PAVEMENT MANAGEMENT ROADMAP

Executive Summary

U.S. Department of Transportation
Federal Highway Administration

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16. Abstract

The Federal Highway Administration (FHWA) sponsored the development of a Pavement Management Roadmap to help identify the steps needed to address current gaps in pavement management and to establish research and development initiatives and priorities. This is the executive summary of the final report entitled *Pavement Management Roadmap* (FHWA-HIF-11-011). This document presents an overview of the 10-year Pavement Management Roadmap, which can be used to guide new research, development, and technology transfer opportunities that will lead to improved approaches to pavement management.

The roadmap was intented from the beginning to be a collaborative process that would involve representatives from each of the various stakeholder groups that either use pavement management data, support the use of pavement management concepts, or provide technical assistance or training to current or future pavement management practitioners. The contents of this roadmap were derived from a series of stakeholder workshops in which representatives from state and local agencies, academia, private industry (including data collection and software vendors), FHWA, and others met to discuss and prioritize the needs of pavement management professionals. The resulting needs were organized and grouped into one of the following four themes that emerged from the process: Theme 1: Use of Existing Tools and Technology; Theme 2: Institutional and Organizational Issues; Theme 3: The Broad Role of Pavement Management; and Theme 4: New Tools, Methodologies, and Technology.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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Introduction

Over the last few decades, transportation agencies have seen tremendous changes in the way business is conducted. For example, since the construction of the interstate highway system, there has been an increased emphasis on performance monitoring and the use of pavement management data to assist with planning and programming for maintenance activities and capital improvements. Additionally, the methods used to assess pavement condition have evolved in conjunction with other technological advancements so that automated procedures are more commonly being utilized than in the past. Moreover, advancements in computer capabilities and their availability have resulted in a plethora of new tools for designing, analyzing, and managing pavements. Most recently, this has led to the development of new mechanistic-empirical pavement design procedures with significantly larger and more diverse data requirements than have been previously used.

In addition to technological changes, transportation agencies have seen adjustments in the way decisions are being made. Within the past 10 years, there has been an increasing emphasis on asset management principles for resource allocation and utilization decisions that are based on system performance objectives. Under an asset management framework, investment decisions consider the trade-offs associated with different strategies and agencies strive to align tactical improvement programs with their strategic priorities. With asset management there is an increased focus on customer expectations and transparency in the decision process. The availability of quality data has a tremendous impact on an agency's ability to compare different investment options and to make sound business decisions that consider both engineering and economic factors.

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Unfortunately, decreases in the purchasing power of available funding, coupled with reduced funding levels, have led to deteriorating network conditions within most transportation agencies at the same time that demand for these facilities is increasing. As a result, many transportation agencies are shifting their priorities from a focus on system expansion to an increasing focus on system preservation. In fact, a number of agencies have recognized the cost-effectiveness associated with the use of preventive maintenance treatments to slow the rate of deterioration and to postpone the need for the most costly rehabilitation strategies. However, the shift towards pavement preservation has not been entirely free from problems. For example, organizations that had previously separated the maintenance and capital improvement decision processes have had to overcome institutional barriers in order to develop effective improvement programs that include preventive maintenance treatments.

As a result of these and other changes impacting transportation agencies, the role of pavement management is changing. In the past, pavement management was primarily considered to be used for assessing and reporting pavement conditions, prioritizing capital improvements, and estimating funding needs. Today, pavement management has the potential to fulfill a much broader (and more significant) role within a transportation agency. In addition to the more traditional roles it serves, pavement management can support an agency's asset management practices by supporting the

development of strategic performance objectives for the highway system. It can also provide a link to maintenance and operations through the analysis of pavement preservation options. And it can provide the pavement performance data required to evaluate and calibrate the mechanistic-based performance models for use within a specific transportation agency.

The successful transition of pavement management into these areas depends on the availability and accessibility of quality data to support an agency's decision processes. Unfortunately, there are a number of agencies that are currently not fully utilizing their pavement management system to support these types of decisions. Therefore, several immediate issues must be addressed to overcome these hurdles and to prepare pavement management for its broader role in the future. Some of the more immediate needs that might be considered are listed below:

- Providing access to integrated, quality data.
- Adapting existing analysis tools.
- Communicating pavement management results.
- Integrating pavement management into the decision process.

The Federal Highway Administration (FHWA) sponsored the development of a Pavement Management Roadmap to help identify the steps needed to address current gaps in pavement management and to establish research and development initiatives and priorities. This document presents a 10-year Pavement Management Roadmap that can be used to guide new research, development, and technology transfer opportunities that will lead to improved approaches to pavement management. This Roadmap can substantially improve current practices by identifying the existing gaps and needs in pavement management.

The Development Process

From the beginning, the FHWA intended the development of the Roadmap to be a collaborative process, involving representatives from each of the various stakeholder groups that either use pavement management data, support the use of pavement management concepts, or provide technical assistance or training to current or future pavement management practitioners.

Representatives from several stakeholder groups were invited to participate in one of three regional workshops held in Phoenix, Arizona; Dallas, Texas; and McLean, Virginia. The stakeholder groups that were invited to participate, and the targeted number of representatives from each stakeholder group at each workshop, are listed below:

- State highway agencies (SHA): 21 to 25 participants.
- Local agencies/technology transfer centers/Metropolitan Planning Organizations (MPOs): 2 to 3 participants.
- Academia: 2 to 3 participants.
- Private Industry (including data collection and software vendors): 3 to 5 participants.
- FHWA: 4 participants.

A total of 87 participants accepted invitations to participate and were able to attend one of the three workshops. In addition to FHWA, the participants represented thirty-one SHAs, seven other government agencies (i.e., cities, counties, and Canadian government agencies), thirteen private contractors, and six academic agencies. Each workshop included breakout groups that provided an

opportunity for the participants to exchange information on a peer-to-peer basis and to collaborate on the identification of research and development needs in this area. A Technical Panel consisting of pavement management practitioners from FHWA, SHA, and academia provided technical guidance throughout the development of the Roadmap.

The primary objective of the workshops was to identify research and workforce development needs within ten pre-established focus areas. These focus areas were identified through a literature search and represented topics that have been identified as subjects important to the pavement management community. During the process of combining and re-arranging needs statements, it became evident that many of the needs statements impacted more than one of the ten focus areas. As a result, it no longer seemed practical to tie the final needs statements to the original focus area topics. Instead, the resulting needs were organized and grouped into one of the following four themes that emerged from the process:

- Theme 1: Use of Existing Tools and Technology.
- Theme 2: Institutional and Organizational Issues.
- Theme 3: The Broad Role of Pavement Management.
- Theme 4: New Tools, Methodologies, and Technology.

The final list of needs was presented to the workshop participants during a webconference, which introduced the four theme areas and the balloting process that would be used to rank the needs in terms of importance. Using an online balloting tool, individuals who had attended the workshops were invited to vote on the relative importance of each of the research needs. In addition, participants were asked to rank both the short-term and long-term needs within each theme area. A process was developed for combining the relative importance of each need statement with the rankings assigned by the participants, which resulted in the final prioritized listing of short-term and long-term needs included in the Pavement Management Roadmap. In addition, by having ranked the needs statements within each theme area separately, the highest priorities within each theme, as well as their overall importance across themes, could be produced.

Final Roadmap and Funding Requirements

The Vision for Pavement Management

The successful adoption of the Pavement Management Roadmap is expected to lead to the increased use, and improved applicability, of pavement management by eliminating the barriers or gaps that limit its effectiveness or hinder its acceptance within an agency. Through comprehensive and coordinated efforts to address both the short-term (i.e., less than 5 years) and long-term (i.e., 5 to 10 years) research, development, technology, and workforce development activities identified in this Roadmap, practitioners can foresee the following vision of pavement management in the year 2020.

The Vision for Pavement Management in 2020

Pavement management will make use of a new generation of technology so agencies are less dependent on manual labor for data collection. Pavement management tools will allow agencies to communicate effectively with stakeholders, using clear statements that are tied to agency goals and pavement worth. Within an asset management framework, pavement management will be used for investigating decisions and program options in both private and public sectors. A pavement management analysis will consider new materials and construction/design practices, as well as other factors that influence project and treatment selection, including safety, congestion, and sustainability. As a result of these changes, pavement management will be robust, comprehensive, and credible, and will address agency needs at the project, network, and strategic levels.

Funding Needs

The Pavement Management Roadmap prioritizes the order in which these activities should be addressed, based on the importance and priority rankings provided by the participants. As such, the prioritized list of short-term and long-term needs represents the urgency with which the participating pavement management stakeholders would address these activities.

In total, the suggested initiatives represent over $14.5 million in funding, with approximately $6.5 million representing short-term needs over the next 5 years and $8 million representing long-term needs to be initiated within the next 5 to 10 years. By theme area, the funding is distributed in accordance with the figures shown in table 1.

Tables 2 and 3 present the prioritized listing of recommended needs to address the gaps in pavement management over the next 10 years, ignoring the four theme areas. Table 2 presents the prioritized listing of the short-term needs, and table 3 includes the prioritized listing of long-term needs.

Table 1. Funding Needs by Theme Area.

Theme	Short-Term Needs (< 5 years)		Long-Term Needs (5 to 10 years)		Totals	
	# of Projects	Funding Requirements	# of Projects	Funding Requirements	# of Projects	Funding Requirements
1: Use of Existing Technology and Tools	8	$2,180,000	2	$850,000	10	$3,030,000
2: Institutional and Organizational Issues	5	$880,000	6	$780,000	11	$1,660,000
3: The Broad Role of Pavement Management	5	$1,550,000	5	$1,300,000	10	$2,850,000
4: New Tools, Methodologies, and Technologies	5	$1,930,000	11	$5,100,000	16	$7,030,000
Totals	***23***	***$6,540,000***	***24***	***$8,030,000***	***47***	***$14,570,000***

Table 2. Prioritized Listing of Short-Term Needs.

Priority Ranking	Title	Theme	Score
1	Communicating Pavement Management Information and Benefits	Inst & Org	2.18
2	Development and Use of Effective Performance Measures	Broad Role	2.16
3	Improving the Skills of Pavement Managers	Inst & Org	2.13
4	Development of Automated Condition Data Processing Tools	New Tools	1.85
5	Methods to Quantify the Benefits of Pavement Management	New Tools	1.85
6	Best Practices for Pavement Management	Existing Tools	1.65
7	Development of Pavement Distress Standards	Existing Tools	1.62
8	Development of Improved Methodologies for Evaluating Data Quality	Existing Tools	1.58
9	Improving Factors Considered in Project and Treatment Selection Decisions	New Tools	1.58
10	Establish and Develop Equipment Calibration Centers and Guidelines	Existing Tools	1.55
11	Comprehensive Study to Guide the Integration of Pavement Preservation and Pavement Management	Existing Tools	1.44
12	Pavement Management Data Mining: Improving Current Uses and Leveraging New Applications of Pavement Management Data	Broad Role	1.37
13	Analysis of Trade-Offs Associated with Alternate Methods of Data Collection	New Tools	1.33
14	Load Limit Impacts on Pavement Performance	Broad Role	1.19
15	Developing and Supporting a Pavement Management Business Plan	Broad Role	1.18
16	Use of Pavement Management Information for National Reporting	Broad Role	1.07
17	Annual Approval of SP&R Funding	Inst & Org	0.89
18	Framework for Minimizing the Delivery of Treatment Application	Inst & Org	0.89
19	Independent Technical Assessments of Pavement Management	Existing Tools	0.84
20	Pavement Management Clearinghouse	Existing Tools	0.8
21	Addressing Trade-offs, Metric Issues, and Purchasing Controls/Policies	Inst & Org	0.62
22	Synthesis of External Issues Driving Pavement Management	Existing Tools	0.6
23	Pavement Management in a Changing World	New Tools	0.49

Table 3. Prioritized Listing of Long-Term Needs.

Priority Ranking	Title	Theme	Score
1	Methods of Defining and Calculating the Effect of Pavement Preservation Treatments on Pavement Life	Existing Tools	2.43
2	Impact of Pavement Management Investment Levels on Benefits	Inst & Org	2.26
3	Using Pavement Management Data to Support Design Activities	Broad Role	2.08
4	Performance Models that Consider Series of Treatments	New Tools	1.97
5	Method for Effectively Modeling Structural Condition	New Tools	1.91
6	Methods to Promote Pavement Management as a Management Tool	Inst & Org	1.82
7	Investigation into the Risk, Uncertainty, and Variability in Pavement Management Decisions	Existing Tools	1.45
8	Automation of Surface Texture Characteristics	New Tools	1.4
9	National Funding Allocations That Account for State Priorities	Broad Role	1.33
10	Identifying Strategies for Incorporating Emerging Technologies into the Pavement Management System	New Tools	1.23
11	Identify Data Needs to Support Other Processes	Broad Role	1.2
12	Quantifying the Cost of Pavement Use	New Tools	1.19
13	Recommended Methodology to Calculate Pavement Asset Value and Communicate to Stakeholders	Inst & Org	1.16
14	Methodologies to Reliably Support Innovative Contracting	Broad Role	1.13
15	Develop NDT for Measurement of In-Place Material Properties	New Tools	1.08
16	Suggested Topics for Pavement Management Into the Civil Engineering Curriculum	Inst & Org	1.03
17	Constant Funding for Pavement Management	Inst & Org	0.96
18	Identify IT Needs to Effectively Manage a Pavement Management System	Inst & Org	0.95
19	Quantifying the Benefits of Pavement Research	New Tools	0.78
20	Impact of Earmarks on Pavement Performance	Broad Role	0.7
21	Develop Default Models for Low-Volume Roads	New Tools	0.47
22	Impact of Climate Change on Performance Prediction	New Tools	0.39
23	Development and Integration of Wireless Sensors with PMS	New Tools	0.36
24	Use of Aerial Images for Distress Analysis	New Tools	0.29

Top 10 Short-Term and Long-Term Research, Development, and Technology Transfer Needs by Theme Area

The regional workshops produced a total of twenty-three short-term and twenty-four long-term research, development, and technology transfer needs. The top ten short-term and top ten long-term research, development, and technology transfer needs are described in this section of the executive summary, by theme area.

The short-term needs, which should be addressed within the next 5 years, emphasize the need for improved access to information about best practices and better methods to communicate the importance of pavement management to transportation agencies. Additionally, stakeholders placed an emphasis on improving data quality and consistency.

The long-term needs, which should be addressed within the next 5 to 10 years, include activities that will require research to develop methods to improve existing practices. The highest ranked needs indicate that efforts are needed to define and calculate the impact of pavement preservation treatments, and to determine the impact of different investment levels on pavement management capabilities. Additional efforts address the need to better support pavement design activities with pavement management, including the need to effectively model structural condition and series of treatments over a pavement life cycle.

Theme 1: Use of Existing Technology and Tools

Needs statements included in theme 1 include recommendations for technology and tools that can support traditional pavement management applications. In general, this theme includes technology and tools that are currently available today but are in need of additional review, analysis, dissemination, and/or updating prior to their use.

The needs from this theme that are featured in the top ten list of short-term needs are provided in table 4. A total of $2,180,000 in funding is required to address these needs.

The needs from this theme that are featured in the top ten list of long-term needs are provided in table 5. A total of $850,000 in funding is required to address these needs.

Theme 2: Institutional and Organizational Issues

The theme 2 needs statements presented in this section of the report relate to workforce development, communication, contracting, and organizational structure. The recommendations in this area are intended to address issues that include the impact pavement management on funding and how to determine, promote, and effectively communicate the use and the benefits of pavement management.

The needs from this theme that are featured in the top ten list of short-term needs are provided in table 4. A total of $880,000 in funding is required to address these needs.

The needs from this theme that are featured in the top ten list of long-term needs are provided in table 5. A total of $780,000 in funding is required to address these needs.

Theme 3: The Broad Role of Pavement Management

Theme 3 includes needs statements that go beyond the standard functions of pavement management and include such areas as pavement design, impact of increasing load limits on pavement performance, and asset management.

The needs from this theme that are featured in the top ten list of short-term needs are provided in table 4. A total of $1,550,000 in funding is required to address these needs.

The needs from this theme that are featured in the top ten list of long-term needs are provided in table 5. A total of $1,300,000 in funding is required to address these needs.

Theme 4: New Tools, Methodologies, and Technologies

The problem statements in theme 4 are related to needs for research and development leading to new tools, methods, and technology to support pavement management. In general, needs statements included in this theme address concepts that are not readily available and will require a higher level of research, analysis, and development prior to implementation.

The needs from this theme that are featured in the top ten list of short-term needs are provided in table 4. A total of $1,930,000 in funding is required to address these needs.

The needs from this theme that are featured in the top ten list of long-term needs are provided in table 5. A total of $5,100,000 in funding is required to address these needs.

Table 4. Top 10 Listing of Short-term Needs Statements by Theme.

Theme 1: Use of Existing Technology and Tools		
Needs Statement	Description	Funding
Best Practices for Pavement Management	There is a significant need to assemble and prepare a best practices document for the operational and functional aspects of pavement management. This guide will include a broad range of topics, such as benefits and limitations of data collection equipment and procedures, processes for developing and implementing a linear referencing system and addressing data integration issues, guidelines for developing and updating performance modeling, methods for using pavement management to support agency decisions and allocated funds, and methods for communicating pavement management data to stakeholders.	$500,000
Development of Pavement Distress Standards	This study will identify distress to be measured, review current state practice, compare state procedures to current AASHTO protocols, identify areas not currently covered by an AASHTO protocol, develop preliminary protocols, conduct webinars or workshops to obtain state buy-in, and finalize the protocol for AASHTO balloting.	$350,000
Development of Improved Methodologies for Evaluating Data Quality	This study's objective is to develop a standard methodology that can be applied to a wide range of pavement condition data to assess quality in terms of accuracy and repeatability. The study results will establish data collection guidelines and evaluate the impact of variability. A product will be the development of guidelines to improve data quality in terms of collection, processing, and reporting.	$350,000
Establish and Develop Equipment Calibration Centers and Guidelines	This study will identify potential calibration sites, recommended calibration frequencies, and calibration procedures.	$250,000
Theme 2: Institutional and Organizational Issues		
Needs Statement	Description	Funding
Communicating Pavement Management Information and Benefits	This study will investigate how highway agencies have successfully gained buy-in from decision makers that have led to increased use of pavement management information. The products will include guidelines for making these types of presentations, and a collection of effective presentations that can be used as templates.	$250,000
Improving the Skills of Pavement Managers	This initiative will provide guidance to help agencies evaluate the economic/organizational impacts of workforce development. This study will develop training guides, a web clearinghouse for resources, and information on pavement management careers.	$250,000
Theme 3: The Broad Role of Pavement Management		
Needs Statement	Description	Funding
Development and Use of Effective Performance Measures	Under this study, examples of effective links between strategic and operational performance measures will be conducted, and guidelines on the use of pavement management measures to support strategic initiatives will be developed.	$250,000
Theme 4: New Tools, Methodologies, and Technologies		
Needs Statement	Description	Funding
Development of Automated Condition Data Processing Tools	Improvements to current tools for automating the processing of some measures of pavement evaluation are needed to accelerate the rate which survey results become available and improve the consistency and reliability of the information. Improvements are needed to the processing of surface distress data, GPR, and rutting.	$800,000
Methods to Quantify the Benefits of Pavement Management	This is a synthesis study in which practices in public and private agencies may be explored to determine current practice. The end product is the identification of effective methodologies that can be used to quantify benefits associated with pavement management.	$30,000
Improving Factors Considered in Project and Treatment Selection Decisions	The study must provide guidance for addressing agency challenges that influence the use of this information. The product of this research will be a process for evaluating the decision factors used in the pavement management treatment selection process and guidelines for addressing any existing gaps in the criterion.	$250,000

Table 5. Top 10 Listing of Long-term Needs Statements by Theme.

Theme 1: Use of Existing Technology and Tools		
Needs Statement	Description	Funding
Methods of Defining and Calculating the Effect of Pavement Preservation Treatments on Pavement Life	This study will quantify the impacts that pavement preservation treatments have on pavement performance, using measured field data from various geographic regions of the country.	$500,000
Investigation into the Risk, Uncertainty, and Variability in Pavement Management Decisions	The objective of this research is to investigate the various forms of variability affecting pavement management recommendations and to develop a process for evaluating its impact and the overall effectiveness of pavement management recommendations. The results are expected to be able to help agencies determine the amount of data needed to provide credible recommendations and to determine what level of risk is considered acceptable, thereby improving levels of accountability and confidence in pavement management.	$350,000
Theme 2: Institutional and Organizational Issues		
Needs Statement	Description	Funding
Impact of Pavement Management Investment Levels on Benefits	A product of this study is the development of an analysis approach that determines the relationship between funding expenditures, data reliability, and system outputs. Another product will be the development of a methodology for analyzing these relationships.	$350,000
Methods to Promote Pavement Management as a Management Tool	Pavement management's value to is not always well understood, especially among executives and elected officials with short-term positions. Public relations is needed to raise the profile of pavement management and communicate its wide-ranging benefits. Research is needed to know how to be most effective with audiences.	$100,000
Theme 3: The Broad Role of Pavement Management		
Needs Statement	Description	Funding
Using Pavement management Data to Support Design Activities	This study will develop a methodology to enhance the sophistication of pavement performance modeling, determine the availability of data fields for both pavement management and pavement design, determine the compatibility of MEPDG and pavement management prediction, enhance DARWin-ME or develop a stand-alone tool, and recommend adjustments to calibrate one or both models.	$350,000
National Funding Allocations That Account for State Priorities	This study will result in the development of a methodology for comparing pavement performance that accounts for the differences in state priorities and objectives.	$250,000
Theme 4: New Tools, Methodologies, and Technologies		
Needs Statement	Description	Funding
Performance Models That Consider a Series of Treatments	This study will include a literature search on the pavement performance impacts of a series of treatments; development of a strategy for evaluating treatments in a series; collection of sufficient data from state agencies to develop, analyze, and validate performance curves; and the creation of guidelines on how to develop performance curves for a series of treatments.	$500,000
Method for Effectively Modeling Structural Condition	This study will quantify the cost/benefit of network-level deflection testing. The researcher will conduct a survey of practice, validate testing with other static devices, determine precision and bias statements, conduct pilot studies, and develop guidelines.	$350,000
Automation of Surface Texture Characteristics	This study will identify surface characteristics that can be identified and quantified using existing high-speed data collection equipment; potential methodologies for quantifying distress; equipment and analysis gaps; and software and equipment modifications.	$500,000
Identifying Strategies for Incorporating Emerging Technologies into the Pavement Management System	The main research objective is to develop a framework for identifying/evaluating the changes that impact pavement management decisions. The framework should be applicable to a wide range of situations and be demonstrated using data provided by state highway agencies. The final product is a set of guidelines for identifying and evaluating factors that influence the recommendations produced by the pavement management system. A clearinghouse for reporting the evaluation of technology may also be a product.	$350,000

Implementation Steps

The stakeholders involved in the development of the Pavement Management Roadmap identified a plethora of research, development, and technology transfer needs that are required to solidify the role of pavement management in transportation agencies today, and to help ensure its applicability to the needs of transportation agencies in the future. As outlined in the Roadmap, this will require a coordinated plan that:

- Enhances the skills of pavement managers.
- Improves the use of existing technology and tools.
- Promotes the concepts of pavement management among decision makers and the public.
- Expands the data considered in a pavement management analysis.
- Explores the use of new tools and technology to improve the current approaches to data collection and analysis.

The Roadmap presents both the short-term and long-term priorities that will enable the pavement management community to accomplish these objectives. In total, the needs identified in the Roadmap will require $14.57 million in funding to achieve the stated goal. This amount of money is clearly beyond the capabilities of any single organization within the transportation community. Therefore, the successful implementation of the Roadmap demands a focused, cooperative approach among national and international organizations that are in a position to fund and support these types of research and outreach activities, including the FHWA, AASHTO, the National Research Academy and the Transportation Research Board (TRB), state highway agency research departments, and other industry representatives. This approach demands that:

- Funding to support pavement management initiatives is increased to meet the needs of stakeholders at all levels.
- Agencies work together to secure the necessary funding for the highest priority items.
- The pavement management community embraces the Roadmap and supports its implementation.
- Effective strategies for implementing the activities developed under this Roadmap are incorporated into each study.
- Responsibility for tracking accomplishments and pushing forward the remaining needs is assigned to a central organization.

Getting Involved

The completion of this document represents the end of the collaborative process that was followed to identify and prioritize the needs of a diverse set of stakeholders who are involved in the use of pavement management data and analysis tools to support the cost-effective management of the nation's pavement infrastructure. As documented in this report, the implementation of the Pavement Management Roadmap will rely on the creativity and resourcefulness of all those working in the pavement management community. No matter how they are connected to pavement management, stakeholders must get involved in supporting the activities outlined in the Pavement Management Roadmap if the community is to reach the vision for pavement management over the next 10 years.

Although the implementation of the Pavement Management Roadmap will require the participation of a wide variety of stakeholders, several recommendations are provided to help ensure that the

implementation is a success at advancing pavement management initiatives. The recommendations include the following:

- **Establish a Pavement Management Roadmap Steering Committee with responsibility for the implementation and oversight of the document.** It is recommended this Committee be organized as a subcommittee under the TRB Committee on Pavement Management (AFD10) with representation from FHWA, state and local transportation agencies, academia, associations, and private industry. This Committee should be responsible for promoting and tracking accomplishments under the Roadmap as a way to keep it in the national spotlight.
- **Assign FHWA primary responsibility for addressing the institutional training and technology transfer initiatives identified in the Roadmap.** The FHWA, through its National Highway Institute, provides training to improve the performance of transportation agencies. In addition, the FHWA has supported the conduct of peer exchanges, national conferences, and other initiatives to advance pavement management activities. Using innovative approaches that recognize the traveling limitations that restrict agency participation in conferences and training classes, the FHWA should continue to be the primary support for these types of initiatives, as outlined in the Roadmap.
- **Identify funding support for two to three problems statements each year through AASHTO and TRB.** This activity requires state support for the initiatives outlined in the Roadmap in order to advance the problem statements through the TRB funding process. Therefore, it is recommended that the AASHTO Joint Technical Committee on Pavements assume responsibility for this effort, for each of the next 10 years outline in the Roadmap. This recommendation in no way restricts support for additional research activities through other organizations. Instead, it merely seeks to provide a mechanism to ensure that financial support for pavement management activities remains a priority over the life of the Roadmap.

- **Raise the profile of pavement management and its effectiveness at supporting sound asset management concepts.** As an industry, we have not placed an emphasis on promoting pavement management concepts within the transportation community. However, with the increased focus on asset management, and the importance of performance measures to improve agency accountability, agencies will increasingly rely on pavement management to support these initiatives. Therefore, the pavement management community needs to become more active in promoting its capabilities and documenting the benefits to an agency that uses these concepts to support investment decisions. The Pavement Management Roadmap can become the instrument needed to champion additional support for pavement management, as a critical tool in transportation agencies. The pavement management community needs to identify and promote a slogan that conveys the benefits, such as "***Pavement Management…the key to preserving your pavement investments***."