**, when competing for funds with other government programs and even during budget declines.
- 2. Asset management as an organizational culture, business-oriented decisionmaking process, and policy direction is a critical foundation for transportation programs facing significant capital renewal and preservation needs.** All of the countries the team visited adopted asset management as a major policy direction for national, state, and in some cases local transportation programs.
- 3. Given the importance of asset management in changing an organization’s culture, it is important to think carefully about what role asset management will play** in the agency’s program delivery effort. In addition, the eventual acceptance of asset management in an organization’s culture will occur when the benefits of such an approach are evident.
- 4. Adopting an asset management approach in an organization does not mean that everything has to change.** In the cases examined, agencies had clearly adapted their asset management efforts to the organizational context. One consequence of this is that incorporating an asset management culture into an organization requires a long-term commitment from top management.
- 5. The principles and benefits of asset management were not linked to agency downsizing or outsourcing of agency services.** This is a common misperception associated with asset management efforts.
- 6. Creating asset manager positions or at least assigning responsibilities for the asset management function is** an important foundation for an effective management program. Such a position or agency unit should report to the top management in an organization. This not only provides a focal point for asset management activities, but also can foster a champion for asset management who can act as a catalyst in the organization.
- 7. All of the asset management programs the team studied used the concept of risk for establishing investment priorities.** Most U.S. asset management experience does not have the same level of application. Risk concepts need to be incorporated more systematically into U.S. asset management efforts.
- 8. Based on experience in Queensland and England, asset values determined using the asset management system provide a more realistic and useful representation of the value of physical assets.** This value supports both the accounting and management functions as opposed to straight-line depreciation, which does not reflect the true value of the assets and serves no purpose for management.
- 9. The most common performance measures used in the scan asset management examples related to condition, function, and capacity of the assets.** In some cases, these categories of performance characteristics can provide the basis for cross-asset evaluation and investment prioritization. Engaging stakeholders in setting performance targets is the most effective way to calibrate fact-based assessment of asset needs with public desires. Stakeholder buy-in to the asset approach and performance measures lends credibility to the effort.
- 10. Asset management should be strongly linked to planning and system operations.** It was apparent in several cases that efforts had been made to institutionalize asset management concepts into state/local planning efforts, and to look at system operations strategies as complementary to asset-based improvements.
- 11. Perhaps one of the most important lessons for the United States was the integration of asset management concepts into public-private partnership**

- agreements.** Several agencies that have entered into such agreements for toll roads have learned from experience that a comprehensive asset management effort needs be part of any agreement to ensure the asset is returned to the owner in good condition.
12. **Asset management efforts are data driven, but developing an asset management culture in an organization does not have to wait the many years it would take to develop database information systems.** Agencies can start with modest efforts and evolve over time into a more comprehensive perspective.
 13. **Data collected should have a clear purpose and be directly related to asset management decisionmaking.** Data-collection costs should be tracked and data itself treated as an asset, with the same design, build, operate, maintain, and life cycle cost analysis used for other assets.
 14. **Tradeoff analysis techniques are more complex than simply assessing priorities in one asset category.** The scan team did not find any case where technically based cross-asset tradeoff tools were used. This is an important area for further development in the United States.
 15. **Cross-functional teams, consisting of engineers, finance analysts, operations staff, and communications experts,** can serve as the best means of understanding the many different aspects of asset management, such as data collection, strategy development, and quality assurance.
 16. The **use of focus groups** to establish and/or validate resource apportionments for different asset categories is a useful tool in asset management programs.
 17. **Before contracting out core services, performance-based management systems should be in place** that allow the infrastructure owner to know what service levels are required. This was described in the scan as being a “knowledgeable owner.”
 18. **Although initial cost savings may be realized by contracting out maintenance services, such program delivery is kept most efficient when both public and private providers have some ability to compete to provide service.** In addition, it was apparent in most of the sites visited that although the number of maintenance personnel in agencies declined following outsourcing, the contract supervision and finance staffs have either stayed at the same levels or increased.
 19. **Asset management training for all levels of transportation officials** is an important initiative for changing the culture of an organization and establishing asset management expectations among key stakeholders.

Chapter 8: Implementation Strategies

The scan team identified several short- and long-term strategies for disseminating and furthering the results of this scan.

Short-Term Strategies

1. The scan results should be disseminated as widely as possible throughout the professional community. Presentations will be scheduled for the annual meeting of TRB, AASHTO, APWA, and 6th National Asset Management Conference in fall 2005. Other opportunities will be identified by scan team members. The Transportation Asset Management community practice Web site will be repackaged to incorporate scan results.
2. The AASHTO Subcommittee on Transportation Asset Management will be encouraged to continue development of the asset management software NT and PT by AASHTOWare. The subcommittee will also prepare a resolution for AASHTO board consideration that reinforces asset management as an important national and state policy.
3. The existing National Highway Institute (NHI) course on asset management should be updated to reflect what has been learned on this scan.
4. A senior executive forum on asset management should be organized to introduce senior leaders at transportation agencies to asset management concepts. This should be similar in format to the performance-based maintenance contracting workshop.
5. A national telecast/Webcast on asset management similar to such telecasts on freight should be organized. A target date for this is summer 2006.

Long-Term Strategies

The following three implementation strategies create a climate of continuous process improvement on transportation asset management in the United States.

Change the national viewpoint of the Interstate System from merely highway expenditures to investments in mobility of people, goods, and services by using an asset management-based methodology that focuses on future conditions while identifying the cost of competitiveness and economic power.

Objectives

1. Advance asset management principles as the strategic tools for assessing the entire Interstate System.
2. Compare and contrast the similarities with other countries' highway networks, England's trunk system in particular, and how asset management can support the new vision for the Interstate System.
3. Develop information on the economic impact of the degradation of the Interstate System.
4. Determine a risk-allocation process for the Interstate System.
5. Identify performance indicators and standards for the Interstate System to ensure its prominence in the delivery of goods and services for the entire Nation (e.g., smoothness, remaining service life) that are common across the system.
6. Assume a national leadership role to protect the highest level of the transportation system, and encourage State and local agencies to work collaboratively on the remaining public assets.

Tasks

1. Initiate a study to determine the benefits of using asset management plans for all segments of the Interstate System. The study should include analysis of the economic, social, and political impacts of requiring such plans and the mechanisms necessary to implement such a requirement.
2. Document asset management practice in England, including national policy, performance indicators, and reporting requirements for national and local agencies. Draft correlating policy indicators and reporting requirements for the United States, which could provide guidance on reporting national, regional, and local transportation network performance.
3. Target a State or region to take a holistic view of the entire public asset inventory that provides increased funding flexibility.
4. Develop linkage between transportation planning and programming and asset management at the metropolitan planning organization (MPO) level.

Join with other efforts, agencies, and resources to embed asset management into existing efforts on an ongoing basis. Create a National Asset Management

Steering Committee (NAMS) in the United States. Such an effort provides a platform to distribute information, provide training, and document best practices on transportation asset management nationally and abroad. Develop an easy-to-understand toolbox for asset management that can be applied at different levels of government. The tools should look beyond transportation to best practices in other industries. These tools should be available on a Web site for free downloading.

Objectives

1. Develop a resource clearinghouse for asset management in the United States that draws from and is directly tied to equivalent efforts internationally and is available in the public domain.
2. Market this clearinghouse to all levels of U.S. agencies and across all types of infrastructure.
3. Investigate whether U.S. efforts to document best asset management practice and provide resources can be integrated with existing international asset management consortia.
4. Participate annually in a national asset management forum to review progress, document case studies, develop curricula, and coordinate research efforts across infrastructure and federal agencies.
5. Inform all levels of transportation agencies—State, MPO, and local—of this resource clearinghouse.

Tasks

1. Meet/communicate with FHWA and EPA to discuss potential alliance of asset management efforts.
2. Develop a white paper discussing the relationships among AASHTO, FHWA, and EPA priorities and opportunity presented in asset management.
3. Contact the international NAMS to identify copyright restrictions and opportunities to add the United States to existing efforts and document U.S. case studies for inclusion in the existing library of best practices. Develop alternatives with recommendations for U.S. clearinghouse implementation.
4. Document the state of practice at the state and local transportation agency level in the United States as part of establishing a national approach to transportation asset management.
5. Communicate with State, MPO, and local transportation agencies to inform them of training, forums, and best practices.
6. Write articles for *APWA Reporter*, *Public Roads*, and appropriate state, municipal, and engineering journals.
7. Support benchmarking of the U.S. asset management process (rather than performance) for local, regional, and State agencies. This should include an assessment of the capability and execution of linking decisions to quantified

asset-related costs and benefits, as well as whether processes have been documented and how often this occurs. Efforts should consider incorporating the AASHTO self-assessment survey. Share results at various State, MPO, and local government conferences and in literature.

8. Create an automated survey tool in the public domain that participating agencies can complete and have results arrayed against comparable levels of governments.
9. Develop a national competition on transportation asset management under FHWA's Transportation Planning Excellence Award Program.
10. Develop videos and training materials aimed at various levels of government.

Extend U.S. asset management practice through NCHRP and other research opportunities.

The scan team identified several potential research projects:

1. Conduct before-and-after studies on the effectiveness of asset management efforts and the identification of benefits.
2. Establish state-of-the-art practices for data collection and analysis for asset management.
3. Define and quantify risk categories for an asset management program.
4. Synthesize data management principles, collection, sampling, and auditing techniques for asset management.
5. Examine world experience with high-speed deflectograph technology, looking at the Denmark technology identified in the England case study.
6. Examine more closely transportation assets other than bridges and road pavement, such as appurtenances, transit, streetlights, etc.
7. Synthesize practice with how 3-D or design files are linked to geographic information systems (GIS).

Appendix A: Scan Team Data

David R. Geiger (FHWA Co-Chair)
Director
Office of Asset Management
Federal Highway Administration
HIAM-1 (Room 3211)
400 Seventh Street SW.
Washington, DC 20590
E-mail: david.r.geiger@fhwa.dot.gov

Paul T. Wells (AASHTO Co-Chair)
Chief Engineer
New York State Department
of Transportation
50 Wolf Road
Albany, New York 12232
E-mail: pwells@dot.state.ny.us

Dr. Michael Meyer
(Report Facilitator)
Professor
School of Civil & Environmental
Engineering
Georgia Institute of Technology
790 Atlantic Drive
Atlanta, GA 30332
E-mail: michael.meyer@ce.gatech.edu

Patricia Bugas-Schramm
Assistant to the Director
Portland Transportation Maintenance
2929 North Kerby Avenue
Portland, OR 97227
E-mail: patricia.bugas-schramm@pdxtrans.org

Lacy D. Love
Director; Asset Management
North Carolina Department
of Transportation
Raleigh, NC 27699-1538
Mailing Address:
1 South Wilmington Street
Transportation Building, Room 106
Raleigh, NC 27601
E-mail: llove@dot.state.nc.us

Dr. Sue McNeil
Director and Professor
Urban Transportation Center
University of Illinois at Chicago
412 South Peoria Street, MC 357
Chicago, IL 60607

(Address after Aug. 1, 2005.)
Dr. Sue McNeil
Professor
Department of Civil and
Environmental Engineering
301 West Dupont Hall
University of Delaware
Newark, DE 19716-3120
E-mail: mcneil@ce.udel.edu

Dennis L. Merida
Division Administrator
New Jersey Division,
Federal Highway Administration
840 Bear Tavern Road, Suite 310
West Trenton, NJ 08628
E-mail: dennis.merida@fhwa.dot.gov

Robert Ritter
Office of Planning, HEPP
Federal Highway Administration
400 Seventh Street, SW.
Washington, DC 20590
E-mail: robert.ritter@fhwa.dot.gov

Kirk T. Steudle
Chief Deputy Director
Michigan Department of Transportation
425 West Ottawa Street
PO Box 30050
Lansing, MI 48909
E-mail: steudlek@michigan.gov

Donald R. Tuggle
Director; Program Administration
Federal Highway Administration
Eastern Federal Lands Highway
Division
21400 Ridgetop Circle
Sterling, VA 20166
E-mail: donald.tuggle@fhwa.dot.gov

Larry Velasquez
District Engineer
New Mexico Department
of Transportation
PO Box 1149
Santa Fe, NM 87504-1149
E-mail: larry.velasquez@nm.state.us

Biographic Sketches

David R. Geiger (FHWA Co-Chair) is director of the Office of Asset Management for FHWA in Washington, DC. He is responsible for promoting the concept of asset management in the agency and for working with State departments of transportation to develop the necessary engineering and

economic analysis tools and management systems to successfully implement asset management as a standard for making investment decisions and managing transportation systems. Geiger has a bachelor's degree in civil engineering from Michigan Technological University and has held several man-

agement-level positions in FHWA's field and headquarters offices. He is a member of the American Public Works Association, American Society of Civil Engineers, and Transportation Research Board Committee on Asset Management. He serves as secretary of the AASHTO Subcommittee on Asset Management, and he is a licensed professional engineer in Wyoming and Louisiana.

Paul T. Wells (AASHTO Co-Chair) is chief engineer for the New York State Department of Transportation. Pavement, bridge, and safety management systems are part of his responsibility. With a large, complex, but aging infrastructure, cost-effective investments are critically important to the New York State DOT, especially when transportation funding is uncertain. Before becoming chief engineer, Wells was the department's chief engineer for construction and oversaw the annual \$1.65 billion statewide construction program, including complex projects in the New York City metropolitan area. Some of the most difficult asset management issues involve rehabilitation and preventive maintenance approaches for the large urban viaducts and East River Bridges in New York City. Wells graduated from State University of New York at Buffalo with a civil engineering degree and is a licensed professional engineer in New York State. He is a member of the AASHTO Standing Committee on Highways, Standing Committee on Research, Technology Implementation Group, and Joint AASHTO/ARTBA/AGC Committee. He also serves on a number of NCHRP panels, such as the Research and Technology Coordinating Committee that oversees FHWA research programs and NCHRP Panel 20-36 on Highway Research and Technology—International Information Program.

Dr. Michael Meyer (Report Facilitator) is professor and former chair of Civil and Environmental Engineering at the Georgia Institute of Technology. From 1993 to 1998, Meyer was director of transportation planning and development for the State of Massachusetts, where he was responsible for statewide planning, project development, traffic engineering, and transportation research. Before that, he was a professor in the Department of Civil Engineering at the Massachusetts Institute of Technology (MIT). Meyer has written more than 160 technical articles and has authored or coauthored numerous textbooks on transportation planning, policy and education, environmental impact analysis, and intermodal transportation. He received a bachelor's degree in civil engineering from the University of Wisconsin, a master's degree in civil engineering from Northwestern University, and a Ph.D. in civil engineering from MIT. He is a registered professional engineer in Georgia.

Patricia Bugas-Schramm is assistant to the director of the Portland Transportation Maintenance Bureau in Portland, OR. Bugas-Schramm has coordinated development of seven

strategic transportation asset-specific management plans for Portland Transportation since 2000. As infrastructure management system (IMS) project manager, she coordinated consultant and staff efforts through the 1990s that resulted in the integration of asset inventories, work management tools, maps, and financial systems in 2000. She initiated Portland Transportation's annual Status and Condition Report, now in its 19th year of publication. She has made presentations on Portland's asset management work at the American Public Works Association (APWA) Oregon Conference, American Society of Civil Engineers (ASCE) Conference in Portland, and the National Highway Institute's Transportation Asset Management workshop for the Oregon Department of Transportation leadership. She is a member of APWA and has a bachelor's degree from the University of Oregon.

Lacy D. Love is director of asset management for the North Carolina Department of Transportation. Love oversees NCDOT's statewide operational programs and administrative units for bridge maintenance, pavement maintenance, roadway maintenance, equipment and inventory control, intelligent transportation systems office, secondary roads, and oversize/overweight permits. In addition to managing these units, he develops performance standards and implements monitoring/management systems for the various highway infrastructure assets. In the past, Love has served in various field and central operations positions with maintenance responsibilities for various highway assets and maintenance programs. He graduated from North Carolina State University in 1979 with a bachelor's degree in civil engineering. He serves on the AASHTO Highway Subcommittee on Maintenance as vice chair of the Management Systems Focus Group. He also served as a member of the panel that developed the AASHTO Guidelines for Maintenance Management Systems.

Dr. Sue McNeil is director of the Urban Transportation Center and professor in the College of Urban Planning and Public Affairs at the University of Illinois at Chicago (UIC). Her research and teaching interests focus on transportation asset management with emphasis on the application of advanced technologies, economic analysis, analytical methods, and computer applications. Before joining UIC, she was a professor of civil and environmental engineering and engineering and public policy at Carnegie Mellon University. McNeil graduated from the University of Newcastle in Australia, and has a master's degree and Ph.D. in civil engineering from Carnegie Mellon University in Pittsburgh, PA. She is a registered professional engineer. McNeil chairs the Transportation Research Board Asset Management Committee and serves on the Executive and other committees. She is associate editor of the Journal of Infrastructure Systems and a member and former chair of the

Infrastructure Committee of the American Society of Civil Engineers.

Dennis L. Merida is administrator of the FHWA New Jersey Division in West Trenton, NJ. He is responsible for administering an \$800 million Federal-aid program in New Jersey. He directs a staff of 27 professionals in engineering, structures, planning, finance, safety, and environmental analysis. He has served in this capacity for the 10 years. Merida is a member of the division administrators' advisory group for asset management policy for FHWA. He has 30 years of experience with FHWA in a variety of engineering, planning, and environmental assignments in headquarters and field offices. He has bachelor's and master's degrees in civil engineering from the University of Michigan. He is a licensed professional engineer in Virginia and a member of the American Society of Civil Engineers.

Robert Ritter is team leader of the Planning Capacity Building Team in FHWA's Office of Planning. The Transportation Planning Capacity Building program provides training, technical assistance, and support to help decision-makers resolve the increasingly complex issues of addressing transportation needs in their communities. Before joining FHWA, Ritter was director of policy activities for the Eno Transportation Foundation, where he was responsible for bringing together government, academic, and industry representatives to address topics such as intermodal freight issues, global climate change, and induced demand. Ritter has a master's degree in transportation from Morgan State University and a bachelor's degree in civil engineering degree from Rutgers University. He is a licensed professional engineer and certified planner. He is a member of the Transportation Research Board's Intermodal Freight Transport and Metropolitan Policy, Planning, and Processes committees, and is FHWA liaison to the NCHRP project panel on research for the AASHTO Standing Committee on Planning.

Kirk T. Steudle is chief deputy director of the Michigan Department of Transportation (MDOT) in Lansing, MI, and is engaged in all aspects of transportation in the State. Steudle represents MDOT on the Michigan Transportation Asset Management Council and chairs the AASHTO Subcommittee on Asset Management. In August 2004, Steudle participated as a member of the National Asset Management Delegation conducting a transportation asset management seminar in Riga, Latvia, for transportation professionals from Estonia, Latvia, and Lithuania. In his previous jobs as bay region engineer for the 13 counties in the Saginaw/Bay City area and deputy region engineer for the Detroit metropolitan region, he was responsible for strategically managing regional assets in a cost-effective and efficient manner, concentrating on planning and programming, program delivery, and monitoring and

reporting results involving road and bridge assets. This was long before asset management became known as a discipline. Steudle has served with MDOT for more than 17 years. He has a bachelor's degree in construction engineering from Lawrence Technological University and is a registered licensed professional engineer in Michigan.

Donald Tuggle is director of program administration in the Eastern Federal Lands Highway Division in Sterling, VA, a post he has held since 2001. Before that, he was special assistant to the FHWA executive director. He is now the Federal Lands leadership sponsor of a multidivision team on context-sensitive solutions. His 28-year FHWA career has included field assignments in Ohio, Michigan, Chicago, IL, and headquarters assignments in the Pavement Division, Construction and Maintenance Division, and Office of Asset Management. He has a bachelor's degree in civil engineering from the University of Wisconsin-Platteville and is a registered professional engineer in Wisconsin.

Larry Velasquez has served the New Mexico Department of Transportation as the engineering/design division director and infrastructure coordination engineer, and is now district engineer for the largest metropolitan area in New Mexico. As district engineer, he is responsible for construction and maintenance operations of a metropolitan and rural transportation system. Velasquez, who has been with the NMDOT for 5 years, has more than 20 years' experience in the transportation field. Before joining NMDOT, he spent many years in transportation engineering and management for municipal and county governments. He has a bachelor's degree in civil engineering from the University of New Mexico. He is a licensed professional engineer in New Mexico. He has served on the AASHTO Standing Committee on Highways and two of its subcommittees. He is on the TRB Synthesis (20-5) Panel. He is a member of the Institute of Transportation Engineers and American Society of Civil Engineers.

Appendix B: Amplifying Questions

Overview of Transportation Asset Management

1. Please provide a brief overview of how your agency is organized. What are the major funding sources for your transportation program? What are the critical transportation issues/challenges facing your state/province/city/agency?
2. Is the asset management function primarily assigned to one office, or is it integrated throughout the organization? What staff resources are dedicated to this function? Has this organizational responsibility stayed the same over time, or has it changed? If it has changed, why was the change made?
3. What were the major reasons your agency adopted an asset management philosophy for organizational decision-making and management? When did your agency first begin to use transportation asset management? How has it evolved since this initial use? What barriers or challenges have you faced in implementing your asset management program in your agency? How were these barriers/challenges overcome?
4. What have been the major drivers of transportation asset management in your agency? Are there legislative mandates for conducting asset management?
5. Do you have a stated goal or mission for your asset management program? How important is asset management as stated in this goal or mission in influencing decisions in comparison to other factors, such as politics, emphasis on large-scale capital projects, regional equity in investment, etc.?
6. Have you defined an “asset manager” position in your agency? If so, what are the duties of this position? Where does the role of asset manager report within your operations and management organization with respect to budget allocation and work assignments?
7. Do you have asset management teams in your agency? If so, what are their role, responsibilities, and composition?
8. We are interested in comprehensive/integrated/organization-

wide transportation asset management programs. By this, we mean an asset management program that considers assets across modes, organizational functions, and asset groups, and that integrates asset management information vertically and horizontally within the agency decisionmaking structure. Would you describe your asset management program as being “comprehensive” and/or “integrated?” What aspects of your program make it so?

Relationship Between Asset Management and Decisionmaking

1. Please describe the investment decisionmaking processes in your agency. How is the information produced from the asset management system used in your agency decision-making, ranging from strategic or corporate planning to operations decisions? Please provide specific examples of this linkage between asset management information and decisionmaking.
2. Have the results of your asset management effort influenced the overall level of funding provided to your agency? If so, can you quantify this impact?
3. Does your agency have a policy that establishes the relative importance of infrastructure maintenance and preservation versus capacity expansion versus operational improvements? How is a balance in investment made among the different types of projects in your agency’s portfolio (e.g., balanced investment among bridge, pavement, operations, preservation, etc., projects)?
4. If investment tradeoffs are made among such things as safety, environmental quality, sustainability, congestion relief, capacity expansion, infrastructure preservation, etc., how are these tradeoffs made? If your agency is responsible for more than one mode of transportation, how are investment tradeoffs made and priorities established among different modal programs?
5. Does your asset management process occur within a much larger transportation system performance measurement or key performance indicator process? If so, what are the key performance/condition measures used in the asset management process?

6. If system performance measurement is used in your agency or jurisdiction, how is decisionmaking influenced by performance indicators? If benchmarks or targets are used as part of the performance measurement program, do these benchmarks/targets support decisionmaking or do they drive it?
7. Do you use return on investment or benefit/cost analyses to establish project priorities?
8. Do you use life cycle costs in repair/replace/build decisions? Is asset data used to establish life cycle cost information? If so, how does life cycle cost information affect decisions relating to budgets for capital investment and for maintenance?
9. For unique projects where special materials are used in project design (e.g., downtown transit or pedestrian malls, main streets, etc.), do you assess the life cycle costs of such special treatments when making a project decision?
10. If you outsource or privatize maintenance/operations activities in your organization, how is your asset management program used in establishing the budgets, priorities, and/or task allocations in such efforts?

Technical Aspects of Transportation Asset Management

1. What are the major components/tasks of your transportation asset management system? What physical assets are monitored?
2. What database systems are part of your asset management program (e.g., pavement, bridge, sign/signal/pavement markings, intelligent transportation system, equipment inventory, etc.)? How are these systems linked or integrated with one another?
3. If you have an integrated or linked set of systems, can managers use them to conduct scenario analyses to investigate the effect on transportation system performance and condition of different levels of investment?
4. For the different assets monitored as part of your asset management program, describe the types of data collected and the data collection strategies used. In particular, how does condition inspection occur for the different types of assets in your agency's portfolio?
5. What is the schedule for collecting data on different assets in your inventory? How is this data collection effort staffed (data collection, data entry, data maintenance, process, etc.)? Is data collection a distinct role/task assigned to dedicated forces or is it piggybacked onto

other work? What are the costs associated with the data collection effort? Have you conducted a benefit/cost analysis of the data collection effort associated with your asset management effort?

6. What quality assurance/quality control policies and/or methods do you employ to assure the integrity and value of the data collected?
7. Do you track planned and emergency maintenance on individual assets? If so, how is this done within the context of your asset management program?
8. What types of information and location technology systems are used as part of the asset management program (field technology, mapping applications, work management systems, global positioning systems, geographic information systems, etc.)? How are they integrated with each other? What, if any, problems have you had with any of these systems?
9. How do you segment linear systems (roads, trails, sidewalks, etc.) into assets?
10. Can mapped data be used to plan and design projects? For example, is the database detailed enough to be able to target sign replacement by sign legend?
11. Do you use remote electronic devices to either maintain asset inventories or track asset condition? Do you have, or do you envision, using "smart" materials or sensors for monitoring the condition of infrastructure?
12. Are benchmarks or target values of asset condition and maintenance incorporated into the asset management analysis? Is the level of service or other measures of operating performance used in the asset management analysis? How are these measures established? Has any effort been made to get input from the public or other groups on what these measures should be?
13. In the context of maintaining infrastructure integrity, how does your agency or jurisdiction establish and enforce restrictions on damage-causing activities such as overweight vehicles? Have the results of your asset management program been used to help define what these activities might be?
14. What technical models/approaches are used as part of your asset management program, in particular to assess the value of assets? What types of asset valuation methods have been used in your asset management program, and have any of these methods been more effective than others?
15. How have you defined "life cycle" or "useful life" time frames for infrastructure management and operations?

Do you calculate “remaining service life” as part of this assessment?

16. Are you aware of protocols or requirements that mandate life cycle costing in different jurisdictions in your state/province?
17. For those projects with multiple assets (e.g., pavement, lights, signals, signs, etc.), how have life cycle costs of alternative project designs been calculated and used in decisionmaking for large, long-term expenditures?

Information Understanding and Dissemination

1. To what extent are asset management and the results of your asset management program understood by senior managers, mid-level managers, and other employees in your agency? By key elected officials? By the general public? Did you make any special effort to educate these groups on what asset management means to your jurisdiction?
2. How are the results of your asset management effort conveyed to agency and government decisionmakers, as well as to the public? What lessons have you learned in this effort on how to communicate such information in the most effective way?
3. How is asset management data/information shared with other units in your organization? Does your agency have compatible data-sharing systems in place that allow other organizational units to tap into the database for their own purposes?
4. If other jurisdictions (e.g., cities) want data on your agency’s transportation infrastructure for their own planning purposes, is there a database they have access to? Is this database provided in print and digital form? Is it accessible via the Internet?
5. What type of research have you conducted to advance the state of practice of asset management? In what areas is additional research needed?
6. Does your agency provide training on asset management to your staff and/or others? If so, what topics are included in this training?

Benefits/Impacts of Transportation Asset Management

1. Do you use any measure or indicator of performance of your asset management function (in this case, we are interested in performance of the asset management program, not of the transportation system)? Are resources allocated within your agency based on achieving perform-

ance indicators?

2. Have you evaluated the effectiveness of your asset management program? If so, what measures of effectiveness have you used? What do you think have been the major benefits of asset management to your agency, whether they can be measured or not?
3. How effectively has the asset management staff function competed for agency resources? Through the use of asset management, how effective has your agency been in competing for resources?
4. Do you benchmark your asset management effort with other agencies and/or jurisdictions? If so, what benchmark measures are used?
5. Based on your experience with asset management, what best practices would you recommend to other agencies?

Appendix C: Asset Management Job Descriptions

Transit New Zealand

Network Operations Division—Asset Management Section

Asset Engineer—Maintenance (2) Job Description

Effective Date:	November 2004
Position:	Asset Engineer—Maintenance (2)
Location:	National Office, Wellington
Responsible to:	Asset Management—Team Leader
Responsible for:	Nil
Functional Relationships:	Regional Asset Staff National Office Staff Local Authorities Network Consultants/Contractors Industry Groups

Principal Objectives

To assist the Asset Management Team in managing the high-way asset effectively and efficiently, including forward planning and investigation of new initiatives to meet the objectives of our stakeholders in accordance with Transit's policies and procedures.

Person Specification

- The person who undertakes this position should have sufficient maturity and judgment to liaise effectively and be accepted by senior managers and engineering staff of consultants, territorial authorities, roading industry, and our customers.

Key Achievement Areas	Performance Criteria
1. Coordinate and oversee priorities and programming of the various maintenance elements.	<ul style="list-style-type: none"> ■ Optimization of expenditure in the maintenance program. ■ Arrange periodic reviews/audits/inspections (both technical and expenditure focused).
2. Coordinate and audit network Annual Plans to maintain integrity, consistency and facilitate the compilation of the annual State Highway Program (SHP)	<ul style="list-style-type: none"> ■ Quality outcomes recommended for funding in the SHP. ■ National Ten-year program is prepared, reviewed, and realistic.
3. Review forecasts, budgets, cash flows, additional funding requests, monthly reviews, and reconciliation of maintenance activities in the current program.	<ul style="list-style-type: none"> ■ Optimization of all maintenance and relevant capital expenditure within budget.
4. Assist with advice on the development and implementation of specifications and best practice guidelines.	<ul style="list-style-type: none"> ■ Regular liaison with other groups within the division (e.g., Engineering Policy and Traffic & Safety). ■ Involvement in the development of implementation plans/workshops for adoption of new/revised specifications/guidelines.
5. Manage specific asset management improvement initiatives from conception through to implementation (e.g., new condition measurement techniques, corridor asset condition reporting, development and implementation of new data management systems, national network risk assessment and coordination, etc.)	<ul style="list-style-type: none"> ■ Identify improvement opportunities, particularly new innovative asset management initiatives. ■ Develop project plans to scope new initiatives. ■ Manage adopted improvement projects from inception through trials to full implementation.

Key Achievement Areas (<i>continued</i>)	Performance Criteria
<p>6. Promote and support the development of Transit asset management systems.</p> <p>Develop procedures/best practice guidelines/manuals for asset management activities.</p>	<ul style="list-style-type: none"> ■ Understand dTIM's, RAMM and NOMAD, FWP, and other asset management systems. ■ Assist with the compilation of national data to improve the utilization in the decisionmaking process. ■ Evidence of systems being continuously being reviewed and improved, as appropriate. ■ Manage Transit's Preventive Maintenance program.
<p>7. Manage the engagement of consultants for professional services contracts, invite proposals, and participate in the evaluation of submissions.</p>	<ul style="list-style-type: none"> ■ Quality documentation on time. ■ Evaluations that conform to CPP requirements. ■ Good leadership in tender evaluations for maintenance and network activities. ■ Input into project tender evaluations.
<p>8. Review contract specifications and documentation for physical works contracts.</p>	<ul style="list-style-type: none"> ■ Consistent physical works documentation complying with Transit's standards. (SOMAC). ■ No justifiable complaints on contract documentation from industry.
<p>9. Arrange audits/reviews of regions against national standards/achievements and consistency across regions.</p> <p>Promote the review and assessment of regional and national performance associated with all maintenance activities.</p>	<ul style="list-style-type: none"> ■ Visit network areas on a regular basis to review management of the asset. ■ Operate relevant sections of Transit's internal audit system. ■ Transit and road users are getting value for money. ■ Transit's standards criteria and guidelines are met.
<p>10. Attend liaison and industry meetings, and develop relationships and partnership building.</p>	<ul style="list-style-type: none"> ■ Transit is held in continuing high regard as a result of Asset Engineer's actions.
<p>11. Facilitate the transfer of good ideas developed at a regional level across the organization.</p>	<ul style="list-style-type: none"> ■ Improvement initiatives are championed across the whole business. ■ Regional business practices are improved to reflect the revised methodology.
<p>12. Assist the Asset Management Team Leader and Network Operations Manager with tasks.</p>	<ul style="list-style-type: none"> ■ Willing to take on tasks assigned. ■ Preparation of Business Plan activities and ensure they are scoped, project plans prepared through to a successful completion of the initiative.

Skills

- A proven ability to communicate clearly and concisely, both orally (including presentation skills) and written word.
- Proven analytical capabilities.
- A desire to think strategically.
- Given the extent of liaison with Transit and consulting staff and the training expectation, must be highly proficient with the English language.
- Highly proficient with computing skills.
- Highly motivated.
- Ability to work under pressure and as part of a team.
- Requiring minimal specific motivation or leadership in progressing the key objectives of this brief.

General

- Transit New Zealand has a non-smoking office environment.

Staff must be able to work in that environment.

- The requirement to work a standard 40-hour week but some key deliverables may require extra hours to ensure key deadlines are achieved.
- The position will adopt the Transit General Conditions of Employment, providing 4 weeks Annual Leave.

Qualifications and Experience Required

- Tertiary Engineering essential and Bachelor of Engineering is highly desirable.
- Significant experience in roading and asset/maintenance management.
- Experience in dealing with the public, public meetings, and media.
- Knowledge of Transit's policy and procedures.
- Driver's license.

Regional Maintenance Engineer Job Description

Effective Date:	July 2002
Position:	Regional Maintenance Engineer— Wellington
Location:	Wellington Regional Office
Responsible to:	Regional Asset Manager
Responsible for:	Graduate (to be appointed) Budget: Approximately \$6 million (as contained in the NRP) Network: Approximately 393 kilometers
Functional Relationships:	Transit Wellington Staff Transit Staff Head Office and Regions Consultancy Staff Contractors Territorial Authorities

Principal Objectives

1. Champion the use of leading-edge maintenance processes.
2. The day-to-day management of the state highway network in the Nelson-Tasman area to achieve Transit New Zealand's objective for a safe and efficient highway operation.
3. Assisting the Regional Asset Manager in other areas of network maintenance, policy, budget, and improvements to improve the regional management of the network.

Key Achievement Areas	Performance Criteria
Structural Bridge Maintenance	
<ul style="list-style-type: none"> Manage the Structural Bridge Contracts in Nelson, Tasman, Marlborough, and Wellington areas (from May 2003). 	<ul style="list-style-type: none"> The bridge assets are maintained in sound condition. Inspections and asset maintenance programme are completed annually. Appropriate preventive maintenance is completed. Bridge asset management plan objectives are achieved.
Overweight Policy	
<ul style="list-style-type: none"> Administration of Transit overweight policy. 	<ul style="list-style-type: none"> No variations from policy. Kept abreast of current issues.
Regional DTIMS Expert	
<ul style="list-style-type: none"> To champion the implementation of DTIMS modelling as a pavement determination prediction tool. 	<ul style="list-style-type: none"> Kept abreast of current issues. Continuous improvement of local models.
Competitive Pricing/Procurement Initiatives	
<ul style="list-style-type: none"> Local champion of CPP and participation on evaluation teams as required. Pursue trials as appropriate. 	<ul style="list-style-type: none"> Procedures adhered to. Unit standards acquired. Prequalification trial implemented. Full implementation of PACE.
Management and Leadership of Graduate	
<ul style="list-style-type: none"> To plan, organise, lead, and control the work of staff employed in a manner which ensures the person feels valued and is motivated to contribute to the achievement of Transit's mission and goals in the region. 	<ul style="list-style-type: none"> Staff performance evaluations completed as required.
Asset Team Coordination	
<ul style="list-style-type: none"> Coordinate region 9 and 10 responses to Head Office to ensure they are consistent, to a high standard, and timely. 	<ul style="list-style-type: none"> All deadlines are met. Responses are consistent and to a high standard.
Strategy Studies	
<ul style="list-style-type: none"> To assist the Regional Asset Manager in developing highway corridor strategy studies across the regional network. 	<ul style="list-style-type: none"> Strategies are soundly based and reflect the National State Highway and Transit objectives. Stakeholders are consulted and brought into the strategy where practical.

Key Achievement Areas <i>(continued)</i>	Performance Criteria
Asset Management	
<ul style="list-style-type: none"> ■ The management and delivery of pavement intervention strategy, resealing and asphalt, rehabilitation and area-wide treatment, drainage maintenance, preventive and emergency work repairs, and incident and emergency response programs. 	<ul style="list-style-type: none"> ■ Pavement intervention strategy, Nomad and ten-year programme are current and robust. ■ Appropriate levels of funding are sought. Levels of service are appropriate or have strategic implementation plans. Priorities have been considered. ■ Performance targets in the Statement of Intent are achieved or satisfactory explanations are provided.
<ul style="list-style-type: none"> ■ To manage the impact of the network on adjoining landowners and road users. 	<ul style="list-style-type: none"> ■ Complaints and enquiries are investigated, evaluated and actioned.
<ul style="list-style-type: none"> ■ To set performance targets in accordance with the Statement of Intent. 	<ul style="list-style-type: none"> ■ Performance targets are achieved or satisfactory explanation provided.
<ul style="list-style-type: none"> ■ To engage legal and other professional advice as required. 	<ul style="list-style-type: none"> ■ Appropriate resources are available.
<ul style="list-style-type: none"> ■ To carry out an appropriate level of inspection of the network so that the consultants and contractors can be audited for performance and levels of service can be assessed. 	<ul style="list-style-type: none"> ■ The entire network is covered each quarter and additional inspections are carried out as necessary. ■ Transit and road users get value for money. ■ No justifiable complaints from road users.
<ul style="list-style-type: none"> ■ To participate in the formulation of local policies and procedures. 	<ul style="list-style-type: none"> ■ Satisfactory performance on local working groups.
<ul style="list-style-type: none"> ■ To manage technical audits and participate in technical audits in other regions. Audit outcome satisfactory. 	<ul style="list-style-type: none"> Audit outcome satisfactory.
Programming and Work Planning	
<ul style="list-style-type: none"> ■ Manage the preparation of forecasts and annual plans, determine priorities and programming for the implementation of maintenance, sealing, shape correction, flood damage, and safety works. 	<ul style="list-style-type: none"> ■ Optimization of expenditure in the maintenance program. ■ Annual plan preparation meets Head Office timetable and quality expectations.
<ul style="list-style-type: none"> ■ Ensure monthly accrual information is accurate and within budget. 	<ul style="list-style-type: none"> ■ On time meeting Head Office timetable.
<ul style="list-style-type: none"> ■ To provide continuous (for items allocated in Proman) management of budgets, accruals, and forecasts. 	<ul style="list-style-type: none"> ■ Financial reports are provided to management on time, surpluses and deficits are handled promptly, budgets are established at beginning of the year and program is delivered without substantial unjustified variance to budget. ■ The February end-of-year forecast is achieved with $\pm 1.5\%$.
<ul style="list-style-type: none"> ■ To ensure that sufficient funding is held for all contracts to be completed. 	<ul style="list-style-type: none"> ■ Action allocation adjustments so that contracts can be paid.
<ul style="list-style-type: none"> ■ To manage contract payments. 	<ul style="list-style-type: none"> ■ Payments are timely and do not incur interest or complaint from service providers.
Identification of Asset Improvements	
<ul style="list-style-type: none"> ■ Identification and preliminary investigation improvement projects. 	<ul style="list-style-type: none"> ■ Priorities and needs identified are transferred into the annual plan. Worthwhile projects are identified and developed. ■ Inventory of improvement projects always up to date, and new opportunities proactively identified.

Key Achievement Areas <i>(continued)</i>	Performance Criteria
Team Leader Nelson-Tasman	
<ul style="list-style-type: none"> ■ To coordinate leadership of Transit's maintenance team. 	<ul style="list-style-type: none"> ■ The inputs into Transit's management of the Nelson-Tasman region Network Consultant contract are consistent and are of a high professional standard. ■ Actions required by the client are directed to the appropriate person and carried out in a timely manner. ■ The consultant cannot fault Transit's performance in terms of timely delivery of responses. ■ Performance targets in the Statement of Intent are achieved or satisfactory explanations are provided.
<ul style="list-style-type: none"> ■ Overview of network fees. 	<ul style="list-style-type: none"> ■ Fee funding request is justified. ■ Financial target for network fees is achieved.
<ul style="list-style-type: none"> ■ Management of annual plan preparation. 	<ul style="list-style-type: none"> ■ The Annual Plan is delivered on time to Head Office. ■ The requests are clearly justified and substantiated. ■ The request meets the funding needs for the following year.
<ul style="list-style-type: none"> ■ Responsible for the management of monthly meeting with Network Consultant. 	<ul style="list-style-type: none"> ■ The monthly meeting is managed in an efficient manner, feedback is communicated on performance. ■ Maintenance activities are monitored monthly with any issue being identified and a process for their resolution being defined.
Asset Information	
<ul style="list-style-type: none"> ■ To manage the development and updating of inventories and databases, including production of SH valuation required for asset management. 	<ul style="list-style-type: none"> ■ Appropriate tools and systems are in place to provide appropriate asset information. ■ Information is accurate and retrievable.
Other Duties	
<ul style="list-style-type: none"> ■ Carry out national duties and other tasks as may be assigned from time to time. 	<ul style="list-style-type: none"> ■ Participate in national working groups as required.
<ul style="list-style-type: none"> ■ Carry out other duties and tasks as may be assigned from time to time. 	<ul style="list-style-type: none"> ■ Exhibit willingness to undertake additional tasks and complete as required, having identified any resource limitations and impact on other work. ■ Complete tasks to agreed time, quality, and cost targets.
Working Together	
<ul style="list-style-type: none"> ■ Work together in a team environment where information is shared, colleagues are supported, encouraged and respected. 	<ul style="list-style-type: none"> ■ Positive contribution at all times.

Person Specification

Age

Sufficient maturity to liaise effectively with senior managers and engineering staff of consultants, territorial authorities, roading industry, and the general public.

Qualifications and Experience

A professional engineer with ten years' and above roading experience and meeting the requirements to qualify for membership to IPENZ. Experience in roading construction and

maintenance required. Knowledge of Transit New Zealand policies and procedures required. Experience in dealing with the general public, public meetings, and media would be an advantage.

Personality and Temperament

Sense of response, maturity, and judgment. To be accepted in this role by technical staff and consultants.

- Dedication to Transit's Mission Statement.
- Ability to work amicably with all personnel.

- Possess good computer skills and knowledge of software packages.
- Knowledge of a related engineering field essential.
- High standard of written and oral presentation, especially language skills.
- Good liaison skills.

Skills Required

Ability to:

- Analyze technical and financial roading proposals.
- Report on problems and proposals clearly and concisely, both orally and in writing.
- Recognize need for appropriate proactive communication strategies.

- Identify performance of the state highway network, both in total and by individual site, by inspection supplemented by performance records as available.
- Identify improvements to technical and administrative policy.
- Show a high level of initiative and a flair for innovative approaches.

General

Transit New Zealand has adopted a nonsmoking office policy so that this person must be able to work in that environment.

A driver's license is essential.

Regional Asset Manager Job Description

Position:	Regional Asset Manager
Location:	Transit New Zealand Wellington Regional Office
Responsible to:	Regional Manager
Responsible for:	Area Engineer(s) Road Safety Engineer Administration Assistant Highway Superintendent Regional Staff
Functional Relationships:	Head Office Staff Local Authorities Contractors and Consultants Iwi External Stakeholders Public and interest groups

Principal Objectives

1. To manage the safety and integrity of the Wellington regional state highway network.
2. To manage consultants employed on projects where nominated as sponsor.
3. To ensure the roading industry, local authorities, and public are proactively consulted in relation to Transit's state highway business.
4. To deputize for the Regional Manager in his/her absence.

Key Tasks	Performance Criteria
1. Determine priorities and programming for the implementation of maintenance, sealing, shape correction, flood damage, safety works, and construction projects	<ul style="list-style-type: none"> ■ Optimization of expenditure in the maintenance program. ■ Quality projects recommended for funding in the Regional Land Transport Program.
2. To develop and publish approved highway corridor strategies across the regional network.	<ul style="list-style-type: none"> ■ Strategies are soundly based and reflect the National State Highway and Transit's objectives. ■ Stakeholders are consulted and brought into the strategy where practical. ■ Strategies are developed efficiently, reflect input by Transit staff, and are expeditiously finalized and presented to the Authority for approval.
3. Ensure that a strategy is implemented to continually identify improvement projects.	<ul style="list-style-type: none"> ■ Inventory of improvement projects always up to date, and new opportunities proactively identified.
4. Manage the preparation of forecasts, reviews and reconciliation of state highway works and fees programmes.	<ul style="list-style-type: none"> ■ Optimization of expenditure within budget. ■ Input of Regional Projects Group into preparation/management of NRP is optimized (noting that accountability for delivery of capital projects is held by Regional Projects Manager).

Key Tasks (continued)	Performance Criteria
5. Ensure monthly accrual information is accurate, within budget, and forwarded to programming section.	<ul style="list-style-type: none"> ■ On time for Authority meeting timetable.
6. Where nominated as project sponsor.	<ul style="list-style-type: none"> ■ Staff develop full potential. ■ Staff fully aware of expectations. High productive output achieve. ■ A demonstrable passion to “go faster” on project delivery. ■ Evidence of satisfactory liaison with Local Authorities, Iwi, and other key stakeholders. ■ Proactive relationships with the media.
7. Provide input, and manage where appropriate, business improvement processes both within the Regional office and across Transit New Zealand.	<ul style="list-style-type: none"> ■ Initiative demonstrated where opportunities for improvement are identified. ■ Input into improvement projects is valued by other Transit staff. ■ Input is provided in constructive and timely manner. ■ Seek appropriate training and expansion of skill base.
8. Organise the preparation of documentation and briefs for engagement of consultants for professional services contracts, invite proposals, assist in evaluation of submissions as a member of tender evaluation team.	<ul style="list-style-type: none"> ■ Quality documentation on time. ■ Evaluations that conform to CPP procedural requirements.
9. Audit consultants’ and contractors’ standards and performance associated with the execution of routine maintenance, bridge repairs, shape correction, sealing works, and major projects.	<ul style="list-style-type: none"> ■ Traverse highway network at least twice a year. ■ Transit and road users getting value for money. ■ No justifiable complaints from road users.
10. Manage handover inspections with consultants for all shape correction, safety, and construction projects.	<ul style="list-style-type: none"> ■ Transit’s standards criteria and guidelines met.
11. Liaise with territorial authorities who manage state highways under delegation on a day-to-day basis in terms of the delegation agreement.	<ul style="list-style-type: none"> ■ No justifiable complaints from local authority engineers.
12. Respond to industry and public enquiries and complaints.	<ul style="list-style-type: none"> ■ Enquiries and complaint answered within 2 weeks.
13. Carry out other duties as may be allocated from time to time.	<ul style="list-style-type: none"> ■ Exhibit willingness to undertake additional tasks and complete as required, having identified any resource limitations and impact on other work.
14. Deputy for regional manager.	
15. Carry out national duties and other tasks as may be assigned from time to time.	<ul style="list-style-type: none"> ■ Participate in national working groups such as best practice groups. ■ Complete tasks to agreed time, quality, and cost targets.
16. Participate in the regional management team.	<ul style="list-style-type: none"> ■ Active support and participation in the Regional Management team and Transit Development Forum.

Person Specification

Age

Sufficient maturity to liaise effectively with senior managers and engineering staff of consultants, territorial authorities, roading industry, and the general public.

Qualifications and Experience

A registered engineer is highly desirable. Experience in roading construction and maintenance required. Knowledge of Transit New Zealand policies and procedures required. Experience in dealing with the

general public, public meetings, and media would be an advantage.

Personality and Temperament

Sense of response, maturity and judgment. To be accepted in this role by technical staff, consultants, local and central government politicians.

Skills Required

Ability to:

- (a) Analyze technical and financial roading proposals.
- (b) Report on problems and proposals clearly and concisely, both orally and in writing.

- (c) Recognize need for appropriate proactive communication strategies.
- (d) Identify performance of the state highway network, both in total and by individual site, by inspection supplemented by performance records as available.
- (e) Identify improvements to technical and administrative policy.
- (f) Show a high level of initiative and a flair for innovative approaches.

General

Transit New Zealand has adopted a nonsmoking office policy so that this person must be able to work in that environment. A driver's license is essential.

Appendix D: Network Management Area Plan

Transit New Zealand

PSMC001

Network Management Area 2005/2006 & 2006/07 *Two-Year Plan*

Maintenance Annual Plan Checklist	
Items Have Been Checked/Included	Tick Box
Signed Confirmation Page	<input type="checkbox"/>
Network Statement	<input type="checkbox"/>
Summary Maintenance Schedule	<input type="checkbox"/>
Maintenance Funding Schedules for each Work Category with supporting documentation (Appendices 1-16)	<input type="checkbox"/>
Maintenance Forward Works Programme (NOMAD Report and Graphs)—Appendix 17	<input type="checkbox"/>
Pavement Deterioration Modelling—dTIMs report—Appendix 18	<input type="checkbox"/>
Changes to Levels of Service—Appendix 19 (signed)	<input type="checkbox"/>
All Schedules submitted electronically to Transit National Office	<input type="checkbox"/>
All above items included Signed _____ Date _____ Transit Area Engineer	<input type="checkbox"/>

Maintenance Annual Plan

Contents

Maintenance Annual Plan Confirmation
Network Statement

Maintenance Summary Schedule

- Appendix 1** Pavement Maintenance
- Appendix 2** Area Wide Treatment (AWT)
- Appendix 3** Major Drainage Control
- Appendix 4** Maintenance Chip Seals
- Appendix 5** Thin Asphaltic Surfacing
- Appendix 6** Seal Widening
- Appendix 7** Bridge Maintenance
- Appendix 8** Amenity Safety
- Appendix 9** Street Cleaning
- Appendix 10** Traffic Services
- Appendix 11** Carriageway Lighting
- Appendix 12** Cycleway Maintenance
- Appendix 13** Professional Services
- Appendix 14** Preventive Maintenance
- Appendix 15** Pavement Smoothing
- Appendix 16** One-off Maintenance Requests
- Appendix 17** Maintenance Forward Works Programme (NOMAD)
- Appendix 18** Pavement Deterioration Modelling
- Appendix 19** Safety Proofing
- Appendix 20** Changes to Levels of Service

Maintenance Annual Plan Confirmation The status of this document is confirmed on this page.

Consultant Approved Programme

Prepared by: Richard Parsons
Name

Signature

_____ Date

Reviewed by: Brennan Daly
Name

Signature

_____ Date

Approved by: Mike Keir
Name (Team Leader)

Signature

_____ Date

This by 30 September 2004

Consultant Approved Programme accepted by Transit

Accepted by: Gerrit van Blerk
Area Engineer

Signature

_____ Date

Endorsed by: Ian Cox
Transit Regional Asset Manager

Signature

_____ Date

This by 31 October 2004

Has the Regional Manager endorsed the content of this Annual Plan?

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1. EXECUTIVE SUMMARY

The PSMC 001 network is managed and maintained under a performance specified maintenance contract (PSMC). This provides for the maintenance of the network within the limits set by the PSMC performance regime and for this to be achieved for tendered Lump Sum payments.

In 1998 Transfield Services and its supplier partners made a detailed study of the State Highways that comprise the PSMC 001 network. Following this a 10-year network management plan was developed and costed. This was prepared in a competitive commercial environment with little capacity for conservatism or contingency. This formed the basis of the successful tender for the management and maintenance of this network.

It is noted that six years have elapsed since the preparation of that plan. Over this time there have been significant changes in the roading industry, and the expectations of key stakeholders; however, it is noted that Transfield Services continues to deliver better than the contract requirements in the key performance measures. In the reporting of network performance we show how the network compares with national average values as well as the contracted requirements for this contract. It should be noted that the national values are derived from networks with varying management regimes, contract performance requirements, and levels of financial control.

Further there have been other benefits achieved over the contract to date, including an appreciable strengthening of the network pavements and a reduction in the social cost of crashes occurring in the network. These achievements are being delivered within maintenance and management budgets that were prepared in 1998.

This document has been prepared to comply with the requirements of Transfund and Transit New Zealand. It sets out our intentions and recommendations for the financial years

2005/06 and 2006/07. It has been prepared as a part of The Transit New Zealand trial of Two-Year Network Maintenance Plans. In it we have taken into account our contractual commitments for cost and levels of service provision. We then combined this with the philosophy outlined in Transfund's National Land Transport Program of providing the most cost-effective strategy in the medium to long term together with Transit's vision of a transport system that builds a better New Zealand and with the aims of Land Transport Management Act 2003.

This annual plan also utilises the lessons learnt in the five and a half years the PSMC has been operating. We believe that it is in the later stages of the PSMC that the effects of ownership will come to the fore and demonstrate the effectiveness of the PSMC procurement model. Key initiatives in this include:

- The use of our PSMC001 PARMMS pavement model to deliver a cost-effective strategy that will meet or exceed the KPI requirements of this contract as well as form a very good understanding of the network and its issues.
- Specifically with regard to water and drainage issues and the instigation of discrete drainage projects on targeted sections of the network.

This annual plan also contains requests for improvements to the network above the requirements of the Lump Sum scope in the form of:

- Major drainage improvements to provide increased network availability through the reduction of flooding (see Appendix 3: Major Drainage/Flooding mitigation SH31/30))
- Seal Widening improvements to address safety and reduce future maintenance costs (See Appendix 2: AWT)
- Preventive Maintenance candidate projects (See Appendix 14: Preventive Maintenance)
- Addition to the contract payments arising from the full implementation of Transit's Code of Practice for Temporary Traffic Management (See Appendix 1: Pavement Maintenance)

2. NETWORK DESCRIPTION

The map below shows the full PSMC001 network.

The PSMC001 network incorporates 3 Regional Councils (Waikato, Taranaki and Manawatu-Wanganui) and 6 District Councils (Waipa, Waitomo, Otorohanga, Ruapehu, Waikato, New Plymouth).

Traffic volumes vary from 250–5,000 vehicles per lane per day across the network. We have a higher-than-expected HCV growth on certain sections, notably SH 30, 31, 39, and 3 South. Section 7 of the Network Statement provides further detail on the traffic profile for these areas.

For the purposes of Temporary Traffic Management at work-sites, the bulk of the network is designated CoPTTM Level 1



with the portion of SH 3 from Hamilton Airport turnoff to Te Awamutu being CoPTTM Level 2 (approximately 19 km).

2.1 Pavement Formation

The highways on the network consist typically of granular pavements, some with a degree of modification, with thin bituminous surfacings. Pavement materials are moderate crushing strength greywackes, with minor amounts of plasticity, varying in depth from 100 mm to 800 mm. There is a supply issue within the region for quality basecourse material. This is compounded by the fact that many of the subsoils throughout the network do not lend themselves to supporting cement stabilised pavements.

The climate can be described as wet temperate with annual rainfall averages ranging from 1,200 mm to over 2,600 mm across the region.

Each highway of the network has different characteristics and is described separately as follows:

State Highway 3

SH 3 is part of a strategic link along the west coast of the central north island and its operation is seen as critical to the health of the Taranaki economy. A special interest group, the SH3 Working Party, has as its principal objective the promotion of roading improvements to SH3 between New Plymouth and Te Kuiti and the protection and enhancement the northern Taranaki corridor as a strategically important route. The group is comprised of representatives of district and regional councils, Transit New Zealand, Transfield and road users, and is convened by Taranaki Regional Council.

SH3 passes through terrain ranging from rolling pastoral in the Waikato to the steep terrain in and around the Awakino Gorge and Mount Messenger. The restrictions created by the latter two geological features, including two tunnels, have a significant effect on alignment, safety, and travel time. The topography and underlying subsoils, particularly the Mahoenui Mudstone, in the King Country are unstable and susceptible to heavy rain and periods of prolonged wet weather, both common conditions experienced within the region.

State Highway 39

SH 39 travels through rolling Waikato farmland and up until January 2001 was part of the Local Territorial Authority road-network. The highway was designated as a State highway

Table 1. *Current Network Statistics*

Item	Question	Unit	Result	Comments
Network Description				
Dimensions	Length of road network	Km	449.7	Centre line Km
	Length of rural road	Km	424.3	
	Length of urban road	Km	25.4	
	Length of Motorway	Km	0	
	Length of Expressway	Km	0	
Contracts	Number of maintenance contract areas	No	1	
	Procurement type	Text	PSMC	
Topography	Predominant topography	Text	Rolling	
Traffic Data	Typical urban AADT	AADT	5,200	
	Typical rural AADT	AADT	2,500	
	Historic 5-year AADT growth	%	1.4%	Plus/minus 2.2%
	Typical urban HCV	%	14%	Estimated
		%	17%	Estimated
Network Condition				
Corridor	Acceptable			

at that time in recognition of the role that it plays in providing a western bypass to the Hamilton Urban area.

State Highway 4

SH 4 travels through the rugged King Country and Taumarunui hill country. When the topography around SH 4 is not steep hill country the road is generally sitting on a flood plain. To the north, the road is near the Mapiu and Mapara Streams, which are bedded in large mudstone alluvial flood plains and to the south the highway sits on the Ongarue River flood plain, which is comprised of soft pumiceous and silty alluvials that erode very readily.

State Highway 30

SH 30 near to Te Kuiti is dominated by the karst environment, with subsidence in the pavement common. Further east, the road is built on volcanic terrain and is often affected by the sensitive clays formed from ash deposits.

State Highway 31

SH 31 travels through rugged hill country from the intersection with SH 39. The topography is very steep and the underlying geology of Te Kuiti Group has formed steep bluffs very close to the road's edge in many sections of the highway. Volcanic deposits from Mount Pirongia

cap the Te Kuiti Group and are readily erodible when saturated.

State Highway 37

While SH 37 is surrounded by the karst topography of Waitomo, the highway travels through easy undulating country and provides an important tourism link to the Waitomo Caves. It is in reasonable condition for its current traffic loading.

2.2 Summary

The network also forms part of an alternative route to SH 1 through the centre of the north island via SH 39, 31, 3, and 4. Both SH 30 and SH 31 have experienced significant heavy traffic growth due to production forests coming on stream for harvest and have had large capital investment in upgrading pavements to cope with this. While treatment to date has been successful, ongoing investment levels need to be maintained. Section 7 of the Network Statement and Appendix 1: Pavement Maintenance elaborates further on this issue.

As detailed above, the network is a challenging one with a range of difficult conditions and issues that have been managed and/or mitigated as part of the PSMC001 Network management strategy and compilation of this 2-year Annual Plan (and associated 10-year forward Works Program).

3. ISSUES AND GOALS

Preventive Maintenance

The Waikato/Bay of Plenty Transfund Representative has endorsed the sites put forward in Appendix 14 of this Bi-Annual Plan. Cost-effective solutions have been promoted to ensure that least-whole-of-life cost options, network security, and safety are maintained. It is likely that the highway infrastructure will be exposed to long-term damage if the proposed strategy is not implemented.

Heavy Commercial Traffic Growth

HCVs on SH 30 (mostly logging related) are still contributing to rapid deterioration of pavements. Also, SH 39 is showing signs of distress due to increased HCV loading related to its designation as a state highway and this is expected to increase significantly with forestry blocks coming on stream in the near future. The Contract Lump Sum caters for HCV traffic growth up to 5 percent annually. This risk profile boundary has been exceeded on SH 30, SH31 (East/West Sub-Network), and SH39 (SH39 Sub-Network). Section 7 of the Network Statement

and Appendix 1: Pavement Maintenance elaborates further on this issue.

CoPTTM Compliance

In 2001 Transit introduced its new Code of Practice for Temporary Traffic Management. At that time an assessment was jointly made of a practical level of implementation. This included working with less than the specified levels of control and not following the Transit classification of the section of SH 3 north of Te Awamutu as Level 2. Since that time the roading industry has moved to a higher level of compliance. As such the interim standards agreed in 2001 are no longer applicable. Further, the section of Level 2 road has not been reclassified (less than minimum length recommended). As a result, we must alter the funding application to suit full requirements of CoPTTM. The details of the merits of this claim and the calculation of its actual value shall be through the regular contractual mechanisms. It has been included in this Plan in order that Transit may take this into account in its future funding planning.

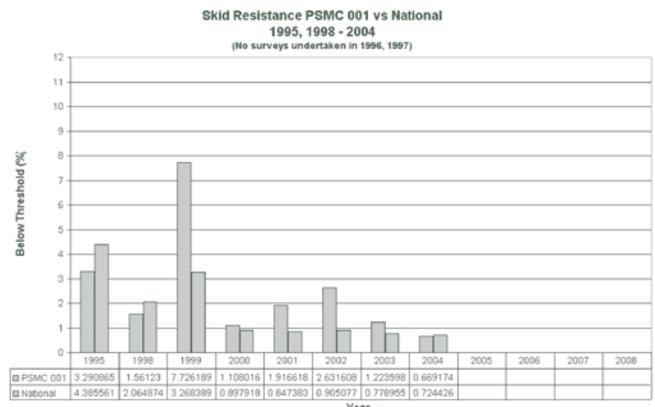
4. NETWORK CONDITION AND ACHIEVEMENT OF CONTRACT KEY PERFORMANCE INDICATORS

4.1 Surfacing

Skid Resistance

The plot to the right shows that the skid resistance below threshold measure is better than the national average for the first time in seven years.

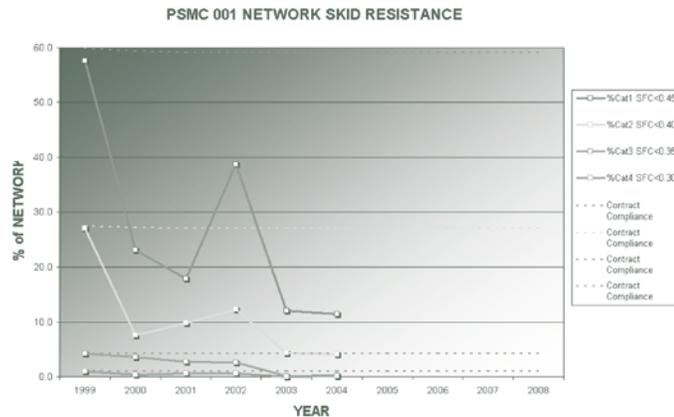
Historically maintaining good skid resistance across the PSMC001 network has been difficult due to the fact that the best locally sourced sealing chip has only achieved a PSV of around 52-53. The locally crushed material was predominantly elongated as a result of the type of crusher typically used in the region. This chip had been used for all sealing prior to 2002.



Since that time, there has been a determined strategy by the PSMC001 team to improve the performance of our seals in terms of skid resistance. This strategy has included:

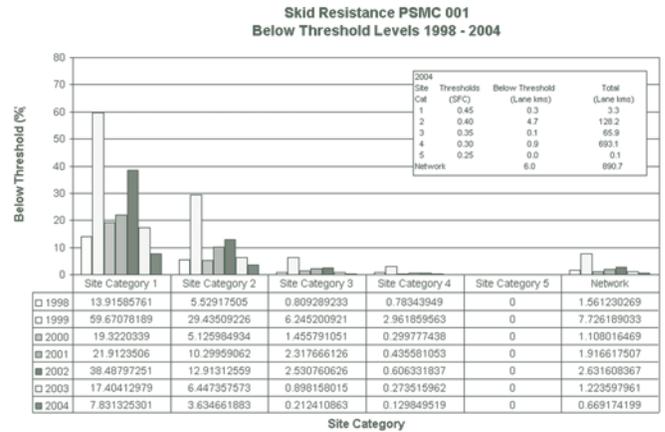
- A change in chip source, improving both shape and PSV. The PSV values have increased from 52 to 54, which is only moderate. It is the combination of this with the increase in ALD/AGD ratio that we expect to deliver better skid resistance properties.
- Change in bitumen type and application rate. We use 80/100 bitumen (rather than 180/200) for all reseals and first coat seals on the network. We have also aimed to reduce bitumen application rates as much as practicable—both in strategic response to the historical flushing problem that has hampered the PSMC001 region.
- A change in works prioritisation to include improvement of network skid resistance as a priority. Given the focus that Transit has placed on skid resistance over the past few years, we have included this factor in our prioritisation of rehabilitation work.

Based on the trend for improvement evident in the graph above, this strategy appears to have been successful in delivering a safer network for the road user. This strategy will be continued with the 2005/06 and 2006/07 programs, in order to extract further benefits.

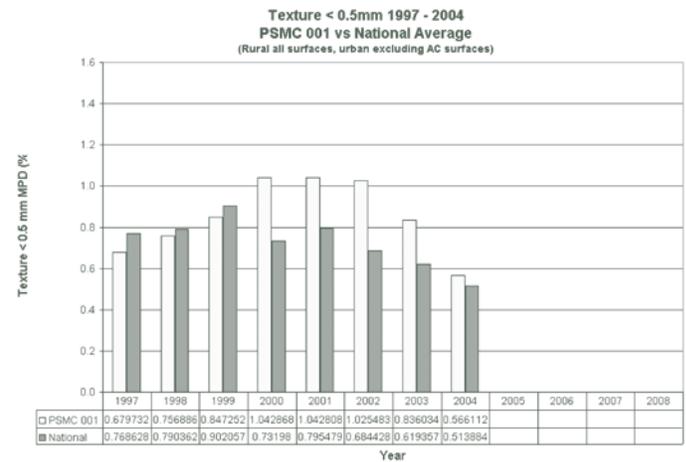


The above graph is used to track and monitor PSMC001 performance against the Network Management contract Skid Resistance Key Performance Indicator (KPI). The data reported on above is sourced from the SCTIM survey conducted by WDM. It is noted that these are less restrictive than the National values and that the network is performing better than the contracted requirements.

The same trend is evident on the National Condition graph as shown at the top of the next column.



The plot below shows that the percentage of the network texture depth <0.5 mm measure is worse than the national average by 0.05 percent; however, this has been showing a trend for improvement over the last few years. The sealing strategy described above has also been utilised towards the reduction of the network area that is low on texture.

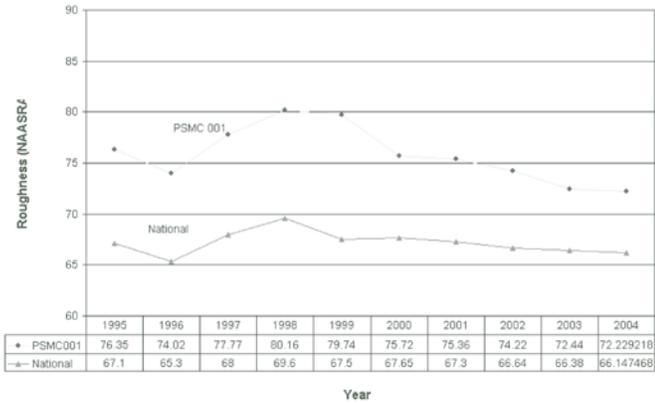


Because there is a high proportion of our 2003/04 sealing program that was completed after the network surveys, we expect this trend for improvement to continue next year.

4.2 Pavement Roughness

The plot on the following page shows that the average roughness for the network exceeds the national average by a 6.1 NAASRA counts at present. The plot also shows that the network average roughness has been reduced by 7.5 NAASRA since 1999, whereas the national average roughness reduction in the same period is 1.4 NAASRA.

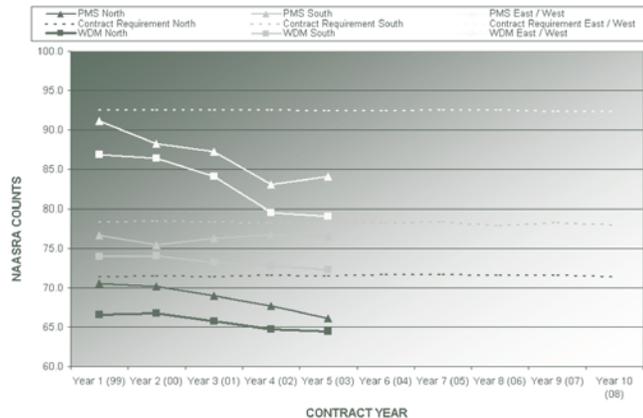
**Roughness Trend
PSMC001 vs National**



This rate of improvement is a significant achievement, yet it has been possible only as a consequence of the poor state of the network at the commencement of the PSMC001 contract. The network condition has stabilised to an extent and it is not likely that we will provide further improvements in average roughness. That being said, we expect to see incremental annual improvements in roughness as a result of PSMC001 contract commitment to rehabilitate 50 percent of the network area through the life of the contract. Our current modeling output and forward works program predict a handover average network roughness of 72 NAASRA counts.

The graph below is used to track and monitor PSMC001 performance against the Network Management contract Mean Roughness Key Performance Indicator (KPI). As is indicated, all KPIs in this category have been met to date, with the forward works program for 2005/06, 2006/07, and future years set at continuing to meet this requirement.

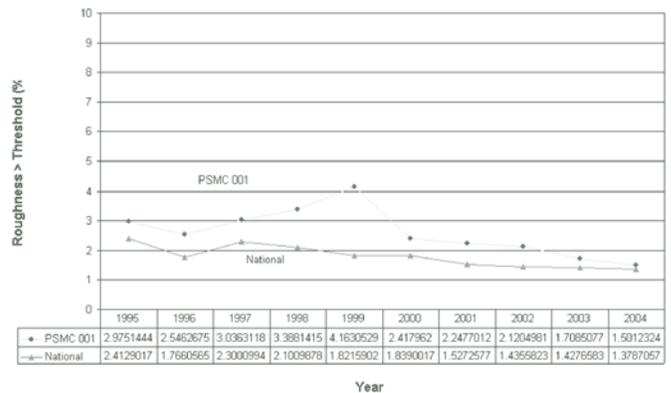
PSMC 001 NETWORK MEAN ROUGHNESS



While we do not expect that our network average roughness will close in on the national average, we will continue to monitor and treat areas of high roughness (big bumps) as

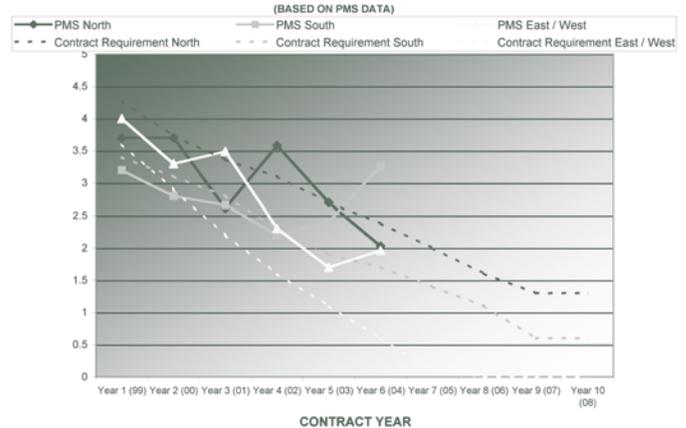
part of our pavement management strategy. We have reduced these areas by 65 percent since the start of the contract and we aim to continue the trend of improvement shown by the graph below.

**Roughness > Threshold
PSMC 001 vs National**



This type of roughness creates short bursts of highly uncomfortable travel for road users, which lead to a very poor perception of overall network condition. Through the timely treatment of such problems, we aim to minimise the occurrence of discomfort and condition perceptions.

PSMC 001 NETWORK ROUGHNESS > 120 / 130 / 150 NAASRA COUNTS



The graph above is based on data sampled by PMS during early 2004, and suggests that there is an increasing trend in the incidence of rough bursts on the network. This is contrary to the WDM information as supplied by Transit, though this may be related to the difference in timing of the surveys. We will monitor this effect over the course of the next 12 months and ensure that this trend, whether real or perceived, is not allowed to continue.

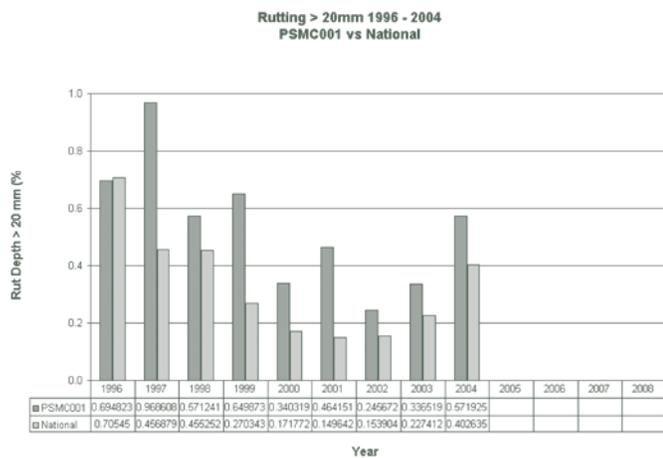
Rutting

Based on the Transit National Survey graph below, the PSMC001 network is shown as drifting out on the length of

rutting greater than 20 mm deep. While it is noted that this trend is in some way contributed to by a change in the setup of the measurement vehicle (as noted in the State Highway Network Condition Report 2004), it is consistent with our understanding of network behaviour. Consideration should also be given to the scales involved. The network appears to be 0.2 percent worse than the national average. This equates to 900 m of carriageway.

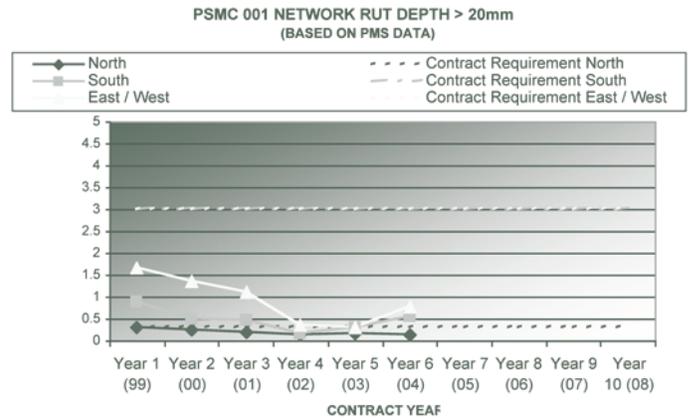
The second plot below is used to track and monitor PSMC001 performance against the Network Management contract Rut Depth >20 mm Key Performance Indicator (KPI). As is indicated, all KPIs in this category have been met to date, with the forward works program for 2005/06, 2006/07, and future years set at continuing to meet this requirement.

Notwithstanding the fact the network is in better condition than is required by the contract, we would like to address the recent deterioration. We have completed a recent study on the difference in rut depth values between the inner and outer wheel path. This study found a high degree of correlation of sites with a high rut differential to those sites with poorly functioning drainage. These sites contained a high proportion of the ruts over 20 mm in depth. For the 2004/05, 2005/06, and 2006/07 seasons, we have programmed a large-scale drainage reinstatement package (Lump Sum activity) and continue with our rehabilitation work to correct the increase in rutting.



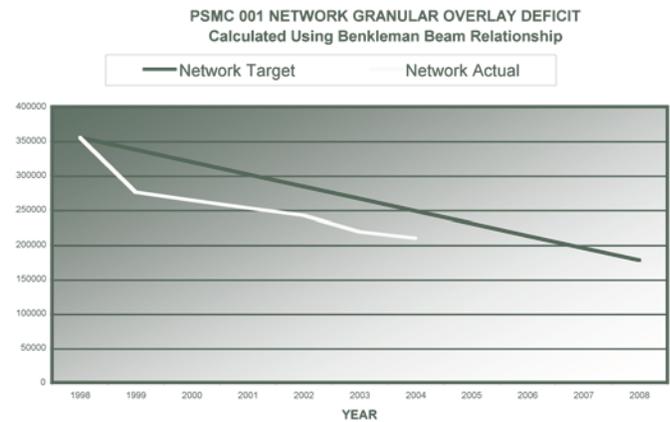
Granular Overlay Deficit

One of the key issues of a long term Performance Specified type contract is ensuring that the contractor continues to invest in the network and does not just consume the investments that have been made previously. Transit covered this particular risk by including a performance measure of the structural integrity of the pavements, called Granular Overlay Deficit.



The granular deficit measure was developed to indicate the structural health of the network. The measure, using deflection and curvature information from a falling weight deflectometer (FWD) with traffic data, then calculates the nominal volume of granular overlay required to produce a 25-year design life using the Austroads Pavement Design Guide procedures.

After almost 6 years of the PSMC001 operation, the effects of the implementation of the PSMC001 Forward Works programme are measurable. The pavement of the Network is substantially stronger than at the start of the contract. The granular deficit has been reduced by almost 150,000 cubic metres (m).



Note that the relationship used to calculate the information used on the above graph is different to that nominated in the contract. This is due to the potential for interpretation included with the contract specified method. It is highly sensitive to pavement profile information and given the paucity of this type of data, we have proposed to use this simpler method. Note that we have recalculated the baseline and network target figures using this same method. The PSMC001 Management Board is currently considering this new methodology.

4.3 Pavement Defects Report

Pavement Issues

There continue to be issues with pavement repairs throughout the network with the worst affected area being SH3, south of 8 Mile Junction (SH4). This problem is a complex one and is related to basecourse quality, topography, climatic conditions, sub-grade standard, and increases in heavy vehicles. Internal Task Groups have been set up to investigate and enhance patching methodologies and techniques, including surface finishings.

Given the range of causal factors it is difficult to come up with a simple one-size-fits-all solution. Rather, we are working on a range of methods to target this problem, including incorporating pavement repairs into our rehabilitation strategy, training staff in both design and treatment of repairs, and looking at alternative treatment methodologies and materials. We have moved to patching potholes with hotmix in dry conditions and good quality premix in situations in wet situations. This has seen a significant improvement in the life of these repairs in wet and adverse conditions.

We are still well in front with KPIs for roughness and rutting over the entire network; however, this year has seen both these measures trend up in the South and East/West sub-networks. This is seen to be related to the issues discussed above as well as being drainage related. There will be an increased focus on drainage works over the next two years, which when combined with an improved pavement repair strategy should lead to further improvements in network KPIs for these sections. We will continue to monitor these issues closely.

In terms of pavement management strategy, we have targeted large-scale pavement strengthening. As part of our tender commitment with Transit, Transfield Services is required to complete 25-year-life reconstruction work on at least 50 per cent of the network by area. This strategy has resulted in large improvements in the network granular overlay deficit since the

start of the contract. Our challenge over the next few years is to refine this strategy to help address the issues noted above in reactive maintenance.

Surfacing Issues

The 2004/05 rehabilitation program includes significant areas of asphaltic surfacings, specifically on Mount Messenger and in the Te Awamutu urban area. These areas have performed relatively poorly and are only about 5 years old.

Currently, there is relatively little asphaltic surfacing on the network; however, with increasing traffic volumes and corresponding increases in surfacing stress levels, it is envisaged that more isolated intersections will require such treatment in the next few years. Due to minimum texture requirements and increasing vehicle stresses, these treatments must be with high PSV Stone Mastic Asphalt (SMA). We have already completed one such treatment in 2003/04 and currently it is performing well.

SCRIM remains an issue of the PSMC001 network due to the high proportion of Category 2 sites combined with a lack of top-quality sealing chip that may be sourced locally. Areas of particular concern are SH 3 south of 8 Mile Junction and SH 4. Our management of SCRIM sites has adopted a practical approach wherein we have made detailed site assessments in conjunction with the SCRIM data prior to making any treatment decisions. This has led to an improvement shown in each of the last three seasons.

In terms of treatments, the rehabilitation and resealing programs address the majority of SCRIM issues. We have certain situations that cater to water blasting; however, this treatment is not seen as a permanent repair method.

Flushing returns within 12-18 months on most of our problem sections, due to the large amount of residual bitumen that exists within our seals.

5. ASSET MANAGEMENT PRACTICES AND STRATEGIES

In terms of the management of the network, our maintenance behaviours are driven by Key Performance indicators (KPIs). There are KPIs that apply to most of the activities performed by Transfield Services against which we are assessed annually. Some of these KPIs have been presented above; however, there

are a total of 214 against which our performance is measured. In this number there is a degree of redundancy that the project team has attempted to reduce and this process of refinement will continue in the ensuing years. The KPIs are broken into three sections, which are summarised on the following page.

Asset Performance Indicators

These indicators relate to the actual condition of the asset at the time of measurement. They represent a snapshot of network condition and give an indication of the quality of the product that is being provided. We have demonstrated a high degree of conformance to the criteria in this section, as is evident from the information tabled above. There are measured results of performance that exceed the contract minimum requirements. Whilst this does equate to tangible benefits to stakeholders, an assessment may be required to ensure this investment is in the areas of best return.

Contract Performance Measures (Response Times)

These measures are a summary of the actual response times to attend to various services as measured through the year. Depending on the particular service, there is a maximum time

for response permitted under the contract and we are measured against this standard. For many of these measures we demonstrate a high level of conformance, most notably in the response to emergency incidents. We have received numerous congratulations from external agencies such as the police and the Road Transport Authority for excellent services provided in incident response situations and this is an area of pride for the contract team.

Management Performance Indicators

These indicators relate to the performance of the management team in contract reporting requirements and customer enquiries. Generally the performance of Transfield Services in this area over the past year has been good; however, we are aiming to provide an improved level of service in terms of the delivery of capital projects into the future.

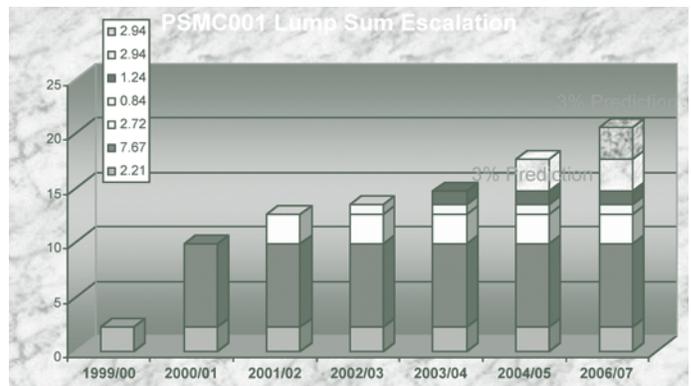
6. CURRENT CONTRACTUAL COMMITMENTS

The PSMC001 contract commenced on 11 January 1999 and has a ten-year performance based duration. A maintenance risk profile is included in the PSMC001 contract, which defines what elements of risk are borne under the lump sum, and which are borne by Transit.

Two items of maintenance funding in excess of the contractors risk profile are forecasted in 2005/06 and 2006/07. These items are:

- Heavy commercial traffic growth above the specified threshold level (Appendix 1: Pavement Maintenance—Miscellaneous Works)
- Implementation of Level 2 CoPTTM—TNZ Policy Change (Appendix 1: Pavement Maintenance—Miscellaneous Works)

Escalation accrues annually and the PSMC001 lump sum



amounts reported in this annual plan reflect a prediction being made that escalation of 17.6 percent will be due through the course of the 2005/06 financial year, and 20.5 percent for 2006/07.

7. TRAFFIC

There have been 9 closures of the SH 3 link in the past year and 5 of these were for under an hour. All were slip, accident, or flooding related. No closures were for more than 12 hours.

There are sections of the network that have experienced traffic growth rates higher than that of the maintenance contract risk profile. We are still working on data on sections of SH 3 sites where initial indications show increases outside the risk

profile of 5 percent. The Traffic Growth Report attached in Appendix 7 details traffic growth statistics for SH 30, 31/0 (East/West Sub-Network), and 39 (SH39 Sub-Network)

Specific sections are summarised as follows:

East/West Sub-Network

SH 30: Continued heavy traffic volumes outside the risk profile due to logging have been recorded along this route. This Two-Year Plan caters for the upcoming update to the current 2003 SH30 Traffic Risk Profile Exception Report. The report outlines extra costs incurred for extra

design/construction of pavements to cope with the increased loadings and maintenance costs incurred above a baseline benchmark that have been incurred since July of 2003.

SH39 Sub-Network

SH39 (and SH 31/0) has experienced increased heavy traffic due to State Highway designation status and resulting improvements made on the road. Transfield is experiencing increased maintenance costs for this section that are over and above baseline maintenance costs and, where relevant, increased design costs.

8. ROAD USER SAFETY

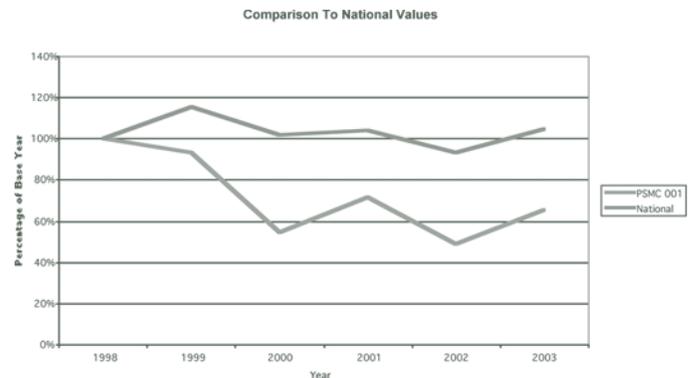
The network has seen a reduction in the social costs of crashes over the last 5 years, from an average of over \$30 million for the three years prior to the PSMC to a \$16 million average for the past four years, a nearly 50 percent reduction, significantly better than national trends.

Year	PSMC 001 Social Cost	National Highway Network
1996	\$29,875,000	\$768,853,000
1997	\$35,609,000	\$804,033,000
1998	\$27,179,000	\$657,281,000
1999	\$25,566,000	\$763,621,000
2000	\$14,501,000	\$663,033,000
2001	\$19,345,000	\$674,826,000
2002	\$12,628,000	\$599,438,000
2003	\$17,316,000	\$682,131,000

However, the management of the PSMC001 Network remains firmly focused on locking this improvement in and gaining further reductions. To this end we have carried out analysis of the network crash history over the past three years. This information shows that the significant accident causal factors on the PSMC001 network are:

Bends

Cornering and related accidents contribute to approximately 65 percent (53 percent last year) of our total accident rate. The social cost of these accidents over the last three years is valued at over \$30 million. This is by far the largest factor in accidents on our network. At present, the PSMC001 contract is meeting its contract specified Skid Resistance KPM requirements and a <% Below Threshold result less than the National average. Regardless of these results, a



large focus of both the maintenance and improvement programmes is on driving down the accident rate experienced on bends.

An example of programme optimisation and safety focus is shown by the PSMC001 use of the Norsemeter ROAR variable slip skid resistance tester to study each skid category 2 corner on the network and rate each one on a probability curve in terms of accident risk. We will then target these corners in a prioritised manner with treatments that will help to reduce accident risk, complimented by the implementation of minor safety programs, signage upgrades, vegetation clearing, and enhanced recovery zones (e.g., Appendix 2: - seal widening associated with AWT). This ROAR Risk analysis process is in the early sages of development with the methodology being presented to the PSMC001 Management Board in late October 2004.

Vehicle Overtaking

Passing and head-on related accidents contribute to around

15 percent (16 percent last year) of crashes on the network with a social cost of \$8 million for the three-year period 2001-03. Transfield Services, in conjunction with Transit and with the support of relevant local authorities, has pushed through a program of passing lanes and passing lane extensions to try and address this issue. However, there are additional sites proposed in the capital plan that are a key part of this ongoing strategy.

Intersections

Turning-related crashes account for approximately 5 percent (10 percent last year) of all crashes. To try and further reduce the number of intersection-related incidents, lighting improvements, pavement marking, signage, sight distance, and surface condition at intersections are taken into account when developing maintenance (Lump Sum activities) and improvement programs (predominantly Minor Safety).

9. MODELLING AND THE 10-YEAR FORWARD WORKS PROGRAMME

9.1 Modelling

The project team has utilised PARMMS road manager as a modelling tool since contract commencement. Transfield has provided a commitment to deliver dTims output files to enable the PSMC network to be incorporated within the National Pavement Model.

Historically the PSMC 001 model has focused on satisfying contract KPMS and long-term pavement performance. This was achieved by assigning a high priority to the roughness condition parameter, as roughness was considered to be the best overall single indicator of the pavement condition.

However there has been a non-programmed increase in isolated reactive pavement maintenance throughout the network. The minimisation of routine maintenance was not a priority for the earlier version of PARMMS road manager. It also did not take into account the effect of drainage on pavement structural layers.

Significant work has been invested into the pavement model this year to take account of both reactive pavement maintenance and drainage issues whilst still focusing on delivery of KPMS and long-term pavement performance. The model has

also undergone significant field validation with operational staff to provide a very strong field-modelling link.

The PSMC001 model is treated as a live program due to the need to:

- Deliver long-term pavement performance.
- Provide cost-effective site selection.
- Provide the flexibility to react to network needs (80 percent committed).
- Allow for ongoing data input/communication between field staff and the dedicated PARMMS modeller.
- Meet the obligations of the lump sum and deliver on business targets.

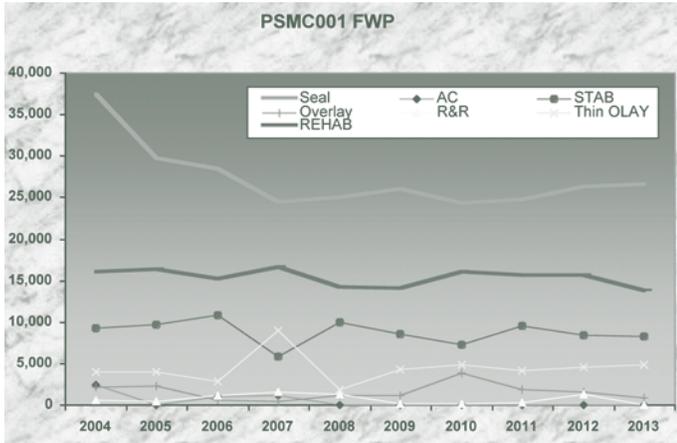
Please refer to Appendix 18, which contains the PARMMS road manager pavement modelling report.

9.2 The FWP

This annual plan is based on a two year program, 2005/06 and 2006/07, which comprise years two and three of the current ten year FWP, which is included in Appendix 17.

The table below and graph (see following page) summarise current predicted rehabilitation and reseal requirements to

(m)	2004/05	2005	2006	2007	2008	2009	2010	2011	2012	2013
Seal	37,000	29,800	28,400	24,500	25,000	26,000	24,300	24,700	26,400	26,600
AC	2,400	—	1,000	1,100	—	—	—	—	—	—
REHAB	16,100	16,400	15,300	16,600	14,300	14,100	16,100	15,700	15,700	13,800
STAB	9,300	9,700	10,800	5,800	10,000	8,500	7,300	9,500	8,400	8,200
Overlay	2,200	2,300	600	400	1,200	1,200	3,800	1,800	1,500	800
R&R	600	400	1,100	1,500	1,300	200	200	300	1,300	—
Thin OLAY	4,000	4,000	2,800	8,900	1,800	4,200	4,800	4,100	4,500	4,800



2013. (Note: Reseal quantities after the coming season do not include SCRIM seals, estimated at 5 km/yr, and risk-excluded second coats, estimated at 7 km/yr.)

The rehabilitation figures shown above are made up from:

- STAB (Stabilisation treatment)
- Overlay (Granular overlay treatment 120+mm)
- R&R (Rip & Remake Treatment)
- Thin OLAY (Overlay 75-120mm)

The philosophy behind our 2005/06 programs is to assist in meeting contract KPIs with a strong emphasis on reducing reactive pavement maintenance. This flows through into 2006/07 and future years. To this end the shorter sections emerging from our model have been progressively incorporated into our works program.

The two-year FWP quantity for rehabilitation and reseals has an 80 percent confidence level (when averaged over the two year period). This is in contrast to expectations contained in TNZ memo *ST7-0013-Instructions to the 2-year Annual Plan*. Reasons for this deviation include climatic and geological conditions, the reality of modelling methodology, "work effects," and the variation introduced from detailed site analysis prior to construction. An expansion of this rationale can be found in Appendix 17 of the *Support Supplement*.

Appendix E: Total Asset Management Template

New South Wales Treasury

(Reprinted by permission of the New South Wales Treasury)

ISBN 07313 3325X Total Asset Management
(set of six volumes)

ISBN 07313 32482

1. Asset management—New South Wales.
2. Capital Investment.
3. Public administration—New South Wales
- I. Title. (Series: TAM 2004)

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 - 2.7 Asset disposal strategy

quality of their Total Asset Management (TAM) Strategies.

It will also be used by the Department of Infrastructure, Planning and Natural Resources (DIPNR) in reviewing agencies' Asset and Capital Investment Strategies to support wider state planning which better integrates land use, transport and key infrastructure planning and development.

The template is accompanied by notes describing its form, content and use. Agencies should consult their NSW Treasury analyst where they require additional advice.

A glossary of the terms used in this template and guideline is included at the end of the guideline.

1. Total Asset Management Strategies

1.1 Guidelines for completing the Total Asset Management template

The Template has been prepared to support agencies develop their Asset Strategy and integrated Capital Investment, Asset Maintenance and Asset Disposal Strategic Plans. Together these form the agency's Total Asset Management Strategies. The template will assist NSW Treasury to assess the effectiveness of agencies' strategic asset management through the

Why a template?

The TAM Manual details how the Government's policy for the management of the State's assets should be implemented. It requires agencies to prepare TAM Strategies, but it does not prescribe the form or level of detail required in such strategies.

TAM Strategies have become narratives of agencies' operations and asset requirements, sometimes at the expense of substance and detail. It is difficult to assess such strategies and it is difficult for those developing them to use them to effectively manage their asset bases, or know if they

adequately fulfill their reporting obligations.

A template has now been prepared to:

- Provide agencies with a disciplined structure upon which to develop their TAM Strategies consisting of their Asset Strategy and integrated Capital Investment, Asset Maintenance and Asset Disposal Strategic Plans.
- Set out the level of detail required in budget sector agencies' presentation of their TAM Strategies to Treasury.
- Set out the level of detail required in agencies' presentation of their Asset Strategies and Capital Investment Strategies to DIPNR. (See Premier's Memorandum 2003-17).
- Set out the level of detail to be provided by self funding agencies seeking Treasury agreement to undertake major capital investments.

An agency's TAM Strategies and their presentation to NSW Treasury varies only in its level of detail.

In developing its TAM Strategies, an agency requires detailed knowledge of government's vision and priorities, its own corporate goals, service delivery strategy, resource levels and its asset base.

The strategies must contain sufficient information to effectively communicate it to those within the organisation charged with its implementation and with broader agency planning. NSW Treasury and DIPNR require sufficient detail to understand the Strategies and gain confidence that government's service delivery priorities are addressed and the risks are appropriately identified and managed. The template promotes clear agency asset planning while discouraging time spent documenting unnecessary material for NSW Treasury and DIPNR.

A template clearly highlights any specific planning weaknesses which need to be addressed by an agency. It will be obvious to the agency from the quality and availability of the information sought at each step in the template, which areas of planning require further development.

The template incorporates the approach set out in the Asset Strategy Guideline which is part of the TAM Manual. Agencies are encouraged to self assess their TAM Strategies against the criteria set out in the Asset Strategy Guideline, prior to submitting them to Treasury and DIPNR. The TAM Manual is accessible on Treasury's website, www.treasury.nsw.gov.au.

By imposing a planning discipline the template is important in raising knowledge and awareness within the agency, and developing a common understanding within Treasury and DIPNR, of agency service delivery and asset dependency. It

also makes it easier for NSW Treasury to assess agency compliance with TAM Policy and their need for resources. It also encourages analysis of performance across the sector and by agencies over time.

What are TAM Strategies?

TAM Strategies establish and document the assets that most appropriately, effectively and efficiently allow an agency to meet its service delivery commitments. The Asset Strategy is the overarching strategy. It is developed in response to the agency's corporate plan, its Results and Services Plan or Statement of Business Intent and its service delivery strategy, acknowledging resource levels available over the life of the strategy to deliver its services.

For agencies required to prepare Results and Services Plans annually their TAM Strategies should reflect the service deliveries set out in these plans.

What use is made of the TAM Strategies?

The Asset Strategy is for use by the agency to establish the optimum form of the assets required for them to deliver, within resource limits, the results and services sought by government. The resulting Capital Investment, Asset Maintenance and Asset Disposal Strategies detail the actions the agency proposes to undertake to manage its asset needs.

The TAM Strategies are required by NSW Treasury to ascertain the assets required for the agency to deliver government's program of services and whether agencies are planning and managing assets in accordance with TAM policy. Budget allocation decisions are influenced by the content of the TAM Strategies. Treasury agreement is also required by self funding agencies beyond the Budget process, prior to them committing to major capital investments.

In addition, the Department of Infrastructure, Planning and Natural Resources (DIPNR) draws on agencies' Asset Strategies and supporting Capital Investment Strategic Plans to advise the Infrastructure and Planning Committee of Cabinet (IPCC) on major infrastructure proposals, asset strategies and Capital Investment Strategic Plans. This committee has the central role in setting the Government's strategic direction for urban and regional development and associated infrastructure priorities through the NSW Infrastructure Strategy. This is outlined in the State Infrastructure Strategic Plan (SISP).

Agencies should consult with DIPNR to ensure appropriate alignment of their Asset Strategies and Capital Investment Strategic Plans with the SISP before these plans or specific project proposals arising from them are submitted to NSW Treasury for Budget approval considerations.

Which agencies are required to prepare TAM Strategies?

The need to prepare Asset Strategies arises from TAM Policy, which applies to all government departments, statutory authorities, trusts and other government entities. State Owned Corporations under the State Owned Corporations Act are exempt although they are encouraged to adopt aspects of TAM that are consistent with their corporate intent.

Budget sector agencies should prepare TAM Strategies based on the agency continuing to provide agreed services within its current resource limits. Depending on Government's priorities, fiscal position and other strategic factors some budget sector agencies may be invited to submit specific proposals for enhanced levels of service. Necessarily, such invitations will be limited. Non Budget sector agencies' TAM Strategies should also be developed within the resource levels available.

Some agencies through self funding are able to internally fund major projects. Procurement Policy requires these agencies to submit any such projects to Treasury for full assessment prior to approval of funding. An agency should demonstrate a need for the project, normally through an Asset Strategy and supporting Capital Investment Strategic Plan.

When are TAM Strategies required?

TAM Strategies are required by Treasury and DIPNR by the end of August to fit within the Budget cycle.

How should the template be used?

The template contains seven headings which the TAM Strategies should address. The headings cover the agency's corporate and service goals, likely resource levels, alternative service delivery strategies, risks to service delivery, performance measures and the asset strategies to achieve its service delivery goals.

Each heading seeks specific information. Explanatory notes detail the scope and depth of the information sought. Some aspects of an agency's TAM Strategies require detailed knowledge of the agency's corporate and service delivery responsibilities as well as intimate knowledge of its assets. The agency's TAM Strategies should contain sufficient information to plan and manage its asset base.

The template approach does not require such detail to be provided in the final presentation of the TAM Strategies document to Treasury and DIPNR. Samples of the agency data used to develop this document should be appended to provide reviewers with confidence in its rigour. By setting clear and reasonable expectations, unnecessary work can be avoided in preparing and assessing the strategies.

Glossary

Results

What the agency is trying to achieve for society. Results are the intended impacts that the services have on the community, the environment or the economy.

Services

The end products the agency delivers for external consumption.

Results and Services Plan (RSP)

A concise statement of the agency's results, services, result indicators and service measures.

Total Asset Management Manual

The Total Asset Management Manual is an internet based document explaining the NSW Government's Total Asset Management Policy and provides details of the five component strategies forming the Total Asset Management Strategies. It also contains a series of guidelines on implementing various aspects of asset planning. The Total Asset Manual can be found at www.treasury.nsw.gov.au.

2. The Total Asset Management Strategies template

This template provides agencies with a structure to construct their Asset Strategy and integrated Capital Investment, Asset Maintenance and Asset Disposal Strategies.

THE ASSET STRATEGY

2.1 RESULTS, SERVICES AND CORPORATE GOALS

2.1.1. Identify the goals of the agency sector in which the agency is located.

- NSW agencies are organised into cluster groups related to their combined service delivery focus, e.g., Human Services Cluster.
- This information should be available from the cluster CEO committees which discuss sector issues.

2.1.2. Identify the agency's corporate goals. Indicate which are being pursued in conjunction with other agencies and the responsibilities of each.

- All corporate goals should be included as each will have asset implications, requiring current or new assets to implement them.

2.1.3. List the corporate performance indicators for each corporate goal.

2.1.4. Clearly define and quantify each of the results

the agency pursues based on there being no change in the agency's service delivery. Identify the corporate goal(s) that each result supports.

- This information should be available from an agency's Corporate Plan and Results and Services Plan (RSP) or Statement of Business Intent (SBI). Where results support several corporate goals, indicate whether that support is of major or minor significance.

2.1.5. Clearly define and quantify each of the changed results the agency plans to deliver based on delivering an enhanced level of service. Identify the corporate goal(s) that each result supports.

- Where results support several corporate goals, indicate whether that support is of minor or major significance to achieving that goal.
- Agencies should not commit undue expenditure on detailed planning of such proposals for enhanced service delivery, until invited to submit specific proposals.
- Early discussion about such proposals with NSW Treasury is important to avoid wasted effort.

2.1.6. Clearly define and quantify each of the services the agency delivers based on there being no change in the services being delivered. Identify links to the result(s) each supports.

- Include all significant aspects of the services being delivered.
- This may entail extensive detail which has usually already been developed by agencies. Where such information exists, refer to it at this item and append it in part or in full to this template in its current form.
- While detailed data is important in preparing and implementing Asset Strategies, it is sufficient at this item for those reviewing the strategy to understand the quality of the information around which it was developed rather than to sight extensive data. Services should be aligned with the agency's corporate plan, Results and Services Plan or Statement of Business Intent.
- The Results and Services Plan requires current services to be prioritised, identifying those considered least important or which could be scaled back.

2.1.7. Outline present and future pressures driving demand for services.

- This should include:
 1. Demographic pressures, market factors, changed government policy, cross-sector objectives, future settlement development plans and the effect of changed service delivery by other agencies.
 2. New standards and changed operating environments.
 3. Demands for higher levels of assets where the asset is

confused with the services delivered, e.g., police stations rather than policing etc.

- Details of these pressures and when they are likely to occur allows DIPNR to predict future trigger points for investment and Treasury to better understand the basis for that future investment.

2.1.8. Clearly define and quantify each of the changed services the agency plans to deliver based on delivering enhanced levels of service. Identify links to the result(s) each will support.

- Include sufficient details of the services to enable details of the assets required, to be determined elsewhere in the Asset Strategy.
- Agencies should not commit undue expenditure on detailed planning of such proposals for enhanced service delivery, until invited to submit specific proposals. Early discussion about such proposals with Treasury is important to avoid wasted effort.

2.1.9. List the performance indicators established for each service.

- Performance indicators could relate to the service overall or to significant aspects.
- There should be few enough indicators to be manageable but sufficient to show the effectiveness of the service delivery.

2.1.10. Outline cross-agency and cross-cluster joint service delivery and asset sharing options, either considered or proposed.

- Outline alternative means of achieving the results sought by the agency.
- Outline service delivery options that have been explored with other agencies. Outline the advantages and disadvantages of these options for each agency.

2.1.11. Outline alternative, less asset dependent service delivery options, either considered or proposed.

- Outline any additional non asset resources such as staff, that would be required for these options to be effective and the overall advantage and disadvantage.

2.1.12. Outline options, considered or proposed, to deliver different services or changed service levels that achieve results more economically.

- Outline the advantages and disadvantages of these options including the impacts on stakeholders including other agencies.

2.1.13. Indicate the range in total resources predicted to be available annually from the Budget, over the next ten years.

- Planning of results and services is of necessity iterative. While driven by community need and government direction, it also considers the resources available, in setting service levels that can be sustained in the longer term.
- Future resources may vary for reasons beyond an agency's control.
- Canvass such risk, its extent and likelihood here. Outline the measures to manage these potential risks here and detail them at item 4.
- Discuss the range in future Budget allocations likely to be available to the agency with NSW Treasury.

2.1.14. Indicate the resource range predicted to be available from other sources over the next ten years.

- Include funding from all sources including Commonwealth allocations.
- Outline the certainty of this funding and measures to manage these risks. Detail risk management strategies at item 4.

2.1.15. Estimate the percentage of these resources that the agency will spend on provision, maintenance and operation of its asset base.

- Agencies are required to support a range of resources to ensure delivery of services.
- The amount of funding it expends on its asset base is a function of the total funding available and the agency service delivery strategy which determines what and how services will be delivered, determining the required range of resources.

2.1.16. Outline demand management strategies, either considered or proposed, to keep service levels sustainable within resource limits.

- Outline the current expectations of stakeholders and the means proposed to change this.
- Estimate the impacts of the demand management measures on stakeholders and on the results the agency is pursuing.

2.2 ASSET STRATEGIES DEVELOPED

2.2.1. Outline the asset performance criteria required to deliver agreed services.

- Having established details of the services being delivered, determine details of the way in which the assets must perform.
- This could include their capacity, location, fitness for their service role, required service life and adaptability.
- The number of criteria selected should be the minimum necessary for efficient and effective service delivery.

2.2.2. Outline how the required asset performance was established.

- This information indicates the rigorous process which determined asset performances and performance levels.
- Show how the asset performance decisions relate to both service delivery levels and to the environment in which the assets must operate.
- For example specified levels of asset reliability or security may be vital in some assets for service delivery while in others aesthetics, privacy or air quality may be vital.
- Show how the required performance levels are used to assess gaps between existing and required assets.

2.2.3. Outline the agency's level of knowledge of its asset base, the basis on which the asset base was segmented, and the analysis of the asset base involved in developing the Asset Strategy.

- Provide evidence of the asset detail that is maintained by the agency and the information systems used to manage that data.
- Advise on what basis assets are segmented or grouped for more effective management.
- Advise how the agency acquires and updates knowledge of its asset base.

2.2.4. Detail each asset strategy and the service(s) it supports.

- Include all high level strategies affecting the asset base.
- Strategies are usually developed separately for each major asset type, group or segment.
- Several strategies may apply to the one group of assets.
- Examples of high level asset strategies include planning appropriate maintenance to ensure asset service lives of 50 years, upgrading security to meet changing risks, accommodating new technologies within particular portfolios, planning use of heritage assets to maximise their service delivery while protecting their cultural values, designing new assets to accommodate regular capacity upgrades or reducing some standards at which low risk assets will be operated.
- Asset Strategies are applied to ensure services can be delivered now and over time.
- Link the services or groups of services to each asset strategy detailed.

2.2.5. Outline the gaps between the agency's existing and required asset base to continue service delivery on a no-change basis. Outline the capital investment, asset maintenance and asset disposal options.

- The gaps identified in the asset base should reflect changes considered necessary to continue delivery of existing service levels.

- Assessments of non asset and less asset based options to close the gap should be included as should proposed changes to service delivery which could impact on asset requirements.
- The iterative nature of all planning requires aspects of service delivery to be reconsidered when addressing gaps in the resources needed to deliver them.

2.2.6. Outline the gaps between the agency's existing and required asset base to provide enhanced service delivery. Outline the additional capital investment asset maintenance and asset disposal options to close the gaps.

- Some agencies may be invited to submit specific proposals for the delivery of higher levels of service, based on Government priorities and factors, including the quality of their asset and overall planning.
- In developing the asset strategy, agencies should not commit extensive effort to planning for enhanced service delivery unless they are invited to submit specific proposals. Rather, they should prepare preliminary assessments of options to enhance service delivery.
- Assessments of non asset and less asset based options to close the gap should be included as should changes to service delivery which could impact on asset requirements.

2.3 Asset performance measures and targets defined

2.3.1. List all asset effectiveness measures kept by the agency.

- Asset effectiveness measures determine the value of the asset in delivering the agency's services. Effectiveness measures allow comparisons between assets and between agencies.
- The measures can be of a discrete asset or of components or aspects of an asset if these are significant to the service delivery.
- Link each of them to the services the asset is used to provide.
- Effectiveness measures link service measures to measures of the assets supporting their delivery.

2.3.2. Compare the effectiveness results obtained over consecutive years. Indicate the conclusions drawn and outline actions to improve effectiveness.

- Compare the effectiveness of the asset base over time and the effectiveness of particular assets or asset classes.
- Improvements may focus on the managing the asset, changes to its operation or changes to other resource strategies or to the services and their delivery.

2.3.3. Document effectiveness targets or benchmarks.

- Effectiveness targets could reflect appropriate targets from

- other jurisdictions or from similar industries.
- Include timeframes for achieving each target.

2.3.4. List all asset efficiency measures kept by the agency.

- Asset efficiency is the measure of how economic of means the asset is in supporting the delivery of services.
- It could include measures of the asset's operation, how fully it is used or the amount of energy, staffing or other support it requires to deliver service.

2.3.5. Compare the efficiency results obtained over consecutive years. Indicate the conclusions drawn and outline actions to improve asset efficiency.

- Compare the efficiency of assets over time and of particular assets or asset classes.
- Results should take into account differences between assets that may account for the different measures, e.g., 24 hour operation or greater staff numbers could account for higher energy usage.

2.3.6. Document efficiency targets or benchmarks.

2.3.7. List all asset management efficiency and effectiveness measures and outline actions to improve asset management effort.

- Asset management functional performance measures gauge how well all the aspects of asset management were undertaken.

2.4 Risk management strategies developed and documented

2.4.1. Document the risk management strategies developed for each service delivered.

- Risks to service delivery can come from either the assets supporting its delivery or from failures beyond assets.
- Focus at this item on asset related risks to service delivery.
- Failures can risk current delivery or future delivery.

2.4.2. Outline the planning procedures in place for conducting both formal and informal Risk Management, Economic and Financial Appraisal, and Value Management exercises.

- Provide evidence of when and how these assessment and decision making tools are used in the agency's asset planning process.

2.4.3. Summarise the application of Risk Management, Economic and Financial Appraisal and Value Management studies to each asset strategy.

- Risk management, Economic and Financial Appraisal and Value Management should be appropriately considered for

each asset strategy proposed.

- Include brief summaries of them here. These studies should be extended to project or program specific studies, depending on their size and risk, as their planning progresses.
- They are essential for all proposed major capital works submitted for Budget funding approval and should be included at item 5.

The Integrated Capital Investment, Asset Maintenance and Asset Disposal Strategies

2.5 CAPITAL INVESTMENT STRATEGY DEVELOPED

2.5.1. Detail the gaps in the current asset base required to deliver the services agreed in the Results and Services Plan, based on there being no change in the services being delivered.

- Gaps may be due to changes in the assets' operating environment including changed stakeholder expectations, changed legislation or deterioration of assets over time.
- The level of service delivered however should remain unchanged.

2.5.2. Detail the gaps in the current asset base required to deliver enhanced services.

- Gaps described here will be due to plans to deliver enhanced levels of services.
- As distinct from general planning of alternative asset solutions, agencies should not engage in extensive planning of specific projects unless they are invited to submit specific proposals.

2.5.3. Detail the project objectives required for the assets to effectively deliver services.

- The project objectives translate the service delivery strategy and the asset operating environment into requirements that the project must meet.
- Provide the project objectives for each project or each group of similar projects.

2.5.4. Document the Capital Investment Projects Proposed. Provide project specific information including estimated total project or program cost, project status (major or minor, new work or work in progress), project type (e.g., land acquisition, procurement of assets), commencement and completion dates and projected cash flows. Show links to Asset Maintenance and Asset Disposal Strategies and Information Communication Technology Strategic Plan where applicable.

- Provide detail on each of the works proposed, similar small-

er scale projects, on a program basis.

- Details linking the proposals to the services they support and information supporting funding should already be included elsewhere in this document.

2.6 ASSET MAINTENANCE STRATEGY DEVELOPED

2.6.1. Outline the maintenance resources, internal or external to the agency.

- All resources, including human resources, available to the agency affect the maintenance delivery options that can be considered.
- Other resources affecting maintenance delivery include knowledge of the asset base, administrative, technical and procurement skill levels, management and construction technology and financial resources.

2.6.2. Outline the long term maintenance strategies for each asset type or risk category. (Include operational, strategic and cultural influences affecting the way maintenance is organised and delivered.)

- Include strategies to address urgent, major, programmed, geographically isolated and high risk maintenance. Outline any links between individual strategies.
- Outline any inter agency strategies. Highlight any constraints on maintenance planning and delivery stemming from service delivery pressures, or organisational pressures.
- Examples might include security difficulties in providing maintenance access or retention of certain maintenance capacities on staff to address emergency breakdowns.

2.6.3. Outline the results of assessing asset condition against performance criteria, for assets to continue to deliver service based on no change in the services being delivered.

- This gap between the current assessed standard of the asset base and the standards required should consider the resources available over the life of the asset strategy.
- A gap larger than the financial resources available to address it indicates the agency must review its asset and other resource standards or the levels of service it plans to deliver.
- The gap should not include increased requirements to support the delivery of enhanced services.

2.6.4. Outline the results of assessing asset condition against performance criteria, for assets to deliver enhanced service.

- Gaps described here will be due to plans to deliver enhanced levels of services.
- As distinct from general planning of alternative asset maintenance solutions, agencies should not engage in extensive

planning of such programs unless they are invited to submit specific proposals.

2.6.5. Document the Asset Maintenance Works

Proposed. Provide a prioritised, costed program of proposed works for the forthcoming year and longer term budget projections.

- Details linking the proposals to the services they support and information supporting funding should already be included elsewhere in this document.

2.7 ASSET DISPOSAL STRATEGY

2.7.1. Identify assets assessed as surplus to service delivery requirements for disposal.

- Include all assets no longer supporting service delivery or which are likely in the future not to support service delivery, due either to deterioration of the asset or changed service requirements.
- Detailed property disposal plans are required for all real property assets in accordance with details provided in the TAM Manual and Asset Disposal Strategic Planning guideline.
- Treasury assesses these plans and provides advice on overall disposal strategies to the Government Asset Management Committee.
- Consider all disposals over the full timeframe of the asset strategy.

2.7.2. Identify opportunities to maximise disposal values.

- Include both agency and interagency opportunities.

2.7.3. Document the Asset Disposal Strategy. Provide a costed program of disposals for the forthcoming year and over the longer term. Show links to the Asset Maintenance Strategy.

- The program should include any expenditure required to plan and achieve the disposals.



Office of International Programs

FHWA/US DOT (HPIP)
400 Seventh Street, SW
Washington, DC 20590

Tel: (202) 366-9636

Fax: (202) 366-9626

international@fhwa.dot.gov

www.international.fhwa.dot.gov

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