



2011 FHWA Infrastructure Research And Technology

STRATEGIC PLAN

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FOREWORD

This 2011 Federal Highway Administration (FHWA) Infrastructure Research and Technology (R&T) Strategic Plan (April 2012) describes the direction and outcomes that will be pursued through FHWA's Infrastructure R&T program for the next 5 or more years. It is founded on and informed by input provided by a broad array of highway stakeholders assembled through formal and informal mechanisms.

Additional details concerning the specific work that will be undertaken by the FHWA Offices of Infrastructure, Infrastructure Research and Development, and Technical Services will be provided in a supporting FHWA Infrastructure R&T program roadmap that will be reviewed and updated on an annual basis. Comments concerning this strategic plan and other input for consideration in the roadmap development can be submitted to FHWA Office of Infrastructure at RNT@dot.gov. Other mechanisms for obtaining stakeholder input will also be used.

This report supersedes the earlier published version of the FHWA Infrastructure R&T Strategic Plan (FHWA-HRT-12-028); it contains editorial updates to both content and format.

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INTRODUCTION

The Nation's highway system is entering a unique era of change that brings with it significant challenges and opportunities for highway infrastructure. Highway agencies are experiencing unprecedented fiscal challenges to operate, maintain, and invest in highway infrastructure to maintain a state of good repair and provide the improvements needed to support economic growth. In these challenging times, highway professionals have no choice but to develop and apply innovative solutions to meet the needs of the traveling public. The Federal Highway Administration (FHWA) Offices of Infrastructure, Infrastructure Research and Development (R&D), and Technical Services will focus on the necessary research and technology (R&T)¹ in which there is an appropriate Federal role by virtue of national needs, scope, duration, or risk to address the many challenges.

Past infrastructure R&T investments have produced and put into practice innovations that have resulted in longer-lived assets at lower costs, reduced environmental impacts, saved lives, and improved economic efficiency. Additional innovation will be needed to further improve safety, reduce congestion, address environmental and energy concerns, provide the quality highway system that U.S. citizens expect, and address the department's strategic goals. Conducting research that addresses national highway infrastructure needs; developing new and updated policy, guidance, and technologies to address these needs; and effectively deploying policy, guidance, and technologies are key programmatic activities that are necessary to meet the current transportation challenges. FHWA must strive to ensure that highway infrastructure is delivered in ways that impact traveler mobility as infrequently as possible and for the shortest amount of time, providing the greatest mobility and safety. The U.S. transportation infrastructure must be managed in a way that addresses the new challenges and puts the needs of the American people and their communities first.

FHWA is, and will continue to be, a leader in shaping the future of U.S. highway transportation. As the country continues to move forward into the 21st century, the FHWA Offices of Infrastructure, Infrastructure R&D, and Technical Services will work together, in collaboration with stakeholders throughout the highway industry, to successfully achieve FHWA's mission and to ensure that America's highway system is the best in the world. In this challenging and dynamic century, it is important to develop a clear and strategic direction. Maintaining and improving the highway infrastructure system to meet growing demands and challenges requires investment and application of innovation and a willingness to move beyond the status quo.

¹The term "research and technology," as used in the planning and conduct of the FHWA Infrastructure R&T program, encompasses all of the infrastructure technology and innovation-related activities in which FHWA engages, including the following:

- Evaluating existing practices/processes and determining whether they best serve the needs of the highway community.
- Conducting exploratory advanced research and applied research.
- Developing research products including equipment, specifications, test methods, procedures, technical guidance, software tools, and other innovations.
- Deploying, implementing, and evaluating new technologies and innovations through the following:
 - Field trials, evaluations, and demonstration projects.
 - Development and delivery of technical training.
 - Development and delivery of technology transfer materials.
 - Technical support and assistance to achieve successful deployment.
 - Development of policy and guidance on technical issues.

It does not encompass the development of policy and guidance on matters that do not involve elements of technology or innovation except in those cases where such policy and guidance can be productively informed through research and evaluation.

Over the years, the United States has built one of the world's more extensive and productive transportation systems, representing trillions of dollars of public and private investment. It is essential that transportation professionals are good stewards of the Nation's highway infrastructure and Federal investments therein. Highway agency managers must proactively apply data-driven asset management principles to maintain and modernize critical infrastructure to maximize its productivity and performance, reduce operational and replacement costs, and extend the system's useful life. Aging infrastructure needs to be preserved and managed, not just replaced. The R&T strategic plan outlines the steps to address these challenges.

This overarching FHWA R&T infrastructure strategic plan and its supporting roadmap will guide Infrastructure R&T efforts for the next 5 years and beyond.⁽¹⁾ The plan will provide a comprehensive focus and direction across organizational boundaries and assist in prioritizing program initiatives, allocating resources, and improving the processes relative to how FHWA staff work together to achieve FHWA's mission in the future. The strategic plan and roadmap will recognize the inter-relationships and interdependencies among the different infrastructure disciplines and provide a framework for collaboration across disciplines and with other FHWA programs.

Achieving the full R&T infrastructure vision will depend on strong and continuing partnerships with other transportation department modes, government agencies, and public and private sector stakeholders. Therefore, FHWA is committed to working with its partners to ensure that its resources and mission are appropriately focused to meet the needs of the American public.

GUIDING PRINCIPLES

The development and application of this R&T strategic plan and its supporting documents are guided by the following principles, which are founded on those articulated in the FHWA *Corporate Master Plan for Research and Deployment of Technology & Innovation*.⁽²⁾

- The FHWA R&T process, from research through implementation, is systematic and begins with the end in mind.
- FHWA engages in advanced and applied research and innovation deployment activities where there is an appropriate Federal role.
- Stakeholders are engaged throughout the process.
- The process is grounded in the FHWA mission and goals and guided by multiyear plans.
- The Infrastructure R&T budget allocation is based on and driven by multiyear plans and priorities.
- The performance of initiatives will be measured and evaluated.
- Programs and projects will be effectively communicated to partners to foster transparency and a collaborative approach.

FHWA will engage in advanced and applied research and innovation deployment activities, establish policy, and provide guidance and Federal aid consistent with its statutory mandate and where there is an appropriate Federal role. The Federal role for the infrastructure program is to lead in developing and advocating solutions to national highway infrastructure needs that are focused on the following:

- Systems and issues of national significance.
- Activities of national interest where there are economies of scale and efficiencies that would be gained by undertaking those activities nationally versus States acting individually.
- Federal staff and facilities that are uniquely qualified to provide needed services and achieve FHWA’s stated goals and projected outcomes.

The inter-relationships and interdependencies among the different infrastructure disciplines (pavement, bridge, geotechnical, hydraulics, contract administration, asset management, policy development, and construction) provide a framework for cross-discipline collaboration and collaboration with other FHWA programs and stakeholders.

The efforts of the Offices of Infrastructure, Infrastructure R&D, and Technical Services—from research to technology implementation and deployment—influence innovation development, delivery, and change practice, such that the transitions among R&T phases are accounted for in program planning and are truly seamless.

The Infrastructure R&T strategic plan and roadmap will guide investments of FHWA resources (human, financial, and capital), inform other internal and external programs, and drive input to the FHWA-wide strategic planning processes.

MISSION STATEMENT

To improve the Nation’s mobility and ensure the long-term performance and preservation of the U.S. highway infrastructure through national leadership, innovation, and program delivery.

VISION

A world-class highway infrastructure that is the backbone of America's mobility.

VALUES

Public Service: FHWA is committed to the pursuit of professional excellence motivated by serving the public interest and providing high-quality products and timely services.

Integrity: Ethics, fairness, and honesty define FHWA's work and how it conducts itself. Researchers have the courage to be both innovative and make tough decisions.

Respect: Researchers value individual diversity and the unique strengths, skills, expertise, and background of FHWA employees, treating others in a polite and courteous manner.

Collaboration: Researchers maximize their collective talents through teamwork and partnerships based on mutual trust, respect, support, cooperation, and communication.

Personal Development: Through a wide variety of learning opportunities, the development and use of leadership, technical, and professional skills are nurtured in all employees.

FUTURE CHALLENGES

Tens of thousands of lives are lost and millions of injuries occur each year on the Nation's highways. Deteriorating bridges and pavements; congestion and delays due to highway construction work zones, crashes, and other incidents; and an insufficient capacity to meet the needs of a growing population and an expanding economy are critical highway transportation problems that demand solutions. Highway infrastructure is the backbone of America's transportation system, making it possible to meet the mobility and economic needs of communities, regions, and the Nation as a whole. Americans use the highway system to make more than 90 percent of passenger trips and move 69 percent of total freight value. Highways accommodate buses, passenger and freight vehicles, bicycles, and pedestrians and provide vital links among all modes of transportation. Thus, the influence of their physical and operational condition extends well beyond the impacts experienced directly by highway users. Highways also serve as a life line of the Nation's economy and directly impact the vitality of the Nation.

The challenges are pervasive, with wide-ranging implications for the Nation's economy and quality of life.

Preserving pavements and bridges, particularly on the national highway system (NHS), is critical to the structural and functional integrity and cost effectiveness of the Nation's transportation system. The ride quality of NHS pavements affects the wear and tear on vehicles, the comfort of travelers, fuel consumption, and traffic congestion. The percentage of vehicle miles traveled (VMT) on NHS roads classified as having good ride quality increased from 46 percent in 2000 to 57 percent in 2009. Similarly, from 2002 to 2009, bridge conditions improved overall as the percentage of deck area on all bridges, both NHS and non-NHS, that were classified as either structurally deficient or functionally obsolete decreased from 30.9 percent to 29.4 percent. While these improvements are indicative of collective progress toward improving bridge condition, significant challenges remain. For example, current combined levels of Federal, State, and local bridge rehabilitation and replacement spending are insufficient to sustain the overall condition of bridges at current levels over the long term. Additionally, the increasing volume of freight traffic is seen as another challenge due the added wear and tear to both pavements and bridges. Without adequate investment in the highway network or diversion of freight to rail or water transport alternatives, transportation safety and efficiency will be adversely affected as highway infrastructure conditions worsen.

Achieving improvements in the condition of highway infrastructure will provide smoother and safer vehicle operating conditions and reduce undue wear and tear on vehicles used for personal, commuter, and freight movements. In this era of limited resources, achieving a state of good repair will require FHWA and State partner agencies to take a strategic approach by considering and evaluating where transportation and community needs have changed and will continue to change over time. This challenge is complicated by a number of factors, which are highlighted in the subsequent subsections.

Highway and Bridge Risk Factors

The fact that so much of the Nation's infrastructure is in need of repair, combined with State rights to choose which projects will be Federally funded, results in a situation where Federal aid is not necessarily being expended on activities that address national goals. Pavements and bridges do not always last as long as they should. Much of the highway infrastructure is at or beyond its design service life and is subjected to traffic weights and volumes well in excess of its original design assumptions. Deficient bridges account for 29 percent of the deck area of the Nation's bridges. The condition of pavements and bridges across the country varies considerably, with many States struggling to keep conditions from deteriorating. Over the past 5 years, over 50 percent of States reported an increase in the number of NHS bridges that are eligible for rehabilitation. Additionally, 34 percent of all NHS travelers have seen a decline in pavement conditions.

Although these measures do not fully characterize the overall structural condition of the Nation's highway infrastructure, many highway engineers agree that 50-year pavements and 100-year bridges should be attainable using current technology. FHWA's long-term success depends on the ability to develop mutually beneficial partnerships with State partners to consistently manage the program to achieve and maintain a state of good repair in the Nation's critical infrastructure.

Funding Constraints

The lack of sustainable funding for highway infrastructure is an external risk factor that could significantly affect the ability to achieve results. State budgets have suffered under economically challenged times. Before the economic downturn, construction costs escalated in recent years due in part to increased global demand for raw materials and rising energy costs.

Demographic Shifts

The U.S. population is expected to expand from the current number, 307 million people, to more than 400 million people by 2050, with growth concentrated in the south and west. More than 70 percent of population growth and 80 percent of economic growth will occur in metropolitan areas. A challenge is to determine how to foster greater efficiencies by creating a stronger highway infrastructure backbone in regions undergoing economic and population growth.

Globalization of Economies

The advent of a truly global economy means that goods and services are being shipped over longer distances, which will fuel strong growth in freight movement and increase the link between transportation and economic competitiveness. Due in part to increased trade between the United States and its North American Free Trade Agreement partners, surface transportation use increased dramatically in recent years—nearly 90 percent from 1997 to 2007.

Economic Competitiveness and Productivity

Marginal reductions in transportation costs for goods movement are critical to the U.S. economic vitality. In addition to direct user benefits, the highway infrastructure must be recognized as an important contributor to industry productivity and competitiveness. Since the inception of the interstate system, U.S. industries have accomplished production cost savings averaging 18 cents annually for every dollar invested in the road network. While the 2007–2009 economic downturn reduced immediate pressures on the transportation system, future growth will create new pressures. The long-term shift in economic activity to services may reduce traditional growth rates in tonnage to be moved, but it will place greater demands on the transportation system for resiliency and reliability. Over the next 40 years, the gross domestic product (GDP) is expected to almost triple. To support this growth, it is expected that the demand for both freight and passenger transportation will increase by about 250 percent by 2050. Maintaining and preserving an efficient transportation system is critical to maintaining the competitiveness of the economy.

Role of Trade

Trade as a percentage of U.S. GDP increased from 13 percent in 1990 to 31 percent in 2008, and it is expected to reach 35 percent by 2020. This growth in trade will increase truck traffic. The average haul length for trucks increased 80 percent from 263 mi in 1970 to 473 mi in 2000.

Congestion

Demand on NHS increased sharply over the past decade. In 2006, total highway travel by personal vehicles, motorcycles, and light and heavy trucks totaled 3 trillion mi, an increase of 25 percent since 1996. Much of the highway system is not only reaching or exceeding its expected service life, but it is also carrying a heavier burden than anticipated. The amount of traffic on rural interstates more than doubled between 1970 and 2005, and the loadings placed on those highways, largely because of more trucks traveling more miles, increased six-fold during that period. The demand for both freight and passenger transportation has been forecasted to increase by about 2.5 by 2050. Between 2010 and 2050, highway VMT can be expected to increase from 2.9 trillion mi to approximately 4.5 trillion mi, an increase of 50 percent.

Climate Change

A new set of transportation challenges include reducing carbon and other harmful emissions, promoting energy independence, and addressing global climate change through adaptive strategies. Meeting the 21st century energy and environmental challenges will require new infrastructure solutions.

Workforce Attrition and Employee Shortages

Transportation agencies at all levels are continuing to lose their senior and experienced personnel due to retirement and job changes. With retirement comes a loss in institutional knowledge, expertise, and experience. Over the next 10 years, 40 to 50 percent of the transportation workforce will retire. State agencies are already experiencing staffing shortages in both technical and non-technical areas.

Awareness of these factors helps guide the strategic direction and approach to achieve the FHWA and United States Department of Transportation (USDOT) strategic goals. The direction and approach are further guided by extensive stakeholder input, which is reflected in an array of industry roadmaps and strategic plans as well as formal and informal forums. (See references 3–8.) Examples of these forums include expert and technical working group meetings, Transportation Research Board (TRB) research needs statements, National Technical Conferences sponsored by State transportation departments/FHWA, American Association of State Highway and Transportation Officials technical committee meetings, reports and discussions with TRB committees established to advise FHWA on different elements of research and technology programs, and stakeholder input gathered at the agency (FHWA) and USDOT level.

STRATEGIC DIRECTION

Outcomes

The strategic direction articulated in this plan is founded in the *FHWA Strategic Plan* and the *U.S. DOT Strategic Plan FY 2010—FY 2015: Transportation for a New Generation*.^(9,10) The expected outcomes to support the goals identified in these plans are as follows:

- Highway safety is improved.

- Management of the infrastructure system is continuously improved.
- Economic returns on transportation infrastructure investments are improved.
- Delivery of high-quality infrastructure projects is expedited.
- Durability and longevity of highway infrastructure are improved.
- The condition of the highway infrastructure is improved.
- The sustainability² of highway infrastructure design, construction, maintenance, and operation is improved, and adverse environmental impacts are reduced through environmental stewardship.
- Personal and commercial mobility is improved.

Program Objectives

The specific objectives to achieve these outcomes and contribute to achievement of the FHWA and USDOT strategic goals are as follows:

1. Reduce the number of fatalities attributable to infrastructure design characteristics and work zones.
2. Improve the safety and security of highway infrastructure.
3. Improve the management of infrastructure assets and advance the implementation of a performance-based program for NHS.
4. Improve the ability of transportation agencies to deliver projects that meet expectations for timeliness, quality, and cost.
5. Reduce user delay attributable to infrastructure system performance, maintenance, rehabilitation, and construction.
6. Improve highway condition and performance through increased use of design, materials, construction, and maintenance innovations.
7. Reduce the life-cycle environmental impacts of highway infrastructure (i.e., design, construction, operation, preservation, and maintenance).

Crosswalks illustrating the relationship among the USDOT and FHWA strategic goals and the FHWA infrastructure outcomes and objectives are provided in appendix A.

²Sustainable transportation means providing exceptional mobility and access in a manner that meets development needs without compromising the quality of life of future generations. A sustainable transportation system is safe, healthy, affordable, and renewable. Additionally, it operates fairly and limits emissions and the use of new and nonrenewable resources.

Strategies and Initiatives

Infrastructure program strategies describe and define the work required to achieve objectives and outcomes and, ultimately, the FHWA and USDOT strategic goals. Carrying out a strategy is intended to achieve an end result or goal. Infrastructure program initiatives are efforts to advance one or more strategies. They may involve collaboration among staff within one office or several offices. Initiatives typically have shorter timeframes and/or scales than strategies. Individual offices will advance an initiative through the activities in their unit plans. Appendix B includes a summary of the infrastructure program strategies. These strategies and supporting initiatives are further defined in the *FHWA Infrastructure Research and Technology Roadmap*.⁽¹⁾

COLLABORATION

FHWA has a long and solid tradition of structured stakeholder collaboration in infrastructure. The FHWA Offices of Infrastructure, Infrastructure R&D and Technical Services are committed to working collaboratively within FHWA and USDOT and with the broader community of highway stakeholders to ensure that the program:

- Addresses agency goals, missions, and requirements.
- Is consistent with FHWA's Federal role and relevant to the mission of the agency.
- Is well coordinated with related work by others to avoid duplication of effort and maximize the use of resources.
- Delivers outcomes at the earliest appropriate time.
- Moves improved practices, technologies, and innovations into practice as quickly as possible to achieve maximum possible benefits to stakeholders and highway infrastructure users.

STAKEHOLDER ENGAGEMENT

The transportation needs of the future require an even greater commitment to a systematic process for stakeholder involvement, and a key to meeting infrastructure strategic goals and objectives is stakeholder involvement. FHWA will enhance the emphasis on stakeholder involvement and partnerships to further improve the effectiveness of the infrastructure initiatives. Different levels of stakeholders exist (some define the agenda and support or identify risks, while others apply the technology), and this must be considered in formulating interactions. FHWA will undertake the following tasks to more effectively engage stakeholders to help achieve goals and objectives:

- Develop a systematic approach to establish a durable and lasting process to formalize stakeholder involvement.
- Share the infrastructure vision with stakeholders, build stakeholder commitment to achieving infrastructure innovations, and develop and implement strategies to enhance transparency and collaboration.

- Devise a process for significant peer review of both plans and R&T results.
- Share and generate plans for technology deployment and engage stakeholders on technology and innovation deployment teams.

PROCESSES FOR COORDINATING AND IMPLEMENTATING THE FHWA INFRASTRUCTURE R&T STRATEGIC PLAN

The FHWA infrastructure R&T strategies articulated in this Strategic Plan are further defined and elaborated upon in its supporting *FHWA Infrastructure Research and Technology Strategic Roadmap*.⁽¹⁾ Formal processes for coordination and implementation of this plan and the roadmap are presented in a companion document.

The processes addressed include the following:

- Processes for stakeholder engagement, periodic reporting, monitoring, and assessment of progress.
- Coordination of activities within FHWA and with other transportation department modal administrations, other Federal agencies, and stakeholders throughout the highway community to ensure continuous progress.
- Periodic review and update of the roadmap.
- Program evaluation, as required by the Government Performance and Results Act.

Figure 1 illustrates the collaborative strategic planning coordination process.



Figure 1. Illustration. Infrastructure R&T strategic planning coordination process.

The process spans throughout the year and lends itself to support other strategic planning efforts such as providing input into annual implementation and staff performance plans.

OUTCOMES AND EXPECTATIONS

The outcomes delivered through pursuit of the objectives articulated in this strategic plan are aimed at delivering benefits to the American public by enabling improvements in safety, performance, and cost effectiveness of the Nation’s highway infrastructure while minimizing the environmental impacts of highway construction, maintenance, and rehabilitation. The results will enable reductions in highway congestion, improved travel time reliability, improvements in highway safety, and enhancement of the overall driving experience for motorists.

FHWA is charged with ensuring minimum standards of safety for people traveling on the Nation’s highways and bridges. While many other organizations and agencies conduct highway infrastructure research, FHWA is uniquely positioned to address the continuum of highway research from high-risk, exploratory, and advanced research through the highly applied problem-specific research that is necessary to address current issues and immediate problems in a well coordinated, integrated, and collaborative manner. This broad range of research capability provides a high likelihood of success that is critical for sustaining the Nation’s economy in the short and long term.

**APPENDIX A. CROSSWALK BETWEEN FHWA AND USDOT STRATEGIC GOALS,
INFRASTRUCTURE OUTCOMES, AND OBJECTIVES**

Table 1. Crosswalk between FHWA infrastructure R&T outcomes and strategic objectives.

Infrastructure R&T Outcome	FHWA Strategic Objective			
	National Leadership	Program Delivery	System Performance	Corporate Capacity
Highway safety is improved	X			X
Management of the infrastructure system is continuously improved	X		X	X
Economic returns on transportation infrastructure investments are improved	X	X	X	X
Delivery of high-quality infrastructure projects is expedited	X	X	X	X
Durability and longevity of highway infrastructure are improved	X		X	X
The condition of highway infrastructure is improved	X		X	X
The sustainability of highway infrastructure design, construction, maintenance, and operation is improved, and adverse environmental impacts are reduced through environmental stewardship	X		X	X
Personal and commercial mobility are improved	X	X	X	X

Table 2. Crosswalk between FHWA infrastructure R&T outcomes and USDOT strategic goals.

Infrastructure R&T Outcome	USDOT Goals				
	Safety	State of Good Repair	Economic Competitiveness	Livable Communities	Environmental Sustainability
Highway safety is improved	X			X	
Management of the infrastructure system is continuously improved		X	X		
Economic returns on transportation infrastructure investments are improved		X	X		
Delivery of high-quality infrastructure projects is expedited	X	X	X	X	
Durability and longevity of highway infrastructure are improved		X	X	X	
The condition of highway infrastructure is improved		X	X	X	
The sustainability of highway infrastructure design, construction, maintenance, and operation is improved, and adverse environmental impacts are reduced through environmental stewardship			X	X	X
Personal and commercial mobility are improved				X	

APPENDIX B. FHWA INFRASTRUCTURE RESEARCH AND TECHNOLOGY OBJECTIVES AND STRATEGIES

The strategies that will be used to achieve the strategic plan objectives are presented below. The following are understood:

- Although not explicitly stated, the strategies will be pursued in a collaborative manner. The objectives will only be achievable by working across boundaries—within FHWA, USDOT, and with stakeholders.
- The phrase “develop and deploy” encompasses all phases of the technology process from research through technology adoption, including development and dissemination of policy and guidance on technical issues.
- Many strategies have activities already in progress that will serve as the foundation for further advancement.

Table 3. FHWA infrastructure R&T objectives and strategies.

Objective	Strategy
1. Reduce the number of fatalities attributable to infrastructure design characteristics and work zones	1-1. Develop and deploy best practices and opportunities to improve infrastructure safety performance. 1-2. Develop and deploy technologies, standards, and test methods that optimize surface characteristics with regard to friction, texture, and splash and spray. 1-3. Develop and deploy technical guidance to support infrastructure safety management programs. 1-4. Develop and deploy construction administration practices that enhance safe operation of the highway system by reducing work zone exposure.
2. Improve the safety and security of highway infrastructure	2-1. Develop and deploy planning, analysis, and design methodologies for highway infrastructure to reduce vulnerability to physical damage. 2-2. Develop and deploy hazard mitigation, adaptation, and restoration strategies and techniques. 2-3. Develop and deploy improved decision support tools and sensing and monitoring technologies for hazard detection. 2-4. Develop and deploy methodologies and guidance for assessing safety of infrastructure after a hazard event.

Objective	Strategy
<p>3. Improve the management of infrastructure assets and advance the implementation of a performance-based program for NHS</p>	<p>3-1. Develop and deploy reliable performance prediction models and practices in the design, construction, and management of the highway infrastructure.</p> <p>3-2. Develop and deploy sound measures and practices to assess infrastructure condition and assure data quality in infrastructure management and performance predictions.</p> <p>3-3. Develop and deploy decision support tools, systems, and processes to support rational and comprehensive engineering and economic analysis methods for project-, program-, and national-level investment decisions.</p> <p>3-4. Develop and deploy guidance, management approaches, and policies for management of infrastructure assets and for implementation of a performance-based program for infrastructure on NHS.</p>
<p>4. Improve the ability of transportation agencies to deliver projects that meet expectations for timeliness, quality, and cost</p>	<p>4-1. Develop and deploy expanded and consistent use of the elements of a quality assurance program to improve infrastructure design, materials testing, construction, and inspection procedures.</p> <p>4-2. Develop and deploy innovative processes and project management practices to enhance project delivery in highway design and construction.</p> <p>4-3. Develop and deploy contracting tools and practices to effectively manage risk in acceptance of and payment for construction and materials.</p>
<p>5. Reduce user delay attributable to infrastructure system performance, maintenance, rehabilitation, and construction</p>	<p>5-1. Develop and deploy tools and methodologies to assess the impact of decisions (design, construction, contracting, etc.) on user delay.</p> <p>5-2. Develop and deploy construction, inspection, maintenance, preservation, and rehabilitation practices that minimize impact to users.</p>
<p>6. Improve highway condition and performance through increased use of design, materials, construction, and maintenance innovations</p>	<p>6-1. Develop and deploy approaches to effectively and systematically preserve and improve highway infrastructure condition and performance.</p> <p>6-2. Develop and deploy design and preconstruction technologies and innovations to improve infrastructure condition, durability, service life, and constructability.</p> <p>6-3. Develop and deploy alternative project delivery methods, construction approaches, and specifications where the emphasis is on the long-term performance of the infrastructure system.</p> <p>6-4. Develop and deploy methods that will improve the quality of materials and systems used for highway infrastructure.</p>

Objective	Strategy
7. Reduce the life-cycle environmental impacts of highway infrastructure (design, construction, operation, and maintenance)	<p>7-1. Advance the application of sustainable practices in project-level infrastructure design.</p> <p>7-2. Develop and deploy sustainable methods to reduce air pollutants and other emissions resulting from construction and preservation practices.</p> <p>7-3. Develop and deploy sustainable methods to reduce water runoff and pollutants through improvements in design, construction, preservation, operations, maintenance, and preservation.</p> <p>7-4. Develop and advance sustainable practices that reduce noise during construction and throughout the service life.</p> <p>7-5. Identify, develop, and advance alternative energy sources for use during construction, operations, preservation, and maintenance.</p> <p>7-6. Advance and increase the use of renewable, reusable, and recycled materials in highway-related infrastructure.</p> <p>7-7. Minimize impacts of highway infrastructure on wildlife.</p>

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