

FHWA'S NEW INFRASTRUCTURE RESEARCH AND TECHNOLOGY STRATEGIC PLAN

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Abstract

In the fall of 2010, the Federal Highway Administration (FHWA) undertook an effort to develop a new, longer-term strategic plan and roadmap for infrastructure research and development, and technology deployment. This paper provides an overview of the new infrastructure R&D strategic plan, and deployment roadmap.

Background

Over the years, the Federal Highway Administration's (FHWA) bridge and structures research and development (R&D) efforts have addressed a range of topics and focal areas. Past efforts have included research as wide-ranging as that of assessing and reducing the seismic vulnerability of the U.S. national highway system, to curved steel I-girder bridge behavior, to understanding the forces associated with spill-through abutment scour, to the use of ground penetrating radar for concrete bridge deck inspection. R&D topics were typically developed based on the knowledge of technology gaps by FHWA engineers, input from a wide variety of stakeholders, and—occasionally—direction from the U.S. Congress. In addition, “failures” within the highway infrastructure also drove the decision-making regarding bridge and structures R&D.

Starting in the middle of 2006, the FHWA Office of Infrastructure R&D took a more strategic approach to its funded and planned research agenda. This approach looked at blending the two distinct infrastructure program areas – pavement R&D, and bridge and structures R&D – into a more comprehensive and integrated infrastructure R&D program. The overall focus of this effort was on long-term infrastructure performance. The result of this was a multi-tiered, multi-year strategic plan and research roadmap, as documented in the 2008 FHWA publication titled “Highways of the Future: A Strategic Plan for Highway Infrastructure Research and Development” (publication FHWA-HRT-08-068, July 2008).

The 2008 strategic plan addressed six primary R&D areas:

- Long Term Infrastructure Performance
- Durable Infrastructure Systems
- Accelerated Highway Construction

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- Environmentally Sensitive Infrastructure
- Performance-Based Specifications
- Comprehensive & Integrated Asset Management

The basis for focusing on these six areas are the many critical challenges currently facing highway agencies, not only in the United States, but worldwide, including:

- The need to extend the service life of existing highway infrastructure.
- The need to build, rehabilitate, and rebuild infrastructure in ways that:
 - Minimizes the impact of construction activities on already congested highways.
 - Optimizes the overall cost/benefit for the improved infrastructure.
 - Facilitates future adaptation to accommodate changing demands.
- The need to effectively address the mobility challenges posed by natural or man-made extreme events and hazards – including earthquakes, hurricanes, floods, collisions, and acts of terrorism – by designing and constructing less vulnerable infrastructure to minimize loss, and employing rapid restoration techniques to restore functionality after a disaster occurs.

This FHWA infrastructure R&D strategic plan was the guiding document for all infrastructure R&D investments between 2007 and 2010.

The 2011 FHWA Infrastructure Research and Technology Strategic Plan

In the fall of 2010, FHWA initiated an effort to better integrate all elements of the agency's work related to highway infrastructure; i.e., not just R&D, but inclusive of all highway infrastructure technology and innovation development and deployment including design and construction, structures and pavement, asset management and long-term infrastructure performance. This required a more inclusive outreach within the agency which brought together all of FHWA's infrastructure offices and functions. The result was a new multi-year strategic plan and roadmap that describes the direction and outcomes to be pursued through FHWA's infrastructure Research and Technology (R&T) program for the next five to ten years. It is founded on and informed by input from a broad array of highway stakeholders gathered through both formal and informal mechanisms.

The United States highway system is entering an unprecedented era of change that brings with it significant challenges and opportunities for highway infrastructure. The country is experiencing unprecedented fiscal challenges to operate, maintain, and invest in infrastructure in order to maintain a state of good repair and provide the improvements needed to sustain and grow the economy. In these challenging times, there is no choice but to develop and apply innovative solutions to meet the needs of the travelling public.

Past infrastructure research and technology 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 the nation'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 must be embraced to meet the challenges faced by the United States – and similarly worldwide. These efforts will be directed to ensure that highway infrastructure is delivered in ways that impact traveler mobility as infrequently as possible, for the shortest amount of time, providing the greatest mobility and safety. 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.

This overarching FHWA R&T infrastructure strategic plan and its supporting roadmap is now guiding FHWA's Infrastructure R&T efforts for the next 5 to 10 years. The plan provides a comprehensive focus and direction across organizational boundaries; assists in prioritizing program initiatives, allocating resources, and improves the processes relative to how FHWA achieves its mission well into the future; and recognizes the inter-relationships and interdependencies among the different infrastructure disciplines and provides a framework for collaboration across disciplines and with other FHWA programs.

The strategic direction articulated in this plan is founded in the **FHWA Strategic Plan¹** and the **U.S. DOT Strategic Plan, FY 2010- FY 2015, Transportation for a New Generation²**. The outcomes that will be achieved to support the goals identified in these plans are as follow:

1. Highway safety is improved;
2. Management of the infrastructure system is continuously improved;
3. Economic returns on transportation infrastructure investments are improved;
4. Delivery of high quality infrastructure projects is expedited;
5. Durability and longevity of highway infrastructure are improved;
6. The condition of the highway infrastructure is improved;
7. The sustainability of highway infrastructure design, construction, maintenance and operation is improved and adverse environmental impacts are reduced through environmental stewardship; and
8. Personal and commercial mobility is improved.

The specific objectives that will be pursued to achieve these outcomes and contribute to achievement of the FHWA and DOT 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 the 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 (design, construction, operation, preservation, and maintenance).

The outcomes delivered through 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 U.S. highway infrastructure, while minimizing the environmental impacts of highway construction, maintenance, and rehabilitation. The results will make possible reductions in highway congestion, improved travel time reliability, improvements in highway safety, and enhancement of the overall driving experience for the American public.

FHWA Infrastructure R&T Program Roadmap – Objectives, Strategies, and Initiatives

Details on the FHWA Infrastructure R&T Strategic Plan are provided in the following program roadmap. As noted earlier, this plan and roadmap will drive FHWA's infrastructure R&D investments for the next 5 to 10 years.

Objective 1: Reduce the number of fatalities attributable to infrastructure design characteristics and work zones.

Strategy	Initiative
1.1 Develop and deploy best practices and opportunities to improve infrastructure safety performance.	1.1.1 Assessment of the adequacy of current policies and practices with regard to ensuring the safety of highway infrastructure and provide updated policy and best practice where warranted.
1.2 Develop and deploy technologies, standards, and test methods that optimize surface characteristics with regard to friction, texture and splash and spray.	1.2.1 Develop, standardize, and deploy test methods, technologies and specifications for enhancing friction/texture on new and existing surfaces.
	1.2.2 Identify and prioritize data needed to fully characterize the safety-related characteristics of highway infrastructure, including geometrics and surface

	characteristics.
	1.2.3 Evaluate, refine, and standardize test methods for friction and texture for effectiveness, repeatability, and reproducibility.
1.3 Develop and deploy technical guidance to support infrastructure safety management programs.	1.3.1 Improve effectiveness of friction management programs.
1.4. Develop and deploy construction administration practices that enhance safe operation of the highway system by reducing work zone exposure.	1.4.1 Evaluate existing practices for accelerated construction practices related to contract administration for effectiveness to reduce crash risk in work zones.
	1.4.2 Update and enhance policy and technical guidance with regard to accelerated construction practices related to contract administration.
	1.4.3 Develop and deliver training and technical support for implementation of policy and technical guidance related to accelerated construction and contract administration.

Objective 2. Improve the safety) and security of highway infrastructure.

Strategy	Initiative
2.1 Develop and deploy planning, analysis and design methodologies for highway infrastructure to reduce vulnerability to physical damage. (Design)	2.1.1 Implement an integrated interagency Federal approach that consolidates capabilities in a unified effort for security to prevent human induced hazard events.
	2.1.2 Improve and optimize Infrastructure System design to improve safety and security.
2.2 Develop and deploy hazard mitigation, adaptation and restoration strategies and techniques. (Rehab)	2.2.1 Research, develop, and deploy strategies, technologies, and programs to mitigate specific known infrastructure hazards and adaptation needs.
	2.2.2 Development of hazard mitigation and adaptation countermeasures for existing and new structures that includes a national data archive resource that captures experimental data as well as field reconnaissance data.
2.3 Develop and deploy improved decision support tools and sensing and monitoring technologies for hazard detection.	2.3.1 Development of improved decision support tools and methodologies for assessing hazards to infrastructure.
	2.3.2 Research, develop, and deploy better detection and surveillance technologies for evaluation, prevention,

(Monitoring and assessment)	and mitigation of extreme events.
2.4 Develop and deploy methodologies and guidance for assessing safety of infrastructure after a hazard event. (Repair and/or replace)	2.4.1 Development of protocols/inspection techniques for rapid assessment of infra structures after a hazard event.
	2.4.2 Research and deployment of ‘smart structure’ designs that sense damage and provide active/semi-active control of structural response to hazard events.
	2.4.3 Research, develop, and deploy new infrastructure systems that can rapidly be repaired and reconstructed following a hazard event.

Objective 3: Improve the management of infrastructure assets and advance the implementation of a performance-based program for the NHS.

3.1 Develop and deploy reliable performance prediction models and practices in the design, construction and management of the highway infrastructure.	3.1.1 Establish performance standards for infrastructure
	3.1.2 Identify and fill gaps in performance prediction models and practices across the asset life-cycle spectrum.
	3.1.3 Develop and deploy improved traffic prediction tools
	3.1.4 Develop and deploy improved prediction tools for environmental and climate change impacts on infrastructure performance.
	3.1.5 Conduct research to understand performance issues; and identify design, construction, preservation, and maintenance strategies to assure durability and longevity of infrastructure.
3.2 Develop and deploy sound measures and practices to assess infrastructure condition and to assure data quality in infrastructure management and performance predictions.	3.2.1 Develop improved methodologies & tools to more effectively collect and manage infrastructure condition data at the national, network and project levels to more effectively identify causes of deterioration and to make more informed decisions on system performance and health.
	3.2.2 Develop and deploy non-destructive evaluation (NDE) tools, software, and guidance for condition evaluation, construction quality assurance, and the prediction of key highway infrastructure performance at the network & project levels through the entire life

	cycles of the infrastructure assets.
	3.2.3 Conduct research to develop and deploy new methods & technologies to monitor infrastructure conditions in real time.
	3.2.4 Develop tools and technologies for, and promote consideration of uncertainties and risks in, data quality.
	3.2.5 Develop and implement guidance, technical support, training, and technology transfer for data quality management and to control affects from data variability.
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.	3.3.1 Identify, assemble, analyze the required data needs & develop analysis methodologies for an overall integrated asset management approach.
	3.3.2 Develop and deploy tools, technologies, and systems for project and program level management decisions
	3.3.3 Develop and deploy tools and technologies for cross-asset analysis involving existing assets and proposed future assets, and including the inherent uncertainties and risks.
	3.3.4 Develop tools and technologies for, and promote consideration of, uncertainties and risks inherent in longer term investment decision making process.
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 the NHS.	3.4.1 Define & deploy a consistent and reliable method to describe and project the health of the highway system in collaboration with stakeholders.
	3.4.2 Conduct research to determine the impact infrastructure condition has on users, and develop analysis tools to better assess those impacts.
	3.4.3 Develop and deploy management approaches and policies for corridors, tunnels, ancillary structures and other transportation assets.

Objective 4: Improve the ability of transportation agencies to deliver projects that meet expectations for scope, timeliness, quality and cost.

Strategy	Initiative
4.1 Develop and deploy expanded and consistent use of the elements of a quality assurance program to	4.1.1 Develop and deploy a composite index for project value that incorporates scope, costs, time, and quality.
	4.1.2 Develop guidance and tools, conduct program reviews, and deploy effective Quality Assurance plans

improve infrastructure design, materials testing, construction, and inspection procedures.	and best practices.
4.2 Develop and deploy innovative processes and project management practices to enhance project delivery in highway design and construction.	4.2.1 Identify, further develop, and deploy improved, streamlined and refined analysis, design, and construction procedures.
	4.2.2 Develop and deploy tools and guidance for innovative project delivery methods.
	4.2.3 Develop and deploy tools and technologies to assure and improve the quality & maintainability of accelerated construction projects.
4.3 Develop and deploy contracting tools and practices to effectively manage risk in acceptance of and payment for construction and materials.	4.3.1 Develop and deploy tools that project the long-term performance and value as a result of the as-built condition of the infrastructure asset.
	4.3.2 Develop and deploy approaches and specifications that link payment and acceptance to long-term performance and quantities to minimize agency risk.

Objective 5. Reduce user delay attributable to infrastructure system performance, maintenance, rehabilitation and construction.

Strategy	Initiative
5.1 Develop and deploy tools and methodologies to assess the impact of decisions (design, construction, contracting, etc.) on user delay.	5.1.1 Improve tools to more effectively assess user delay during design.
	5.1.2 Develop and deploy tools to evaluate the impacts of different construction delivery approaches on user delay (i.e. full closure vs. variable closures) at the project and corridor levels.
	5.1.3 Develop methods to evaluate the impacts of different contracting methods on user delay (i.e. design build, warranties).
5.2 Develop and deploy construction, inspection, maintenance, preservation, and rehabilitation practices that minimize impact to users.	5.2.1 Develop and deploy techniques for prefabricated construction of the infrastructure.
	5.2.2 Research, develop and deploy technologies and processes to accelerate construction and preservation.
	5.2.3 Develop and deploy approaches to automate the construction and preservation inspection, sampling and testing associated with the production and placement of highway related materials and systems (includes all related highway systems; pavement, bridge, culvert,

	etc.).
	5.2.4 Research, develop and deploy new approaches to conduct infrastructure condition inspections to minimize user delay.

Objective 6: Improve highway condition and performance through increased use of design, materials, construction and maintenance innovations.

Strategy	Initiative
6.1 Develop and deploy approaches to effectively and systematically preserve and improve the highway infrastructure condition and performance.	6.1.1 Develop methodologies to effectively apply treatments using asset management principles at the project and network levels.
	6.1.2 Develop and deploy technologies and processes to enhance the effectiveness of preservation activities.
	6.1.3 Develop and deploy technologies and techniques to enhance the effectiveness of rehabilitation and reconstruction activities.
6.2 Develop and deploy design and preconstruction technologies and innovations to improve infrastructure condition, durability and service life, and constructability.	6.2.1 Deploy existing and proven criteria, technologies and procedures to design infrastructure to more reliably achieve intended performance and service life.
	6.2.2 Research and develop the next generation of analysis and design tools to improve design reliability to achieve intended performance and service life.
	6.2.3 Develop and deploy contracting procedures to improve infrastructure condition and performance. (warranties, value engineering, etc. to allocate risk)
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.	6.3.1 Develop and deploy tools to assist in the allocation of risk between agencies and industry.
	6.3.2 Develop and deploy technologies to improve the efficiency of construction processes.
6.4 Develop and deploy methods that will improve the quality of materials and systems used for highway infrastructure.	6.4.1 Develop and deploy new tests and methods to more accurately and efficiently characterize materials.
	6.4.2 Develop and deploy best practices for selection of materials and systems, tests and methods to assure and improve quality.
	6.4.3 Develop and deploy innovative materials, and systems to improve the durability and longevity of

	highway infrastructure.
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Objective 7: Reduce the life-cycle environmental impacts of highway infrastructure (design, construction, operations, preservation, and maintenance).

Strategy	Initiative
7.1 Advance the application of sustainable practices in project level infrastructure design.	7.1.1 Develop and deploy Life-Cycle Assessment (LCA) methodologies, tools, policy and guidance to implement and to quantify the environmental impacts of design.
	7.1.2 Develop and deploy tools and practices for assessing sustainability in project-level decision-making.
	7.1.3 Develop policy and guidance, and implement sustainable design approaches to adapt to the impacts of Climate Change.
	7.1.4 Develop policy and guidance, and implement context sensitive design practices that improve sustainability.
	7.1.5 Evaluate, develop policy and guidance, and implement sustainable aspects of existing and new materials, technologies and practices.
	7.1.6 Develop policy and guidance, and evaluate practices that maximize the use of marginal and locally available materials.
7.2 Develop and deploy sustainable methods to reduce air pollutants and other emissions resulting from the construction and preservation practices.	7.2.1 Evaluate, develop policy and guidance, and implement aspects of infrastructure materials and technologies to reduce air pollutants and other emissions.
7.3 Develop and deploy sustainable methods to reduce water runoff and pollutants through improvements in design, construction, operations, maintenance, and preservation.	7.3.1 Evaluate, develop policy and guidance, and implement use of materials and technologies to reduce water runoff and pollutants.
	7.3.2 Develop policy and guidance, and implement practices to improve storm water management.
	7.3.3 Develop policy and guidance, and implement practices related to non-storm water runoff and pollutants.
7.4 Develop and advance sustainable practices that reduce noise during	7.4.1 Develop, standardize and deploy test methods for pavement noise to more effectively characterize noise performance of surfaces.

construction and throughout the service life.	7.4.2 Evaluate, develop policy and guidance, and implement use of materials and technologies that reduce noise such as optimizing pavement surface mix designs to reduce noise.
7.5 Identify, develop, and advance alternative energy sources for use during construction, operations, preservation and maintenance.	7.5.1 Evaluate, develop policy and guidance, and implement aspects of materials and technologies for the use of alternative energy sources.
	7.5.2 Develop policy and guidance, and implement infrastructure component technologies that generate energy.
7.6 Advance and increase the use of renewable, reusable, and recycled (3R) materials in highway-related infrastructure.	7.6.1 Evaluate the long-term performance of renewable, reusable, and recycled (3R) materials and implement the expanded use of 3R materials in highway-related infrastructure.
7.7 Minimize impacts of highway infrastructure on wildlife.	7.7.1 Develop, evaluate, improve, and deploy practices that minimize impacts on wildlife.
	7.7.2 Develop and deploy highway materials that are benign or less damaging to wildlife.

References

¹ FHWA Strategic Plan. Washington, DC : U.S. DOT, Federal Highway Administration, October 2008. Publication No. FHWA-PL-08-027.

² U.S. DOT Strategic Plan, FY 2010- FY 2015, Transportation for a New Generation, Washington, DC : U.S. Department of Transportation, April 15, 2010.