

FINDINGS FROM AN INTERNATIONAL STUDY ON MANAGING PAVEMENTS, MONITORING PERFORMANCE

Kathryn A. Zimmerman, Applied Pavement Technology, Inc. (Corresponding author) 115 W. Main Street, #400, Urbana, IL 61801 USA kzimmerman@appliedpavement.com

Julius B. Wlaschin, Federal Highway Administration 1200 New Jersey Ave., SE, HIAM-1, Room E75-115, Washington, DC 20590 USA Butch.Wlaschin@dot.gov

Richard M. Tetreault, Vermont Agency of Transportation 1 National Life Drive, Montpelier, VT 05601 USA Richard.Tetreault@state.vt.us

ABSTRACT

Agencies in the United States and around the world are dealing with the challenges associated with managing their pavement assets as construction costs and traffic demands increase and pavement conditions and funding for improvements tends to decrease. At the same time, politicians, the public, and transportation decision makers are demanding increased transparency in agency decisions.

A number of agencies have recognized the benefits associated with performance-based management as a strategy for preserving assets under constrained conditions. The adoption of these practices in public agencies in the U.S. has been slow, due to disconnects between actual infrastructure performance (conditions) and decision-making focused on financial investment in the highway network, particularly when looking at long term economics. In addition, during eras of economic growth, such as the one experienced in the mid 1990s, increasing revenues easily offset rising expenditures, which tended to mask the need to address long term sustainability issues.

Today, the situation is different in the U.S. Some elected officials and policymakers have recognized that past methods for managing infrastructure, and pavements in particular, are unsustainable. Many agencies are finding that unless costs can be reigned in and revenues aligned to realistic performance measures, highways (and pavements as the principal component) are unsustainable at their current level of performance. Performance measurement, monitoring, and ultimately network management are at the focus of these efforts, but successful examples of business practices that link investment decisions to on-the-road performance are virtually unknown in the U.S.

Transportation agencies in selected countries in Europe, Australia, and New Zealand have already faced these challenges and forged policies and programs to effectively deal with rising costs, declining revenues, and increasing demands for mobility and growth. They have developed and fostered a culture to effectively manage pavement assets over the whole life of the asset, often foregoing expansion or capacity improvements. Inherent in this approach is a preserve and maintain approach versus a worst-first approach to managing pavements. To this end, a team of U.S.-based delegates investigated international practices in the following four topic areas:

- Discovering *processes for implementing sustainable performance-based programs* for managing pavements, and the use of pavement condition information and projections to support programs such as pavement preservation, public private partnerships, and safety hazard mitigation.
- Acquiring *effective communication methods for upper management and legislative support*, including effective strategies to secure public and legislative support.
- Developing *agency cultures that support performance based programs*, including identifying effective capacity building programs.
- Identifying *techniques, tools, analyses, and reporting mechanisms that support and encourage performance based management* and optimal use of available resources in transportation agencies.

The delegates traveled to New Zealand, Australia, Sweden, Netherlands, and England in June 2011 to learn more about the practices in these countries. This paper presents the initial findings and recommendations that emerged from the study.

1.0 INTRODUCTION

Numerous publications report that the condition of highway pavements in the United States (U.S.) has declined in recent years (FHWA 2006, FHWA 2008). Rising costs, increasing traffic, expansion, a worst-first approach to selecting capital projects, and the age of our infrastructure have all been cited as reasons for this deterioration.

Performance-based management has been successfully used in industrial and commercial applications in the U.S. and abroad for many years. The adoption of these practices in public agencies in the U.S. has been slow, due to disconnects between actual infrastructure performance (conditions) and decision-making focused on financial investment in the highway network, particularly when looking at long term economics. These disconnects appear to have been related to a lack of quality information, an inability to make meaningful projections linking investments to actual performance (impacting system credibility), and a perception that a “business” approach is not appropriate for public infrastructure. In addition, during eras of economic growth, such as the one experienced in the United States in the mid 1990s, increasing revenues easily offset rising expenditures, which tended to mask the need to address long term sustainable solutions.

Today, the situation in the U.S. is changing. Some elected officials and policymakers have recognized that past methods for managing infrastructure, and pavements in particular, are not sustainable in the long run. Many agencies are finding that unless the costs of constructing and maintaining our pavement infrastructure can be reigned in and the revenues allocated to those activities aligned to realistic performance measures, neither the current level of performance, nor, perhaps, even an acceptable, safe level of performance, are attainable. In fact, the condition of the U.S. transportation system is declining and stakeholders are seeking ways to contain costs, guarantee revenues, and preserve the nation’s transportation system under the increased demands for mobility and economic growth. Performance measurement, monitoring, and ultimately network management are at the focus of these efforts, but successful examples of business practices that link investment decisions to on-the-road performance are virtually unknown in the U.S.

Transportation agencies in selected countries in Europe, Australia, and New Zealand have already faced these challenges and forged policies and programs to effectively deal with rising costs, declining revenues, and increasing demands for mobility and growth. They appear

to have developed and fostered a culture to effectively manage pavements over the whole life of the asset, often foregoing expansion or capacity improvements, when forced to make a decision between those capital programs and preservation and maintenance.

In order to learn how others have successfully addressed these challenges, and how those practices could be adapted and implanted in the United States, a group of nine US-based delegates undertook an international study to look at the following four topic areas:

- Processes for implementing sustainable performance-based programs for managing pavements, and the use of pavement condition information and projections to support programs such as pavement preservation, public private partnerships, and safety hazard mitigation. This may include the use of financial and other incentives for linking pavement budgeting decisions to cost effective management practices over the life cycle of the pavement.
- Effective communication methods for upper management and legislative support, including effective strategies to secure public and legislative support.
- Agency cultures that support performance-based programs, including identifying effective capacity-building programs. This includes strategies for addressing organizational or institutional issues to ensure that a decentralized organization works toward specific performance targets established for the entire network.
- Techniques, tools, analyses, and reporting mechanisms that support and encourage performance-based management and optimal use of available resources in transportation agencies.

The delegates included three representatives from the Federal Highway Administration (FHWA), four representatives from state highway agencies, one representative from a local technical transfer office at a university, and one representative from private industry who served as the report facilitator.

1.1 Agencies Visited

The transportation agencies and industry representatives selected for further study had demonstrated the use of sound management principles and philosophies for managing their road (and other) assets. Even though the participants represented agencies that ranged in size and population, they each had implemented systematic processes for preserving and managing their road networks in response to external pressure to improve government efficiency and increase customer satisfaction, even during periods of tightened budgets. Without exception, each transportation agency outsourced 100 percent its road maintenance and restoration activities in response to the external pressure. Most were also incorporating a service-based approach that focused on stakeholder expectations into their road management practices.

The delegates traveled to New Zealand, Australia, Sweden, Netherlands, and England where they met with representatives from the agencies shown in table 1.

Table 1: Agencies participating in the study.

New Zealand	Australia	Sweden	Netherlands	England
<ul style="list-style-type: none"> • New Zealand Transport Agency 	<ul style="list-style-type: none"> • Institute of Public Works Engineering Australia (IPWEA) (Sydney, Australia) • Roads Corporation of Victoria (VicRoads) (Australia) • Government of South Australia, Department of Planning, Transport, & Infrastructure (Adelaide, South Australia) 	<ul style="list-style-type: none"> • Swedish Transport Administration (Sweden) • Finnish Transport Agency (Finland) • Danish Road Directorate (Denmark) • Norwegian Public Roads Authority (Norway) 	<ul style="list-style-type: none"> • Road Traffic and Transport Authority (RDW) (Netherlands) • The Institute for Transport Sciences (Hungary) 	<ul style="list-style-type: none"> • Highways Agency (United Kingdom) • Transport for London (London, England) • Transport Scotland (Scotland) • Transport Research Laboratory (TRL) (United Kingdom)

A separate visit to Adelaide, South Australia was cancelled due to air travel disruptions related to volcanic activity in Chile. However, information from the Government of South Australia’s Department of Planning, Transport and Infrastructure was submitted to the team electronically and a webconference was conducted in June 2012 to discuss their practices.

1.2 Pavement Management Perspective and Terminology

Although the focus of the study was on pavement management policies and practices, some of the agencies visited conduct pavement management within an asset management framework that considers factors such as strategic fit, effectiveness, efficiency, and risk in determining levels of investment for each asset for which they are responsible.¹ These agencies operate within a culture in which the long-term implications of their decisions are understood and communicated to decision-makers using strategic performance measures that are linked to tactical decisions. While the focus of the findings and recommendations is on the use of asset management principles and tools for managing pavements, it is understood that the same concepts have also been applied successfully to other transportation infrastructure assets.

These asset management principles and practices are integral to the development of the strategic goals and performance targets within these agencies. From that perspective, the practices identified during the study are similar to the performance management functions that have been defined in the U.S.

The delegates also identified differences in the terminology used in the U.S. and abroad. For instance, transportation agencies in the U.S. commonly refer to pavement preservation as planned treatments that are applied to pavements in relatively good condition to restore or preserve their functional condition. In the countries visited, representatives referred to these types of non-capital activities as maintenance and renewal treatments. Capital improvements were often funded differently than maintenance and renewal activities and were not a major focus of the study. Other differences in terminology are clarified within the report as necessary.

¹ These assets include roads, waterways, rail, and other assets

2.0 KEY FINDINGS

The economic situation currently facing the U.S. is similar to the economic situations that many of the countries visited during the study faced a number of years ago. These agencies, which were under pressure to improve government efficiency, responded by implementing systematic processes for maintaining the existing road network that emphasized reducing total maintenance and renewal costs over the life of pavement, managing future investment requirements, and minimizing agency risk. Although most of these agencies continue to face declining budgets, they have clearly defined priorities and investment strategies that have been accepted by stakeholders. The stakeholders also understand and accept the resulting impact of these decisions on the condition of the pavement network.

The timing of the study proved to be extremely beneficial to the participants, since many state highway agencies (SHA) in the U.S. are facing conditions similar to those in the countries visited. The facilitated conversations provided an opportunity for the study participants to learn from agencies that had already experienced difficult financial situations and had emerged from those situations with strong support for road maintenance and renewal among agency leadership, elected officials, and the general public. The lessons learned from the technology exchange with these individuals led to six key findings, which are listed below and expanded further in the paper:

1. Agency culture supports a long-term view towards managing pavements.
2. Elected officials understand their responsibilities as stewards of public funds.
3. The road network is managed as a service provided to the traveling public.
4. Agency priorities are known and agency personnel are held accountable for their actions.
5. Agencies recognize the importance of building internal capacity and capabilities.
6. Efficiency and value have driven program delivery approaches.

The study team noted that although the focus of the study was on pavement management, many of the findings relate to the broad application of a systematic process for managing pavements and other transportation assets under constrained conditions. Therefore, the findings from the study are equally applicable to pavement management and asset management practitioners, as well as other transportation officials who are striving to obtain the greatest value possible for the funding levels available.

2.1 Culture Supports A Long-Term View Towards Managing Pavements

As in the United States, many of the transportation agencies included in the study are facing outside pressure to be more efficient even as customer expectations increase and available funding decreases. In response to these pressures, several agencies have implemented systematic processes for maintaining their road network, improving customer service, and maximizing the value they receive for each dollar spent. These systematic processes focus on decisions that support a long-term vision for a sustainable pavement management program. The resulting framework is driven by an assessment of the whole life costs of preserving the value of the road assets and documenting the information in a long-term financial plan. In several of the countries visited, agencies either fund the depreciation in the road network each year or they are forced to account for the unfunded liability. Project priorities for road maintenance and renewal were found to be based primarily on reducing agency risk and liability. There was also evidence of multi-year financial plans to manage the road network that provide flexibility in moving funding

from one year to another year and stability since the plans cannot easily be changed once they have been approved. Evidence of these findings include the following examples (FHWA 2012)

- In Australia, three of the six Australian states have mandated that local governments use 10-year financial plans.
- In Melbourne, VicRoads is temporarily focusing on maintaining the local road network to reduce the risks associated with the deterioration of those pavements.
- Local authority councils in Australia are required to establish levels of road renewal that keep pace with the rate at which roads deteriorate.
- “Value for Money” is a common policy theme for the UK Highways Agency, Transport for London, and Transport Scotland.
- The Finnish Transport Agency has shifted from annual performance targets to 4-year performance targets. This has helped regions shift towards longer-term solutions.

2.2 Elected Officials Understand Their Responsibilities As Stewards of Public Funds

In some of the countries visited, especially in Australia, there was a strong use of long-term financial plans at the local level. These financial plans outline the strategies that will be used to effectively manage the road network and to communicate risk and deferred liabilities for any underfunded maintenance and renewal activities. The long-term financial plans are developed collaboratively with government officials, who are held accountable for their use of public funds. As fiscal stewards, these individuals are responsible for the long-term viability and sustainability of the investment programs. In several of the agencies that met with the study team, there was evidence that government officials understand and honor their fiduciary responsibilities, which has enabled transportation agencies to adopt programs that support their long-term objectives. Examples of how elected officials have become fiscal stewards, and how they honor this role, are provided (FHWA 2012).

- Government spending in Scotland and England is audited by independent commissions made up of economists, engineers, and other professionals. The primary focus of the commissions is to see that government is getting the best value for its funding.
- The long-term financial plans used by local governments in Australia provide elected officials with information about liabilities for unfunded road maintenance and renewal activities (IPWEA 2011a).
- At VicRoads, maintenance costs for the next 30 years are incorporated into the calculation of whole life costs when financing new projects.

2.3 The Road Network Is Managed As A Service Provided To The Traveling Public

The agencies that participated in the study are moving towards a service-based approach for managing their road network rather than a condition-based approach. Under this service-based approach, customer-driven priorities, such as safety, reliability of travel, comfort, and livability are becoming the primary drivers for road maintenance and renewal actions. This change in philosophy is more meaningful than merely reporting on condition-based performance metrics. Rather, the change has influenced the types of data that are collected and the performance targets used to drive the maintenance and renewal program. The New Zealand Transport Agency

compared the philosophy to managing a utility. For instance, under the more traditional model, a road may not have been available to carry an unusually heavy load due to existing road conditions. Under a service approach, the agency considers it their responsibility to find a way for the heavy vehicle to be able to use the facility, representing a major shift in their philosophy and the way they approach programming decisions. The following list includes other examples of how this shift has impacted programs in other agencies (FHWA 2012):

- The emphasis areas being used by the UK Highway Agency are highway availability and reliability and not just pavement condition.
- The Road Traffic and Transport Authority in the Netherlands develop Service Level Agreements (SLAs) between the Asset Owner and the Asset Manager. In the past, these SLAs have been based primarily on pavement condition indicators, but they are developing new metrics for highway availability and reliability, which better dovetail with higher level policy issues.
- VicRoads is relating the physical condition of the road with factors that represent how the community uses the road, so there is more of a link between road conditions and user needs.
- Transport for London considers risk, customer satisfaction, and cost as the three factors that must be considered to provide an acceptable level of service.
- The New Zealand Transport Agency has recognized that staff tend to focus on urgent needs at the cost of the long-term strategic needs identified by the agency. Therefore, the agency is focusing on developing two separate asset management positions, with one position focusing on the important strategic initiatives of the organization and the other position focusing on urgent needs.

2.4 Agency Priorities Are Known and Agency Personnel Are Held Accountable For Their Actions

As in the United States, most of the agencies participating in the study are facing significant budget constraints and increasing demands to improve agency efficiency. In response, many of these agencies have established clear priorities that place an emphasis on service levels, while assessing the various options based on strategic fit, effectiveness, efficiency, and risk. As a result, these agencies have placed the highest priority on the maintenance and renewal of the existing highway network rather than spend limited dollars on capital enhancements. In some cases, as in England, the opportunities for expansion are limited because of space constraints. This places even more importance on the highway agency's emphasis on asset management as a way to maintain the value of the existing road network. To help ensure the implementation of asset management programs, many of these agencies have established methods for holding agency personnel and contractors responsible for their actions through audits and contractual agreements. The following examples illustrate these points (FHWA 2012):

- At VicRoads, safety issues are currently the highest priority, followed by strategies for keeping the moisture out of the pavement. Other priorities, such as reducing roughness and minimizing user costs, are deferred until more funds become available.
- The Chief Executive Officer of the UK Highways Agency is responsible for ensuring that funds are used properly and for reporting to Parliament in terms of the outcomes achieved for the funding levels spent. Agency priorities are agreed upon by the Secretary of State for Transport.

- The Finnish Transport Agency provides incentives to Region personnel for meeting standards. For example, if a region meets its condition targets all workers in the region receive merit pay increases of 2 to 3 percent on annual salaries.
- The Road Traffic and Transport Authority in the Netherlands has clearly defined roles for all individuals involved in asset management. For instance, the Asset Owner is responsible for the future of the network, focusing on strategic issues associated with setting performance targets, risk levels, and investment levels.
- In an effort to improve the transparency of the agency, the Danish Road Directorate carefully tracks each pavement rehabilitation project to ensure it is being managed effectively and any deviations from the plan greater than 10 percent in cost have to be explained to elected officials.
- Outside audits are another important way to hold individuals and/or agencies accountable for their actions. In both Scotland and England, for example, outside audits are used to keep public officials and maintenance operators accountable.

2.5 Agencies Recognize the Importance of Building Internal Capacity and Capabilities

The agencies that have successfully navigated a paradigm shift in the way road networks are managed have fostered a culture in which road maintenance and renewal costs are known and the long-term implications of decisions are understood and communicated by decision makers at various levels. As a result, these agencies have more mature asset management programs, as evidenced by the branding of asset management in the Netherlands to align the organization.

Without exception, the agencies that participated in the study have committed to building and retaining internal capacity in asset management. As a result, there was evidence of a strong investment in the asset management capabilities of their staff. In some cases, internal capacity building was focused on regaining some of the internal capabilities that had been lost when maintenance and renewal activities were contracted out. However, there is now a sense of urgency in replacing the competencies that were lost and building new capabilities that allow agency personnel to act as “smart buyers” of future maintenance and renewal services.

Examples of how these agencies are building internal capacity and capabilities include the following (FHWA 2012):

- Transport for London reports that Senior Management understands that Asset Management is the key to delivering the agency’s strategic objectives. They have found that investing time and effort early in the implementation process reduces resource needs later in the process.
- The UK Highways Agency regularly benchmarks its practices with other countries as a method to improve their practices.
- Due to the difficulty in modeling pavement performance, the New Zealand Transport Agency has established 63 long-term pavement performance (LTPP) sites on state highways and 91 on local authority roads. These sites are used both to establish and calibrate performance models and to calibrate their data collection vehicle.
- As shown in Figure 1, the branding of asset management by the Road Traffic and Transport Authority in the Netherlands uses a yellow line as a symbol to connect asset management with pavement management as well as the management of bridges, traffic equipment, and people (including engineers, contractors, and management). Their implementation strategy has moved from “thinking” to “getting things done” by making

regional offices responsible for maintenance and renewal activities and the central office responsible for the development of appropriate standards and policies; all of which is done in partnership with Agency stakeholders. Training is a high priority for the agency because a “loss of technical knowledge can lead to diminished organizational capabilities and less technical quality with time.”

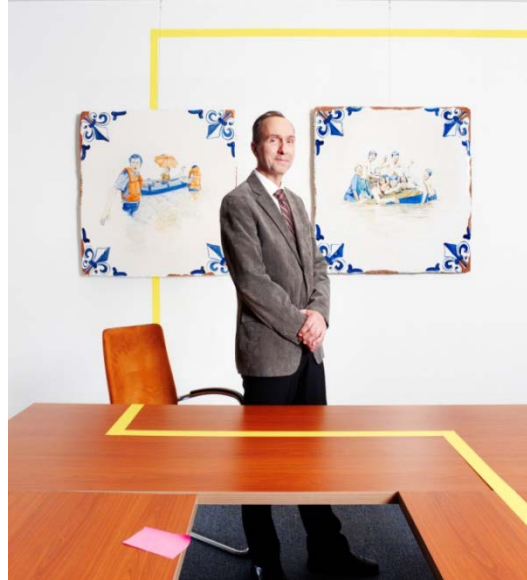


Figure 1: An illustration of the yellow line used to brand asset management in the Netherlands (Road Traffic and Transport Authority 2011).

- Succession planning has become an important component to attracting and retaining a sustainable workforce in many of the agencies visited. The New Zealand Transport Agency, for example, recognizes that the skills required to be an Asset Manager are different than the skills required for a more traditional engineer, with more of a focus on strategic planning, risk, financial management, and performance management.
- The IPWEA has identified three fundamentals for establishing a sustainable asset management program: work within a national framework, provide the tools required, and add drivers to motivate people to use the tools. As a result, the IPWEA has taken the lead in Australia of developing a uniform set of templates and tools that are used by many local agencies within the country, as shown in figure 2 (IPWEA 2011b).

2.6 Efficiency and Value Have Driven Program Delivery Approaches

Each of the participating agencies contracts out 100 percent of its pavement maintenance and renewal activities. According to the information provided by the participants, the privatization of these activities was initiated in response to pressure for improvements in efficiency during times with limited funding with a focus on maximizing the value received for each expenditure made. Over time, as agencies have gained valuable experience with these types of contracts, there have been several innovative approaches to managing privatized contracts, as the following examples show (FHWA 2012):

- In addition to outsourcing maintenance and renewal activities, Transport Scotland also outsources audit and performance assurance services, the latter of which evaluates each of the four regional maintenance contracts.

- VicRoads has established teams of internal providers who compete with private industry for maintenance contracts with no support from VicRoads.
- For the most part, local agencies in Australia are using the tools and templates provided by the IPWEA for developing their asset management plans and long-term financial plans. The consistency in the definition of asset management and the techniques and tools used has significantly contributed to improved efficiencies in the country.



Figure 2: Tools and templates developed and distributed by IPWEA (IPWEA 2011b).

3.0 IMPLEMENTATION STRATEGIES

The study team included representatives from federal, state, and local agencies to help foster the implementation of the study findings into the practices of transportation agencies throughout the U.S. The representatives from the FHWA and the SHAs have identified strategies that can be implemented through FHWA programs, the National Cooperative Highway Research Program (NCHRP), and/or state initiatives. The local agency representative will work with the FHWA’s Local Technical Assistance Program (LTAP) to help foster the adoption of the key findings at the city and county level.

Based on the findings from the international study, the delegates identified the following implementation strategies to foster the use of systematic processes for managing pavements that support performance-based decisions to improve serviceability, accountability, and stewardship in the U.S.:

- Foster the use of asset management plans and long-term financial plans to support pavement maintenance and renewal activities. Use the tools and templates available through the IPWEA to pilot the tools at the state and local levels and share the results with practitioners at each level.
- Based on the results of the pilot, establish a strategic plan for providing the framework, tools, and drivers that may be needed to support effective pavement management at the federal, state, and local levels. As part of this process, promote consistent definitions of pavement and asset management terms.
- Support the paradigm shift from managing pavements based on condition to a service-based approach. Identify Key Performance Indicators (KPIs) that will help facilitate this shift.
- Support changes to current program funding and delivery mechanisms to better support multi-year obligations tied to KPIs. This may include block grants for maintenance and renewal expenditures, multi-year budgets, restrictions on changes to programs without community input, and public-private partnerships. Establish pilot programs to demonstrate the effectiveness of these changes.
- Explore the use of independent performance audits as a way to improve agency efficiency, to foster fiscal stewardship by elected officials, and to help ensure that long-term financial strategies are implemented.
- Develop core competencies and job descriptions for asset managers and identify strategies to build these core competencies within transportation agencies.
- Recommend improvements to current pavement management practices. For instance, promote the use of surface texture information to establish safety intervention guidelines that can be incorporated into pavement management system. Also promote the use of test sites to develop pavement performance models and/or to evaluate the effectiveness of separate mix designs on truck lane, passing lanes, and shoulders.
- Establish mechanisms for communicating the findings and recommendations from this study and integrating them into day-to-day practice in state and local highway agencies.
- Support the use of asset management to drive the consideration of value in the use of public funds.

4.0 CONCLUSION

A group of nine U.S.-based delegates undertook a study tour to investigate the strategies that have been used internationally by transportation agencies that have faced fiscal challenges and have forged policies and programs to effectively deal with rising costs, declining revenues, and increasing demands for mobility and growth. The organizations selected for the study have developed and fostered organizational cultures that effectively manage pavement assets over the whole life of the asset, often foregoing expansion or capacity improvements. These agencies, which were under pressure to improve government efficiency, responded by implementing systematic processes for maintaining the existing road network that emphasized reducing total maintenance and renewal costs over the life of pavement, managing future investment requirements, and minimizing agency risk. Although most of these agencies continue to face declining budgets, they have clearly defined priorities and investment strategies that have been accepted by stakeholders. The stakeholders also understand and accept the resulting impact of these decisions on the condition of the pavement network.

This paper summarizes the findings from the study tour and outlines the steps that the delegates will take to foster the increased use of systematic processes for managing pavements that support performance-based decisions to improve serviceability, accountability, and stewardship in the U.S.

5.0 REFERENCES

Federal Highway Administration. 2006. *Status of the Nation's Highways, Bridges and Transit*. Federal Highway Administration, Washington, DC.

Federal Highway Administration. 2008. *The Road Information Project: Key Facts About America's Road and Bridge Conditions and Federal Funding*. Federal Highway Administration, Washington, DC.

Federal Highway Administration. 2012. *Managing Pavements, Monitoring Performance: Investigating the Practices in Agencies and Associates in New Zealand, Australia, Sweden, Norway, Finland, Denmark, The Netherlands, Hungary, England, and Scotland*. Federal Highway Administration, Washington, DC.

Institute of Public Works Engineering Australia (IPWEA). 2011a. *Australian Infrastructure Financial Management Guidelines*. Institute of Public Works Engineering Australia, Sydney, Australia.

Institute of Public Works Engineering Australia (IPWEA). 2011b. Presentation made by Mr. Chris Champion to the International Scan Tour Group, June 2011.

Road Traffic and Transport Authority. 2011. Presentation made to the International Scan Tour Group, June 2011.