United States Department of Transportation

Annual Modal Research Plans
Fiscal Year 2019

Federal Highway Administration

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Contents

Executive Summary

The Federal Highway Administration (FHWA) addresses current issues and emerging challenges, creates efficiencies in the highway and transportation sector, and provides information to support policy decisions through its Research and Technology (R&T) Programs. The FHWA conducts advanced and applied research, coordinates and collaborates with other research organizations, both nationally and internationally, to leverage knowledge, and develops and delivers solutions to address highway transportation needs. The FHWA is uniquely positioned to identify and address highway issues of national significance, and build effective partnerships that leverage and maximize the value of the federal investment in highway research and technology investment.

The primary goal of the FHWA R&T programs is to deliver research and development of national significance addressing critical knowledge gaps that are not effectively addressed by other highway research sponsors and to accelerate implementation of technologies to meet current and future highway transportation needs. The FHWA R&T program is responsible for conducting research and technology transfer activities that produce a clear public benefit; support Federal stewardship roles; meet and address current and emerging needs; and ensure the coordination of highway research and technology transfer activities. In pursuit of these responsibilities FHWA's role is to conduct research, in coordination other research partners, that addresses market failures of national significance that may exist due to the level of risk or the long-term nature of certain innovation development processes. The FHWA R&T program also aims to maximize value and avoid duplication by focusing on innovations with broad applicability and by leveraging our programs aimed at successful technology transfer. The FHWA R&T program also ensures that critical technical expertise is available in times of crisis or for sensitive matters. This includes an ability to provide technical support during natural disasters, participate in sensitive Federal investigations, and work with other Federal agencies on issues related to national security and defense.

The FHWA R&T programs cover the entire innovation life cycle, including agenda setting, conduct of research and development, technology testing and evaluation, and the deployment and evaluation of market-ready technologies and innovations. This holistic approach to innovation allows FHWA and the USDOT to serve as national leaders in transportation, thus providing the Agency and Department legitimacy in shaping the direction of innovation development in support of national interests. This credibility and influence ensures that, in working with our partners, we are collectively pursuing a transportation future that is aligned with the strategic goals of the agency and promoting the most safe and efficient transportation system for the taxpayers. Without the FHWA R&T program the Nation would lack strategically aligned innovation development and deployment activities resulting in world-class technical expertise, relevancy, and strategic influence to ensure that the public has access to the safest, most reliable, and most resilient infrastructure.

The FHWA R&T program is structured to adjust to year-to-year changes in priorities and emerging needs. In addition, the FHWA programs utilize long-range roadmap processes that support iterative technology and innovation development as well as transition steps that move lab-validated innovations to field testing and, eventually, to full deployment. The FHWA R&T roadmaps were updated in response to the release of the U.S. Department of Transportation (USDOT) Strategic Plan. This Annual Modal Research Plan reflects those strategic adjustments in the FHWA R&T program investments for fiscal years (FY) 2019 and 2020. The funding amounts allocated to the R&T programs presented in this plan are the result of a cross-agency review of prioritized needs that are responsive to Agency and Departmental goals and ensure adequate investment and progress in meeting those goals.

The FHWA has a long history of strong partnerships with the States, Federal agencies, academia, and private industry to coordinate efforts and leverage the unique capabilities of each to advance shared goals. The FHWA R&T programs are coordinated with R&T conducted through the University Transportation Center (UTC) research program, the Transportation Research Board's National Cooperative Highway Research Program (NCHRP), and State-based R&T initiatives. In addition, FHWA develops joint strategies to address USDOT goals with modal stakeholders, including Federal Transit Administration (FTA), Federal Railroad Administration (FRA), National Highway Traffic Safety Administration (NHTSA), Federal Aviation Administration (FAA), and Federal Motor Carrier Safety Administration (FMCSA). The FHWA provides unique capabilities to support research that is of national significance but which other partner organizations and private industry are unable or unwilling to conduct. Working within this partnership framework, the FHWA strategically identifies opportunities for collaboration, coordination, and independent research that advances the goals of the Agency and the Department. The FHWA also works closely with the TRB-sponsored advisory group, the Research and Technology Coordinating Committee (RTCC), which is comprised of academic and industry specialists, to provide an outside perspective on the direction of the R&T program as well as identify future opportunities for coordination and collaboration. This independent evaluation and consultation provides valuable insight into the opportunities for continuous improvement within the R&T programs.

FHWA's Office of Research, Development, and Technology (RD&T) is located at the Turner-Fairbank Highway Research Center (TFHRC), a federally owned and operated national research facility in McLean, Virginia. The TFHRC houses more than 20 laboratories and support facilities, and conducts exploratory and applied research. The TFHRC staff administers the majority of FHWA's research and development activities in the areas of infrastructure, operations, and safety. Research in areas of Intelligent Transportation Systems (ITS), policy, innovative finance, planning, operations, and the environment is primarily conducted or administered by FHWA offices located at USDOT Headquarters. The deployment of research products is led by the subject area program offices at USDOT headquarters and through the headquarter-based Office of Innovative Program Delivery in cooperation with Technical Service Teams based in the FHWA Resource Center.

FHWA's core Research and Development (R&D) programs improve safety, reduce congestion, enhance infrastructure design and construction, and provide data and analyses to decision-makers throughout the transportation community.

- The Safety research area addresses the contributing factors to deaths and injuries related to roadway design, construction and maintenance, and develops robust data analysis tools that enable transportation professionals to match those contributing factors with cost-effective countermeasures. The FY19 FHWA Safety R&T Programs will invest in topics such as data-driven safety plans to reduce rural roadway departures as well as development of a Level 2 capable Automated Vehicle for field research to evaluate human behaviors related to automated vehicle technologies.
- The Infrastructure area engages in forward-looking research that supports safety, durability, resilience, environmental sustainability and asset management. FHWA infrastructure research outcomes stimulate economic growth, productivity and competitiveness through contributions to improved mobility and accessibility. The FY19 program will accomplish this by conducting R&T aimed at improving bridges and roads through the advancement of test methods and specifications, including the promotion of best practices for using unmanned aerial systems (UAS) in highway construction and inspection as well as the development of degradation resistant solutions for steel and concrete bridges that result in improved infrastructure durability. The Infrastructure area will also provide technical assistance and resources to State and local partners through activities that include developing analytical tools for calculating cost-benefit analysis and program prioritization that are needed by States and MPOs for Transportation Performance Management implementation as well as developing and demonstrating the return on investment of Building Information Modeling (BIM) for highway construction.
- The Operations area develops innovative technologies and processes that lead to system-wide improvements in how FHWA and its State and local partners manage and improve the efficiency and reliability of the National Highway System (NHS). The FY19 FHWA Program will invest in topics such as development of a Concept of Operations for near-term deployment of automated driving systems (ADS) into a mixed traffic environment as well as the development of technical guidance and resources to support public agencies planning for and pursuing integration of advanced technologies (e.g., AI, Machine learning, decision support subsystems). The Operations area will also continue to support freight mobility to enhance the movement of goods and support economic competitiveness through efforts such as an analysis of urban and rural intermodal freight connectors, producing improved analytical tools, peer exchanges, and dissemination of best practices to State and local partners.
- The Policy area offers comprehensive quality data, evaluates the impacts of a broad range of policy options, and analyzes current and emerging issues that will affect the way transportation projects are regulated and permitted, and how transportation systems are constructed, operated, and maintained. The FY19 Policy Programs will explore alternative private sector data sources, improve a variety of data collection methods, take advantage of "big data" for integrated and linked data systems, and support research to identify policies to streamline the regulatory process. The Policy area will conduct important studies on topics such as policy alternatives and

system impacts for emerging technologies including shared modes, on demand transportation, automated and connected vehicles, alternative fuel vehicles, and multimodal corridor investments. Additionally, the Policy area will establish a framework and quantitative tools for assessing market viability and economic impacts of emerging transportation services, including shared mobility, at varying population densities, levels of access, and socio-economic characteristics.

- The Planning and Environment area assesses new tools and processes that consider the complex relationships among individuals, communities, the economy, and the environment, to enable better decisions and lead to improved outcomes. The FY19 FHWA Planning and Environment R&T Programs will invest in topics such as regulatory reform that expedites environmental review, permitting, and project delivery as well as develop the next generation of transportation models and scenario planning tools, which integrates research on the impacts of emerging technologies, including automated and connected vehicles, on system performance.
- The Exploratory Advanced Research program conducts longer-term, higher-risk research in all the research areas above. These research products have the potential for dramatic breakthroughs in transportation. The FY19 program will support research on advanced topics such as new methods in machine learning for analyzing unstructured data to improve highway safety as well as next generation technologies for connected vehicles to improve highway system mobility.

The technology and innovation deployment efforts under the R&T program aim to accelerate the adoption of proven innovative practices and technologies as standard practices to significantly improve safety, system efficiency, infrastructure health, reliability and performance, and livable/sustainable communities.

- Every Day Counts Program *(EDC)*: EDC identifies under-utilized, market-ready technologies with high pay-offs and accelerates their deployment and acceptance throughout the Nation.
- Accelerated Innovation Deployment (AID) Demonstration Program: Provides incentive funding for eligible entities to accelerate the implementation and adoption of innovation in highway transportation.
- State Transportation Innovation Council (STIC) Incentive Program: Offers technical assistance and up to $100,000 per STIC per year to support the costs of standardizing innovative practices in a State Department of Transportation (DOT) or other public sector STIC stakeholder.
- *Memorandum of Understanding (MOU) with American Association of State Highway Transportation Officials (AASHTO):* The MOU supports a cooperative agreement between the AASHTO Innovation Initiative (AII) and the FHWA Center for Accelerating Innovation (CAI) for AII to serve as AASHTO's point of contact for stakeholder engagement in EDC and to collaborate on the deployment of EDC and foster the EDC innovation pipeline. Beginning in FY 19, AII will support FHWA as technical peer evaluators on Accelerating Market Readiness proposals received from external sources.
- *Accelerated deployment of pavement technologies*: The FAST Act extends the designation of $12 million per fiscal year to promote, demonstrate, support, and

document the application of innovative pavement technologies, practices, performance, and benefits.

Each USDOT modal administration is responsible for ITS requirements, guidance and research relevant to that mode, and uses a combination of mode-specific funding and dedicated ITS funding to accomplish that mission. Some JPO funds supplement modal research activities where additional revenues are needed to meet program objectives or to ensure synchronization with USDOT multimodal needs. ITS JPO also has a role in coordinating USDOT's overall ITS research program to ensure multimodal collaboration and avoid duplication of efforts. Staff from ITS JPO and modal agencies work jointly to accomplish the defined ITS research program and avoid duplication. The research programs and funding discussed in the FHWA AMRP do not directly include the $100 million dedicated ITS research program, which is discussed in the OST-R section of the plan, with one notable exception. The dedicated ITS research program provides $21 million of the $60 million annual ATCMTD grant program funding. FHWA administers the ATCMTD program. In addition, FHWA's Connected and Automated Vehicle Research and Transportation Systems Management and Operations Research areas may receive additional funding from the dedicated ITS research program to fully accomplish their objectives, but the funding totals shown in the following sections reflect only funding from FHWA's HRD and TIDP programs. Finally, FHWA administers the ITS JPO, providing staffing and administrative processes.

Technology Transfer

FHWA has embraced a culture of innovation and actively supports and advances innovation across the entire breadth of FHWA's activities. FHWA has woven innovation into its business practices, from the development of innovative technologies at its world class Turner-Fairbank Highway Research Center; to the Office of Innovative Program Delivery (OIPD) that works across FHWA and with our partners to identify and focus innovations for implementation; to its field structure in the Office of Technical Services and its Division Offices that provide technical assistance to our State and local partners to deploy the innovations; to its Federal Lands Highway program that works with our Federal partners (e.g., National Park Service) to deploy innovations on transportation assets on federal lands. The innovation life-cycle is tracked across these different components through multi-year roadmaps to promote parallel development and deployment tracks and to ensure a comprehensive view of what is needed to advance innovation. This promotes cost-effectiveness and timeliness in the innovation development and deployment process, thereby ensuring that FHWA is continually serving a good stewards of taxpayer funds. Across the Agency, FHWA has the organizational capacity to advance innovation through two primary methods – the identification and development of innovative technologies and practices, and the implementation of innovation at the Federal, State and local levels.

FHWA has traditionally used a multi-prong approach to deploying new and proven technologies and transportation-related innovations and processes. This includes direct technical and financial assistance, training, peer exchanges, collaboration with industry groups to disseminate knowledge and information, and evaluation of deployment methods to determine effectiveness, assess needed improvements, and document outcomes.

Key deployment and technology transfer (T2) stakeholders include State DOTs, Federal Land Management agencies, local agencies and industry groups. Additionally, the Local and Tribal Technical Assistance Program centers play a critical role in T2 activities. These stakeholders are often the intended audience for the FHWA R&D programs' research outputs.

In the early stages, as an innovation or technology moves from research to development, FHWA will seek out willing State and local transportation agencies to pilot new technologies or be early adopters. The pilot States and other early adopters often receive financial and technical assistance to mitigate the increased risk of using new technologies or initiatives or to offset unprogrammed costs.

As the innovation or technology becomes more mature and is ready for more widespread use, training aids are developed for delivery and early adopters often become "lead" States. Lead States share best practices, challenges, and successes and encourage others to adopt the innovation. Peer exchanges and pooled funds are extremely effective ways for States or other transportation agencies to directly share knowledge and information and transfer technology.

FHWA strongly encourages the use of market-ready technologies and innovations. Specific programs provide resources that enable States and local agencies to accelerate the speed with which innovative technologies and practices enter into standard practice. Resource Center technical specialists, program office subject matter specialists, and field office personnel encourage their use during regular office visits and in program discussions with stakeholders. State and local agencies are key motivators in encouraging the use of these technologies by their peers as they are best positioned to discuss how these innovations addressed their transportation issues and provided benefits and efficiencies.

Lastly, a robust evaluation program is critical to sharing results and quantifying the overall benefits gained by Federal, State and local transportation agencies and the traveling public. FHWA's evaluation programs include both output and outcome measures. Output measures are key to describing the overall saturation of a technology or innovation. Outcome measures assist with measuring the overall performance of the program and help refine and improve technology transfer efforts.

The primary funding sources for technology transfer activities is the Technology and Innovation Deployment Program (TIDP), authorized under 23 U.S. Code § 503(c). TIDP funds efforts to accelerate the implementation and delivery of new innovations and technologies that result from highway research and development to benefit all aspects of highway transportation and eligible activities, including:

- Deploying research results and products developed under the Highway Research and Development program;
- Establishing and carrying out demonstration programs;
- Providing technical assistance and training to researchers and developers;
- Developing improved tools and methods to accelerate adoption of proven innovative practices and technologies as standard practices; and
- Implementing the Future Strategic Highway Research Program findings and results. [23 U.S. Code §. 503(c)(2)]

All FHWA R&D project data and published reports are transmitted to the USDOT Research Hub and the National Transportation Library Repository and Open Science Access Portal (ROSA P). This includes all data elements that currently make up a complete data entry in Research Hub. The FHWA is working with the Office of the Undersecretary for Research (OST-R) to revise the current beta version of Research Hub to provide more real-time upload of project activity and to improve the ability to track views and downloads of projects by FHWA R&D Program area and downloads of reports and data sets. In 2019, FHWA will initiate work to fully transfer the FHWA Research Projects database to Research Hub.

The FHWA R&D Program submits information on Technology Transfer activities through OST-R to support the Department of Commerce (DOC) Federal Laboratory T2 Fiscal Year Summary Report to the President and the Congress in accordance with 15 U.S. Code § 3710(g)(2).

Evaluation / Performance Measurement

The FHWA R&T Program purpose is to identify and address issues of national significance that cannot or will not be pursued by other research sponsors, including needs that require high-risk, long-term, distinctive areas of research. In this role, FHWA shapes and executes a national research and development, deployment, and training program that produces and delivers the solutions needed to meet current challenges, assesses future needs, and responds to those needs proactively and effectively. FHWA relies on both internal measures of performance as well as input and feedback from our partners to ensure that our R&T investments are addressing priority needs and producing the desired results.

The R&T Program Evaluation effort is able to show the value of select innovations and technologies developed or deployed through the FHWA R&T Program. However, due to the extended interval between development of innovations and sufficient deployment to provide data for evaluations and the inability to separate out the individual effects of a given product or innovation relative to impact of others that are addressing the same goals, it is not always possible to evaluate the individual contribution of a given technology or innovation on a holistic level or within a short timeframe. As such, FHWA considers and measures the performance of the R&T program from many levels, including the identification of research priorities, effective project management, targeted deployment, and finally, through end-state evaluations of deployed innovations and technologies.

Selecting the right research:
The research activities of the FHWA R&T Program are closely aligned with our industry and governmental partners through active coordination with appropriate organizations including TRB and AASHTO, as well as coordination through the FHWA division offices, which work directly with the State DOTs to identify emerging needs. These partnerships have existed for decades and have built-in structures that allow for insight and coordination of each organizations' research efforts. In particular, the R&T program leverages relationships with the AASTHO Special Committee on Research and Innovation (R&I), other AASHTO Committees, the RTCC, and TRB committees to ensure that research priorities are aligned with State, local, and industry partners. Feedback received through these relationships help guide the research direction of the Agency to ensure we addressing existing needs as well as addressing longer-range requirements.

In addition, FHWA has developed several tools and datasets to support robust analyses to establish performance baselines, conduct modeling and simulation of proposed innovations, and assess the aggregate impacts of innovations over time. These tools and datasets are typically developed in cooperation with State and local DOTs and are available for use by researchers in the government, academia, and industry, both nationally and internationally. FHWA, other USDOT modes, and our partners use these data and tools to track the long-term performance of the highway system. By providing a holistic view of the highway system, FHWA and its partners can identify where the greatest improvements have been made and where research is still required and invest accordingly.

Monitoring and evaluating project performance:
Once the research priorities are identified, the R&T programs conduct individual research projects, which employ a variety of methods to quantify the potential impact of innovative products, procedures, and concepts throughout the project lifetime. These assessments may be produced through simulation and modeling, laboratory testing, and piloting innovations in a controlled environment. In many cases, FHWA will partner with one or more public agencies to conduct pilots on public roads. These efforts provide estimates, with varying degrees of reliability, regarding the potential impact of the innovation.

Research results and deliverables from the FHWA HRD program may be integrated into and disseminated through FHWA technical guidance, presented in the form of draft standards to organizations such as AASHTO for possible adoption, or handed off to other FHWA deployment programs, the FHWA Resource Center, and Local and Tribal Technical Assistance Programs for implementation and end-user outreach.

Technology and innovation deployment:
The EDC program has had a significant positive impact on the transportation community's adoption of new technologies and processes. Since the program began, every State transportation agency has used 14 or more of the 43 EDC innovations advanced through the program, and some have adopted more than 30. Many of these innovations are now mainstream practices across the country. The State Innovations Accomplishment Map, available at: https://www.fhwa.dot.gov/innovation/stic/state_innovation.cfm, illustrates State by State participation. The FHWA compiles a semi-annual report on the state of practice of the current round of EDC innovations, which illustrates the progress made in advancing the technologies and practices, the innovation implementation stage in each State, and the number of States that have demonstrated, assessed or institutionalized each innovation. This implementation stage is compared to the baseline at the beginning of each EDC round and the goal set for the innovation by each State.

R&T Program Evaluation:
While individual research programs aim to contribute to the overall performance of the highway system, whether through enhanced infrastructure performance, reduced congestion, or lives saved, the overall measurement of the effectiveness of research programs, and even specific projects, in relation to these goals, is difficult. To address this issue, in 2014 the FHWA initiated the R&T Program Evaluation effort, with the goal of examining the impact of select projects within the FHWA R&T portfolio. In addition to quantifying the effects of these innovations and technologies, the program also explores why these programs were successful as well as what can be improved. Based on these results, FHWA ultimately works in consultation with the RTCC to identify where process improvement and strategic investment opportunities exist within the FHWA R&T program.

Further, FHWA works closely with State and local DOTs to track progress from deployment of innovative products, technologies and processes. These reports are posted on FHWA websites and presented to stakeholders. Results and lessons learned from technology transfer activities, and the interaction with stakeholders during and after the deployment inform further lessons learned reporting, dissemination programs and follow-on research.

Acquisition and Assistance

FHWA uses a broad array of acquisition and assistance mechanisms to support and stimulate highway related research. FHWA's research funding is authorized by statute to allow discretion in the selection of contracts, grants, cooperative agreements, and interagency agreements where appropriate for the specific project. The selection of the appropriate acquisition or assistance vehicle is made by a warranted Contracting Officer in FHWA's Office of Acquisition and Grants Management in consultation with the requiring program office. This decision is made at the earliest stage of the planning process and helps shape important factors such as the degree of control FHWA may have in the direction of the project, rights in ownership of research results, potential leveraging of non-Federal funds, and the marketplace of interested vendors or recipients.

Acquisition – contracts and purchase orders

Acquisition encompasses the mechanisms used to acquire supplies or services primarily through the issuance of contracts and purchase orders that are for the direct benefit of the Government. The term contract applies to awards made for supplies or services of value above the Federal Acquisition Regulation's Simplified Acquisition Threshold (currently $150,000). Simplified acquisition procedures, which are quicker and more streamlined, may be used for needs under $150,000. An acquisition award under $150,000, using simplified acquisition procedures is referred to as a purchase order – within the FHWA research program purchase orders are most commonly used to acquire supplies necessary for laboratory operation.

FHWA strives to utilize the most efficient and effective methods to support research activities with contracts that offer economical, best value for the taxpayers while engaging myriad highly sophisticated private sector organizations; ranging from small disadvantaged business enterprises to Fortune 500 corporations and universities. The FHWA research program has highly diverse needs. Examples of common research funded contracts include: the procurement of scientific, engineering, and testing equipment for nondestructive evaluation of highway structures; engineering and professional services to operate the Turner-Fairbank Highway Research Center laboratories; studies to investigate connected-automated vehicle technology, improve the longevity of pavements and bridges, and enhance the safety of guardrails and other roadway devices; training for State DOT officials; and technology transfer to share research results with States, localities and industry. Contract types span the breadth from short term firm fixed price awards and cost reimbursement studies with uncertain outcomes to multi-year indefinite delivery indefinite quantity awards the allow expeditious ordering of goods and services. Additionally, solicitation methods such as Broad Agency Announcements (BAA) enable industry to propose unique and innovative solutions to address problem statements and allow FHWA to make multiple awards from a single announcement and using both acquisition and assistance award types. The Exploratory Advanced Research Program is a key example where BAAs have yielded highly successful results.

Assistance – grants and cooperative agreements
Assistance describes the process by which the Government provides support to accomplish a public purpose that is authorized by Federal statute – such as the Highway R&D program. The instruments used to carry out assistance are grants and cooperative agreements. The majority of FHWA's research grants and cooperative agreements require a minimum non-Federal matching contribution, typically 20 to 50 percent, as required by the specific legislative authority for the program. Grants and cooperative agreements are similar and are governed by the same regulations found in 2 CFR Part 200. The distinction between the two is the degree of Federal involvement in the carryout of the specific award. Grants are used when no substantial government involvement is envisioned in the technical direction of the award. Cooperative agreements are used when FHWA contemplates substantial technical involvement during performance with the recipient. Cooperative agreements constitute the majority of the assistance activity within the FHWA research program.

Typical recipients of FHWA grants and cooperative agreements are universities and non-profit organizations such as the American Association of State Highway Transportation Officials (AASHTO) and the National Academy of Sciences.

Interagency and Intra-agency agreements (IAA)
Interagency and Intra-agency agreements are awards between FHWA and another Federal entity. An interagency agreement is used if the partner agency is outside the USDOT. Intra-agency agreement is the term when the partner agency is another USDOT operating administration. FHWA's research program both receives funds to conduct work for other agencies and sends funding to other agencies to participate in collaborative research of interest to both partnering agencies. Aside from the Volpe Center, nearly all FHWA research funded IAAs are awarded under the authority of the Economy Act, which requires a determination that it is more efficient and economical to conduct the work with the specific partnering agency versus contracting with the private sector. IAAs with Volpe are not subject to the Economy Act as the Volpe Center has specific authority to perform research for USDOT operating administrations.

Alignment with Administration Priorities

Economic Impact of Regulatory Reform
Through the Accelerating Project Delivery Program FHWA continues to pursue opportunities to show the impact of regulatory reform and support work to accelerate project delivery through interagency collaboration, capacity building for environmental practitioners, integrating planning and environmental processes, and disseminating information about environmental program and process efficiencies. One of the highlighted, recently completed projects related to the Indiana Bat and Northern Long-Eared Bat Programmatic Consultation shows how a coordinated effort between multiple Federal agencies to reduce the burden associated with regulatory process. This program will continue to conduct assessments related to regulatory reform, including the implementation of One Federal Decision to identify the value and impact of those measures.

Economic Impact of Permitting Reform
By continuing an effort that began in FY18, the Accelerating Project Delivery Program will conduct a study to improve our understanding of how benefits may accrue due to accelerated project delivery times. The assessment will focus on determining the economic benefits of a shortened NEPA and permitting timeline for transportation agencies, businesses, and the general public.

Performance-Based Regulations and Safety
The FHWA Safety Program will advance the use of scientific methods and data-driven decisions to reduce the number and severity of crashes on our rural and urban roadways. FHWA uses safety data to identify those areas with the greatest need for improvement because understanding the most prevalent safety problems on our roadways is the first step in solving them. Data effectively drives the Office of Safety program and focus areas, informing our efforts at each step along the way. FHWA utilizes a "Focused Approach to Safety" which prioritizes resource investment toward three critical areas identified as providing the greatest potential to reduce highway fatalities using infrastructure-oriented improvements are namely roadway departure, intersection crashes, and pedestrian/bicycle crashes. This approach increases awareness on critical severe crash types, leads to key safety infrastructure improvements, assists in prioritizing limited resources, and creates positive organizational changes in safety culture, policies and procedures. In FY19 this program will continue to implement FHWA safety programs legislative requirements; inform Congress, State DOTs, other Federal, State, and local government agencies, Tribes, academia, and the public about how FHWA safety resources are invested and the safety improvements achieved from FHWA efforts; strengthen States' abilities to implement a performance driven safety program by sharing information, training, and assistance; improve technical capacity of transportation safety professionals at all levels of government to advance safety programs; foster a safety culture through technical assistance and marketing and communications programs; and promote an integrated, multidisciplinary (4E's) approach to safety.

Potential Impact of Asset Recycling
FHWA is not investing research and technology funds into studies related to Asset Recycling.

Potential Impact of Value Capture
The Innovative Program Delivery (IPD) Program description provides tools, training and technical assistance that support the transportation community's use of cutting-edge financial and procurement strategies to deliver critical infrastructure projects – including Value Capture. Value capture begins with the value created by the access transportation provides. Value is then enhanced through private sector investment and economic development enabled by the public investment. A portion of that value created by the infrastructure can be "captured" by the public sector to reinvest in, operate, or maintain transportation infrastructure. The IPD will include education materials describing the successful implementation of "value capture" techniques to help finance transportation projects via the incremental property value generated by the project itself. The IPD will support development and deployment of Value Capture guidebooks and training courses.

Improving the Mobility of Freight
FHWA's Offices of Operations Freight Management and Operations Research, Development and Technology (RD&T) Program are developing and supporting innovative technology and processes that lead to system-wide improvements in how FHWA and its State and local partners and other stakeholders manage and increase the reliability of the National Highway System and the movement of people and goods throughout the transportation networks. The objectives of this program are to assess the condition and performance of key freight infrastructure; improve the understanding of the impact of freight movement on this infrastructure and vice versa; develop and improve freight data analytical tools, data collection techniques and standards, and industry data analysis methods; and convene stakeholder forums and outreach, peer exchanges, pilot implementations, and technology transfer to help ensure safe, durable, and high performing infrastructure. In addition, system-wide improvements to mobility, such as managing disruptions to traffic flow operations and improved transportation system management developed and supported by the Managing Disruptions to Operations Program and the Transportation Systems Management and Operations Program - will provide benefits to all road users, including the freight community. In addition, the Truck Size and Weight (TSW) Research, Development and Technology (RD&T) Program will provide States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in harmonizing oversize and overweight (OS/OW) permitting requirements.

Feasibility of Micro-Transit
FHWA is not investing research and technology funds into studies related to micro-transit.

Improving Mobility for Underserved Communities

In FY19, the Safety Design & Operations Program will work with State and local agencies to develop data-driven safety plans to reduce rural roadway departures, which account for a disproportionate number of roadway fatalities. Additionally, the Policy Analysis and Global Outreach Program will initiate a new study to provide new insights on future policy considerations and alternatives that are unique to rural communities in the context of emerging trends and technology driven transportation modes and services. Specifically, this study will identify rural transportation supply and demand drivers; identify needs and barriers to access; and quantify the costs and benefits of alternatives.

Cybersecurity

In FY19 the Transportation Systems Management and Operations Program will conduct research to 1) identifying highway system cybersecurity vulnerabilities related to technology-based deployments and transportation operations assets, such as traffic signals and traffic management centers, and 2) working with partner agencies, associations and system manufacturers to define systematic strategies to address them vulnerabilities and advance the state-of-the-practice.

New High-Priority Projects for Fiscal 2019

Research Project Name/Topic Area	Modelling AV Performance
Total Funding in FY19	$500,000
Period of Performance	March 2019 – Dec. 2020
AMRP Program	Automated Vehicles

What are the anticipated outcomes of this project?

Automated vehicles (AVs) have the potential to yield significant safety, mobility, environmental, and energy benefits to our Transportation system. These benefits may include crash reduction, reduced travel times, improved travel time reliability, and reduced vehicle emissions and energy consumption. As these AVs are introduced into the traffic stream, there will be changes to the overall transportation system. These changes or impacts caused by the AVs need to be assessed. Analysis, Modeling and Simulation (AMS) tools are needed to quantify these changes or impacts to the transportation system. Currently, these AMS tools are not at the stage where they are capable of analyzing AVs and their impact to the general driving population. Further research needs to be undertaken to:

1. Improve the AMS tools,
2. Assess different market penetrations of AVs and their benefits/impacts,
3. Assess the various levels of automation,
4. Assess AVs with and without cooperation

FHWA anticipates contributing toward this research initiative in 2019. JPO research funds may also contribute to the FHWA-led research program.

What specific problems will be solved with this research?

The AMS tools will be used to evaluate and enhance the performance of the automated vehicles under various operational scenarios (e.g., vehicle dynamics, road type and configuration, environmental factors such as pavement condition, visibility, temperature, precipitation), various levels of automation with and without the ability of the human driver to take control when necessary, and different levels of cooperation and market penetration. Such testing and evaluation is not possible through real world deployments as it is not feasible to test and evaluate every use case.

Will non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Yes. Car and technology companies and Original Equipment Manufacturers (OEMs) developing the innovative technology and control logic as well as the on-board units in vehicles will serve as partners in this work. Additionally, universities conducting research, building smart test tracks, simulation technologies, and the commercial simulation models that will enable the evaluation of the use cases will be active partners. The data required to be able to evaluate and enhance the performance of the automated vehicles will be obtained through these partners including control logic, performance and interaction between human-driven vehicles and self-drive vehicles.

Who are the beneficiaries of this research and how will they benefit?

Transportation agency policy-makers (USDOT, states, MPOs) are expected to benefit from this research by helping them assess the safety, mobility, environmental and energy benefits of the automated vehicle technology, assist them in developing guidance on the safe deployment and operation of these vehicles, and support transportation agencies in making informed decisions for infrastructure investments and develop safety regulations.
Why do we need to make this investment in research? Why should this research be funded by the government and not the private sector?
Currently, the private sector is developing the automated vehicle technology and is very rapidly evolving. Each car manufacturer and OEM is developing and testing their vehicle equipment and technology to ensure safe operation. This research will help in the estimation and prediction, with some degree of confidence, of the outcome of these vehicles being deployed at such a rapid pace. It will assist government policy makers in their decision on the path forward in terms of automated vehicle deployment and the levels of automation, market penetration, and level of cooperation to gain the greatest benefits in terms of safety, mobility, environment and energy. It will assist in the evaluation of the transportation system as a whole to ensure that these vehicles are operating in the most optimal manner under various operational conditions and scenarios. It will assist in determining what infrastructure investments are needed to ensure that the automated vehicles and their interaction with the roadway and human-driven vehicles are coordinated and synchronized in the most effective and efficient way.

Research Project Name/Topic Area	Rural Transportation – Emerging Mobility, Economic Vitality, and Safety Opportunities
Total Funding in FY19	$450,000
Period of Performance	2019-2020
AMRP Program	Policy Analysis and Global Outreach

What are the anticipated outcomes of this project?

Building on FHWA rural transportation policy research, this project further explores and quantifies opportunities and barriers for rural mobility, economic growth, and safety. Given the shift in transportation options such as shared mobility and the emergence of connected and automated vehicles, particularly in urban/suburban settings, it is critical that research is conducted to understand the impacts of these changes as they migrate to rural environments. It is likely that demographics, geography, and access to technology will pose unique opportunities and risks in these environments. This research will provide new insights on future policy considerations and alternatives that are unique to rural communities in the context of emerging trends and technology driven transportation modes and services. Specifically, this study will identify rural transportation supply and demand drivers; identify needs and barriers to access; and quantify the costs and benefits of alternatives. The outcome of this study is a cost benefit evaluation and comparison of various technology driven rural transportation options against a "no investment" scenario, including externality effects, and other social benefits.

What specific problems will be solved with this research?

The impact of technology driven transportation services such as ride-hailing apps and shared mobility on rural communities is unknown. Both the feasibility and net benefits of technology driven transportation solutions have not been examined for rural communities. It is likely that these emerging technologies may provide opportunities for increased access, mobility, economic vitality, and safety. This research provides a quantitative assessment of specific scenarios and solutions and will present much needed insight into the feasibility of adoption and implementation and net benefits to rural communities and the nation as a whole. This research provides FHWA with the information needed to prioritize policy and program needs and sets the baseline for measuring progress on rural transportation initiatives.

Did non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Yes. FHWA has coordinated extensively with non-governmental partners on rural transportation research, and, in particular, future mobility solutions in the context of emerging trends and transportation services. For this project, FHWA will partner with non-governmental groups through a cooperative agreement.

Who are the beneficiaries of this research and how will they benefit?
The crosscutting scope of this study will benefit the public by providing actionable information for decision makers on rural transportation policy options. This will provide the information that FHWA and other Government Agencies will need to set policy priorities to ensure access and benefits from emerging technology-driven technologies in rural communities. This allows decision makers to use public funds efficiently by prioritizing investment decisions that are supported by actual data on how the mobility, economic vitality, and safety of rural transportation will be affected. This research will also benefit state agencies on short- and long-term planning and performance measurement.
Why do we need to make this investment in research? Why should this research be funded by the government and not the private sector?
This research will support initiatives that align with Administration priorities. The associated work may lead to changes in policies or programs that are managed by FHWA and are inherently governmental responsibilities. Also, because rural spending does not always have a positive return on investment, research on rural transportation services may not be a priority for the private sector. This research will not only identify needs for the overall public good, but also may uncover niche markets and untapped demand for private sector participation.

Research Project Name/Topic Area	SHRP2 Safety Pooled Fund Study (PFS): Advancing Implementable Solutions
Total Funding in FY19	$1,000,000 FHWA R&T / $1,300,000 State DOTs
Period of Performance	2019 - 2022
AMRP Program	Safety Data and Analysis

What are the anticipated outcomes of this project?

The goal of this pooled fund study is to conduct practical research in the broad areas of Safety, Operations, and Planning using the groundbreaking SHRP2 Naturalistic Driving Study (NDS) data and the companion Roadway Information Database (RID), collectively known as the SHRP2 Safety Data. Since the 'system' of driver-vehicle-roadway and driving conditions was captured, the value of these data would not only support research in the individual areas above but in a connected-automated roadway system as well.

Drivers cause or contribute to over 94% of all crashes, resulting in a tragic loss of life and serious injuries in the U.S. Understanding driver behavior is critical to achieving our goal of Zero Fatalities in this country. In the past, research has studied driver behavior only indirectly by examining crashes and attempting to reconstruct the events that produced them. However, creation of the SHRP2 Safety Data provided researchers with the most comprehensive database of direct observational data of real-world driving behavior ever gathered. Over 2 petabytes of data were collected during a two-year period from approximately 3,200 volunteers in 6 sites across the U.S. The SHRP 2 NDS data provides information on the driver and driving behavior; individual trip characteristics, including events (crashes and near-crashes); non-event 'normal' driving (exposure data); and vehicle characteristics and performance. The data are geo-referenced, allowing driver behavior to be associated with the physical environment, such as signs, other roadside hardware, and road design details, as well as with transient elements of the driving environment such as work zones and weather.

Research using this data is expected to answer questions about how drivers react to the environment and how they make decisions under different conditions. Answers to these questions will allow us to develop more effective safety countermeasures, improve predictive models, design guidelines and policies, and ultimately, provide a safer more reliable transportation system for all users.

What specific problems will be solved with this research?

The Technical Advisory Committee (TAC) for this pooled fund developed a candidate list of 37 projects, which will be sent to the AASHTO Research Advisory Committee (RAC) on May 1, 2018 for their input on prioritization.

The objectives of this pooled fund are to:

- conduct groundbreaking research using the SHRP 2 NDS data and RID that will result in a more efficient, reliable, and inherently safer experience for road users,
- advance development of implementable solutions that address issues of high-priority to State and Local transportation agencies with an emphasis on the broad areas of Safety, Operations, and Planning,

- create a venue for highway practitioners in the above broad areas to share information and collaborate on research that advances their individual disciplines and addresses cross-cutting areas, including but not limited to, the development of a connected-automated highway system, and
- communicate and collaborate with transportation providers and other stakeholders, to leverage research investments and results and accelerate achievement of our collective goal to provide a safer and more reliable experience for the road user.

Will non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Desired. Creation of the SHRP 2 Safety Data was accomplished via a partnership between FHWA, the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB) at a cost of approximately $70 Million. Currently, those same partners are working together to implement a long-term sustainable plan for operating and maintaining the data that will allow public, private and academic researchers to access and leverage this data for years to come.
Even though the current partners in this PFS are either federal or state government agencies, outreach continues to potential new partners, which could also include interested non-government groups.

Who are the beneficiaries of this research and how will they benefit?

The crosscutting scope of this study will benefit the public through its focus on making the roads safer and more reliable in terms of highway operations. It will provide practitioners with actionable results to help in achieving these goals.

This PFS will be led by FHWA, with active participation from State and Local member agencies, to determine the research that will be undertaken. A Technical Advisory Committee (TAC) will direct the pooled fund activities. Projects with an emphasis in three broad areas—Safety, Operations, and Planning—will be pursued.

The TAC will determine yearly funding allocations for research. Due to the uniqueness of this pooled fund and its crosscutting approach, the TAC should provide adequate representation of the focus areas in the portfolio of projects. The TAC may pursue activities focused on topics that overlap one or more of these areas. Such overlap may support advancing a connected and automated highway system or other high-priority areas identified by the TAC.

The TAC will define the research needs for the PFS, select the projects to be conducted, approve research teams, and oversee the work to ensure the objectives are met. Projects will primarily focus on advancing implementable solutions for state and local transportation agencies. This could include development and improvement of countermeasures, development and improvement of predictive models and design guides, and policy recommendations.

Why do we need to make this investment in research? Why should this research be funded by the government and not the private sector?
The research conducted through this PFS is needed to address the safety, operations, and planning needs of the state and local agencies that operate the transportation network. This research project involves the NDS, which is a unique resource that provides insights on how drivers respond to the roadway designs they encounter. The need for investment in this research is to develop more effective ways of crafting a roadside design that does not impede the driver's capabilities or otherwise cause harm. It is critical to the public trust that safety countermeasures be developed in concert with public agencies working with industry and academia. Only through this approach can safety countermeasures be developed in a precompetitive and unbiased arena. Additionally, although the services of private companies may be procured to conduct some of the research, the private sector would not be capable of shaping safety solutions that can be applied to withstand the rigorous scrutiny that federal, state, and local agencies apply. The private sector does have a substantial role in crafting appropriate safety solutions, and the existing partnership the private sector has with public agencies has led to substantial benefits. This project will build upon the effective partnerships that were developed to address a range of roadway safety matters.

Research Project Name/Topic Area	Promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection
Total Funding in FY19	$200,000
Period of Performance	2018-2021
AMRP Program	Construction and Project Management

What are the anticipated outcomes of this project?

Highway agencies will make effective use of UAS in highway construction and inspection, resulting in improved construction quality, increased safety, quicker completion scheduled, and more cost-effective oversight processes.

What specific problems will be solved with this research?

Sensor technology, post processing, and even airframe payloads capabilities are growing at nearly an exponential rate. This is resulting in the ability to cheaply and quickly gather a wide range of data. The question being raised is what data leads to actionable information and what traditional processes can be reliably changed with UAS technology.

We need to evaluate new sensors, software, and even the airframes to ensure that the quality of this data is at least equivalent to traditional data collection methods. It will also be necessary to understand the cost and benefits of implementing UAS, to ensure both cost and quality and well understood.

Will non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Desired. Non-government groups could play an important role in the advancement of this research, specifically groups such as Association of General Contractors and UAS test sites located at several Universities. These organizations already own large UAS fleets, have access to large computing power and sites that could be used to test innovative UAS technology.

Who are the beneficiaries of this research and how will they benefit?

Highway agencies will be the immediate beneficiaries through more effective, cost-effective construction and inspections. Many construction and other inspection tasks are routine and predicable, which makes them ideal candidates for UAS which can be a highly automated system. For example, after a rain event a UAS could fly a preprogramed path along a silt fence and look for elevation changes from a previous flight to identify silt fence that needs to be replaced or that is at risk due to sediment build up. Automating this task and creating a digital record has the potential to reduce costs while increasing compliance as difficult to access areas could be more easily flown.

Tax payers will be the ultimate beneficiaries through improved construction quality and/or reduced highway costs resulting from the use of this technology. As reliability and proliferation of the technology increases both agencies and contractors can depend on the efficiencies and deliver faster and lower cost projects for the tax payers.

Why do we need to make this investment in research? Why should this research be funded by the government and not the private sector?
This research supports the Department's Innovation and Infrastructure goals. Private sector entities that might find a profit motive to pursue work in this area lack the objectivity required to provide a credible assessment of effectiveness, or be credible in promoting the technology. Several States have already noted both during the FHWA National UAS Roundtable and the NCHRP UAS Domestic Scan that the sales pitch from vendors has not matched the operational capabilities of the UAS platform. If FHWA does not lead an encompassing national effort, then UAS research and deployment activities will likely be disjointed and duplicative resulting in significant delays in realizing the benefits that UAS can provide to tax payers.

Research Project Name/Topic Area	Develop and deliver training and guidance to support effective bridge and tunnel safety inspection practices.
Total Funding in FY19	$600,000
Period of Performance	2018-2020
AMRP Program	Structures

What are the anticipated outcomes of this project?

FHWA will produce revised regulations, guidance, and training to ensure that highway agencies and consultant personnel responsible for bridge and tunnel inspections will do so in a manner consistent with current law, and deliver complete inspection data that accurately reflect the condition of the inspected infrastructure.

What specific problems will be solved with this research?

The National Tunnel Inspection Standards, published in 2015, were developed to ensure that the regulations for tunnel inspections was consistent with the provisions of the Moving Ahead for Progress in the 21st Century Act (MAP-21), which includes requirements for establishing a highway tunnel inspection program, maintaining a tunnel inventory, and reporting to FHWA of inspection results and, in particular, critical findings, which are any structural or safety-related deficiencies that require immediate follow-up inspection or action.

Routine and thorough inspections of our Nation's tunnels are necessary to maintain safe operation and prevent structural, geotechnical, and functional failures. Data on the condition and operation of our Nation's tunnels is necessary for tunnel owners to make informed investment decisions as part of an asset management program for maintenance and repair of their tunnels. Policy and guidance for tunnel inspections need to be updated to reflect lessons learned during the first few years of the tunnel inspection program.

In addition, the National Bridge Inspection Standards are being updated to incorporate the new requirements from MAP-21, to incorporate technological advancements, and address ambiguities identified since the last update to the regulation in 2009. The current guidance and training will be updated to reflect the revised policy requirements.

Will non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

No. Non-government groups will not serve as partners.

Who are the beneficiaries of this research and how will they benefit?

Ensuring timely and consistent inspections of highway bridges and tunnels not only enhances the safe passage of the traveling public, but also protects investments in key infrastructure, as early detection of problems in tunnels and bridges will likely increase their longevity and lead to lower repair costs than problems found later.

Highway infrastructure owners will benefit from up-to-date training so their staff can follow the new regulations and policies. In addition, the data from the inspection will be

more complete and reliable on which to make management decisions and ensure the infrastructure is safe.

The public will benefit from more effective management of highway infrastructure resulting in improved highway safety.

Why do we need to make this investment in research? Why should this research be funded by the government and not the private sector?

Congress enacted the Moving Ahead for Progress in the 21st Century Act in 2012, which required the Federal Highway Administration to develop new regulations for the safety inspection of highway tunnels and to update the regulation for the safety inspection of highway bridges. The tunnel safety inspection regulations were published in 2015 and the bridge safety inspection regulations are in progress.

The bridge and tunnel safety inspection regulations specify the method with which bridges and tunnels are to be inspected, establish the intervals between inspections, establish the qualifications of staff in charge of the safety inspection programs, and collect and submit bridge and tunnel inspection data. In addition, the regulations are needed to ensure bridge and tunnel owners are properly identifying critical findings and then addressing to maintain the safety of the travelling public.

Both sets of regulations have required trainings that agency program managers and inspection team leaders are required to successfully complete for their position. It is through these trainings the Federal Highway Administration can maintain a consistent inspection program regardless of bridge and tunnel type, owner, or location.
The required guidance and training are central to FHWA's responsibility to ensure the safety of highway bridges and tunnels.

Research Project Name/Topic Area	Economic Benefits of Accelerating Project Delivery
Total Funding in FY19	*$300,000*
Period of Performance	*18 months*
AMRP Program	*Accelerating Project Delivery*

What are the anticipated outcomes of this project?

Federal, state, and local decision-makers will be better equipped to deploy best practices for accelerating project delivery. This project will take advantage of FHWA's ongoing efforts to reduce project delivery times to: review prior work; summarize the overall NEPA and specific permitting processes; document practitioner experiences; develop a set of case studies; and quantitatively estimate the potential accrual of benefits from improving typical project delivery times from 72 months to 48 months and from 48 months to 24 months. Finally, the project team will provide an in-person, executive level briefing at the project mid-point as well as upon completion of the research.

What specific problems will be solved with this research?

Additional justification for the economic benefits of accelerating project delivery will provide incentives for deploying best practices. Communicating how reducing project delivery time can potentially improve investment returns will drive the increased use of methods to speed project delivery. This research project will contribute and communicate important information on this strategic issue.

Will non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Yes, we plan to partner with private sector firms in this research via a competitive procurement process.

Who are the beneficiaries of this research and how will they benefit?

Federal, state, and local transportation decisionmakers are the primary beneficiaries. We anticipate second and third order benefits may also accrue in State programs and local economies.

Why do we need to make this investment in research? Why should this research be funded by the government and not the private sector?

FHWA is engaged in an ongoing, multifaceted effort to reduce project delivery times. This research takes advantage of unique synergies with those efforts and administration priorities.

Completed High-Priority Projects from Fiscal 2017-2018

Research Project Name/Topic Area	National Household Travel Survey (NHTS)
Total Funding Amount	FHWA R&T: $6 Million / State and local agency partners: $25 Million
Period of Performance	2015 - 2018
AMRP Program	Highway and Transportation Data

What were the outcomes of this project?

The outcome of this project is the successful delivery of a national multimodal travel behavior dataset on why, how, and when people travel by a range of data dimensions (e.g., age, gender, income, ethnicity, employment status, vehicle ownership, household size, area types - rural and urban), filling a significant information gap and enabling trend tracking.

The project also delivered 12 state and locality specific multimodal travel behavior datasets that addressed special local issues in addition to the universal national data dimensions.

The project delivered a set of new address-based sampling (ABS) methodologies for large scale data collection. The ABS method coupled with web and smartphone based data retrieval approaches for data collection has been proven to be very effective in gaining representative data.

What specific problems that were solved with this research?

The national level dataset fills the national travel behavior data and information gap and builds the historical trend on travel behavior. The localized data offers State and local transportation agencies the latest information on their resident's travel behavior, which would otherwise not be available.

The research work resolved the challenges posed by the failure of the traditional random digit dialing (RDD) sampling survey method resulted from the decline of household landline phones. The research has developed a functional solution with proven field results. The new address-based sampling (ABS) method coupled with web and smartphone data retrieval mechanism is reliable and cost-effective.

Did non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

No.

Who are the beneficiaries of this research and how will they benefit?

FHWA, FTA, NHTSA within the US DOT are direct benefactors from this research. The data offers an inventory of the nation's state of travel behavior, shows travel behavior trends, and offers new information on how technology is affecting people's travel behavior. These data and information enable agencies to understand the current challenges more precisely, see the future needs and demands more accurately, and develop more focused strategies in areas of safety, infrastructure planning, and investment decision making.

Specifically, the information will improve US DOT's ability to a) conduct and perform effective highway safety analysis, 2) evaluate how quickly technology affect people's travel behavior, 3) gain trending data on people's needs with all modes of transportation,

4) forecast future highway travel demand for infrastructure planning, and 5) evaluate transportation investment needs for all modes in a balanced way.

In addition, the latest national data quantitively measures how fast new technologies and businesses models are being adopted and how such adoption affects people's travel behavior (e.g., trip rates, modes used, trip times). Given the rapid development of driverless vehicles and other new technologies related to transportation, the new data enables a more reliable assessment of the impact of such technology's deployment on safety and infrastructure demand.

The 12 locality specific datasets offer coverage for localized areas (e.g., a neighborhood, a county). These data will significantly improve the local agency's ability to a) assess the specific challenges for their transportation needs, b) forecast their regions' future transportation demand with all modes, and c) develop strategies for all their citizens in both rural and urban areas.

State DOTs and Metropolitan Planning Organizations (regardless if they are add-on partners or not) will benefit directly from this research effort. The data delivered by the research will improve the ability of all State DOTs and MPOs to forecast multimodal transportation needs, develop more effective transportation project program, and improve safety analysis and strategy development.

The greater transportation community including academic researchers, private businesses, and not-for-profit organizations will also benefit from this research work. The data offers a trough of information which can be analyzed and utilized in a very broad way for new discoveries and new business opportunities.

The successful ABS based survey method developed is beneficial to all entities engaged in survey information data collection and analysis. These entities can utilize the method with appropriate modification and apply it to their specific data effort knowing the approach will work.

Research Project Name/Topic Area	Freight Intermodal Connectors Study
Total Funding Amount	$420,000
Period of Performance	2014 – 2017
AMRP Program	Freight Management and Operations RD&T

What were the outcomes of this project?

The outcome of this project provided FHWA with information on the use, condition and performance of freight intermodal connectors and options for policy and program initiatives to improve freight intermodal connectors. FHWA conducted a study to provide a comprehensive understanding of the condition and performance of a representative sample of the NHS freight intermodal connectors and to develop options for prioritizing investments.

Final Reports

Freight Intermodal Connectors Study : Freight intermodal connectors are roads that provide the "last mile" connection between major intermodal freight facilities (e.g., ports, airports, and intermodal rail yards) and the National Highway System (NHS). Although the officially designated network of NHS, intermodal connectors account for less than one percent of total NHS mileage. Nonetheless, these roads are critical for the timely and reliable movement of freight. It is therefore important to understand the use, condition, and performance of the nation's intermodal connectors since they have a direct impact on efficient goods movement and economic health.

Findings on Connector Designation, Data to Support Planning, and Incorporation into State Freight Plans : The purpose of the study was to identify and describe options for improving the use, condition, and performance of freight intermodal connectors through the provision of better data for planning and programming. This study describes issues related to the designation of freight intermodal connectors, examines data needs and options for a long-term data program, including the potential for the development of a stand-alone intermodal connector database; reviewed options for improving data quality and amount of data available for planning on intermodal connectors, and developed guidance on how to incorporate freight intermodal connectors into State Freight Plans.

What specific problems that were solved with this research?

Included in the Moving Ahead for Progress in the 21st Century Act (MAP-21) are several provisions that highlighted the importance of obtaining more data and information about intermodal connectors. MAP-21 also used these facilities as criteria for many of its freight related provisions (i.e. Sec. 6303 intermodal transportation databases; Sec. 1115 National Freight Policy). The objective of this work was to conduct research to produce a study that would provide a comprehensive understanding of the nation's intermodal freight connectors.

This includes the following specific project objectives:

Project Objectives

1. Understand how freight intermodal connectors are being used by the industry
2. Understand changes in the freight industry structure and requirements as they pertain to intermodal connectors

3. Evaluate the condition and performance of NHS connectors to major intermodal freight terminals including identifying and calculating performance measures of the connectors during periods of peak and off-peak truck traffic.
4. Determine the relationship between the NHS connectors' conditions and the conditions of the adjacent NHS and surrounding roadway network.
5. Develop an understanding of implications at the Federal, State, local and private levels of the condition, performance and use of intermodal connectors.
6. Review improvements and investments made or programmed for these connectors.
7. Identify impediments and options to making improvements to the intermodal freight connectors, including implementing traffic management and intelligent transportation systems.
8. Identify solutions to better address the needs of the industry and condition and performance of these facilities.

Did non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Yes – A National Freight Stakeholders Focus Group was engaged to ensure case studies were representative of national experiences. This group included private sector representatives across all modes and major industries.

Who are the beneficiaries of this research and how will they benefit?

Intermodal freight connectors are a vital part of our Nation's transportation system, providing critical connections between our ports and rail systems and the highway network that is usually needed to deliver freight to its final destination. There are several beneficiaries of this research. State Departments of Transportation and local governments (e.g. MPOs) will benefit from documented methods for evaluating the condition and performance and using the results of evaluations to inform transportation investment decision-making. Public and private sector freight stakeholders (a port or rail owner, a public terminal operator) can use the data and information from the research as a basis to formulate infrastructure investment strategies that leverage Federal and State, or local transportation funding with other funding sources (e.g. private sector funding) to improve the condition and performance of intermodal connectors.

Research Project Name/Topic Area	Indiana Bat and Northern Long-Eared Bat Programmatic Consultation
Total Funding Amount	$1.2 million
Period of Performance	2012 – 2018
AMRP Program	Accelerating Project Delivery

What were the outcomes of this project?

In May 2016, Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), Federal Transit Administration (FTA), and the U.S. Fish and Wildlife Service (FWS) finalized a range-wide programmatic biological opinion (PBO) for the Indiana bat and northern long-eared bat (NLEB) that included a standardized, landscape-level conservation strategy encompassing the geographic ranges of both bat species.

In February 2018, the FWS and FHWA issued a second revised version of the PBO and supplemental documents based on input collected over the past year. The changes to the PBO address specific topics and clarify the consultation process.

In less than two years (as of July, 2017), over 1,900 projects across 28 States used the range-wide programmatic consultation. As a result, timeframes for consultations have been reduced from approximately 135 days to as few as 15 days.

What specific problems were solved with this research?

With the Indiana bat and NLEB species covering 22 and 37 States, respectively, the sheer size of the species' ranges means that a large number of transportation projects have the potential to benefit from a programmatic approach to Endangered Species Act (ESA) Section 7 consultations. Transportation agencies that receive federal funding for their projects are required by Section 7 of the ESA to consult with FWS on the Indiana bat and northern long-eared bat to ensure actions are not likely to jeopardize these bats or destroy or adversely modify critical habitats. The implementation of this conservation strategy streamlines the review process, reducing consultation time and waiting periods, thereby accelerating projects.

Did non-government groups serve as partners in this research? (Yes/No) If yes, what was their role/contribution?

Yes. As part of the Indiana bat and NLEB programmatic efforts, a rangewide In-Lieu Fee (ILF) Program Instrument with The Conservation Fund (TCF) has been established as an approved compensatory mitigation option for projects that are "Likely to Adversely Affect" Indiana bats. The ILF Program Instrument provides a practical option for transportation agencies to address their responsibilities under ESA Section 7(a)(2) and implement compensatory mitigation for unavoidable impacts to the Indiana bat, provided the impacts are caused by transportation projects or other actions and that the projects are consistent with the PBO.

Who are the beneficiaries of this research and how will they benefit?

This approach provided transparency and predictability to FHWA and State Departments of Transportation (DOTs) for projects within the range. Project sponsors for FHWA/FRA/FTA projects located within the range of the Indiana bat and NLEB benefit from the use of the programmatic consultations that were created by this research. The PBO and subsequent revisions help accelerate the consultation process related to transportation projects and provide a consistent approach to conservation for the Indiana bat and NLEB species.

Section 1 – Program Descriptions, FY 2019

FY 2019 RD&T Program Funding Details

RD&T Program Name	FY 2019 Pres. Budget ($000)	FY 2019 Basic ($000)	FY 2019 Applied ($000)	FY 2019 Development ($000)	FY 2019 Technology ($000)
Structures	5,220		2,420	1,400	1,400
Pavements and Materials	4,720		2,420	2,300	
AIDPT	12,000				12,000
TPM	3,800		700	300	2,800
Construction and Project Management	1,100		400	300	400
Geotechnical and Hydraulics	3,100		1,900	1,200	
Long Term Infrastructure Performance Programs	8,620		5,520	3,100	
Safety Program Delivery	2,500				2,500
Safety Design & Operations	4,290			3,300	990
Safety Data and Analysis	3,920			3,070	850
Human Factors Analytics	1,570			1,570	
Transportation Systems Management and Operations	6,000		6,000		
Connected and Automated Vehicles	5,800		5,800		
Managing Disruptions to Operations	2,730		2,730		
Freight Management and Operations	3,400		3,400		
Truck Size and Weight	1,100		1,100		
Accelerating Project Delivery	3,000		2,250		750
Performance Based Planning	2,000		2,000		
Modeling	2,000		800	500	700
Resiliency	1,800		720	540	540
Multimodal Connectivity	1,000		1,000		

RD&T Program Name	FY 2019 Pres. Budget ($000)	FY 2019 Basic ($000)	FY 2019 Applied ($000)	FY 2019 Development ($000)	FY 2019 Technology ($000)
Policy Analysis and Global Outreach	4,660		2,250	1,810	600
Highway & Transportation Data	6,440		3,660	1,290	1,490
Every Day Counts	6,500				6,500
State Transportation Innovation Council	5,600				5,600
Accelerated Innovation Deployment	6,500				6,500
Accelerating Market Readiness	2,500				2,500
Innovative Program Delivery	890		100	100	690
Research Infrastructure, Technology Transfer and Partnerships	14,000		9,330		4,670
Small Business Innovation Research (SBIR)	2,000		1,850	150	
Exploratory Advanced Research	4,740		4,740		
Advanced Transp. and Congestion Management Program (ATCMTD)	39,000			39,000	
Surface Transp. Funding Alternatives (STSFA)	20,000				20,000
Totals	**192,500**	**0**	**61,090**	**59,930**	**71,480**

FY 2019 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2019 Pres. Budget ($000)	SAFETY ($000)	INFRA-STRUCTURE ($000)	INNOVATION ($000)	ACCOUNT-ABILITY ($000)
Structures	5,220	1000	2,420	1,800	
Pavements and Materials	4,720		3,720	1,000	
AIDPT	12,000		4,000	8,000	
TPM	3,800		2,900	900	
Construction and Project Management	1,100		300	400	400
Geotechnical and Hydraulics	3,100	700	1,700	700	
Long Term Infrastructure Performance Programs	8,620		8,620		
Safety Program Delivery	2,500	2,500			
Safety Design & Operations	4,290	4,290			
Safety Data and Analysis	3,920	3,920			
Human Factors Analytics	1,570	1,570			
Transportation Systems Management and Operations	6,000		6,000		
Connected and Automated Vehicles	5,800			5,800	
Managing Disruptions to Operations	2,730	910	910	910	
Freight Management and Operations	3,400		2,600	800	
Truck Size and Weight	1,100	300	600	200	
Accelerating Project Delivery	3,000		1,200	1,200	600
Performance Based Planning	2,000	200	1,000	600	200
Modeling	2,000		800	1,000	200
Resiliency	1,800		900	900	
Multimodal Connectivity	1,000	500	500		

RD&T Program Name	FY 2019 Pres. Budget ($000)	SAFETY ($000)	INFRA-STRUCTURE ($000)	INNOVATION ($000)	ACCOUNT-ABILITY ($000)
Policy Analysis and Global Outreach	4,660	700	1,070	1,990	900
Highway & Transportation Data	6,440	1,860	1,490	550	2,540
Every Day Counts	6,500	1,300	1,625	3,250	325
State Transportation Innovation Council	5,600	1,120	1,400	2,800	280
Accelerated Innovation Deployment	6,500	1,300	1,625	3,250	325
Accelerating Market Readiness	2,500	500	625	1,250	125
Innovative Program Delivery	890		445	445	
Research Infrastructure, Technology Transfer and Partnerships	14,000	3,500	3,500	3,500	3,500
Small Business Innovation Research (SBIR)	2,000	500	500	500	500
Exploratory Advanced Research	4,740			4,740	
Advanced Transp. and Congestion Management Program (ATCMTD)	39,000		39,000		
Surface Transp. Funding Alternatives (STSFA)	20,000			20,000	
Totals	**192,500**	**26,670**	**89,450**	**66,485**	**9,895**

Structures Research and Technology
$5,220,000

Program Description/Activities:
The Structures Research and Technology (R&T) Program is a coordinated and cohesive program of research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, structural integrity, longevity, construction processes and cost-effectiveness of highway bridges, tunnels and other structures. Activities include research and development to identify and advance cost-effective use of improved materials (e.g., ultra-high performance concrete (UHPC) and new steel formulations) and engineering innovations to improve bridge performance, development and delivery of training and tools to support reliable and effective safety inspection and load rating of bridges and tunnels, as well as improved non-destructive evaluation technologies to support infrastructure condition assessment.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others. Additionally, this program support implementation of other statutory mandates, specifically, Transportation Performance Management, and the National Bridge and Tunnel Inspection requirements (23 CFR 650).

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Structures R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Structures R&T Program will contribute directly to highway safety and the Department's Systematic Safety Approach by providing tools, technologies, guidance and training to support infrastructure owners in ensuring that highway bridges, tunnels and other structures are designed, constructed, inspected, evaluated, and maintained to safely carry traffic loads and withstand the forces of nature. This includes, but is not limited to, contributions to the Department's Data strategy, as it relates to implementation of the National Bridge and Tunnel Inspection Standards (NBIS and NTIS).

Infrastructure/Improving Infrastructure: The Structures R&T Program supports the Life Cycle and Preventive Maintenance objective through research and development addressing

"weak links" in prefabricated bridge construction technologies in support of the Rebuild strategy. Additionally, the program will continue to pursue material and design innovations to improve highway structures, as well as nondestructive damage detection technologies to evaluate highway structures while minimizing impacts to traffic. Effective bridge management and best approaches for preservation and maintenance are also addressed within the program.

Innovation: The Structures R&T Program supports the Department's Innovation Goal by undertaking research and development in structural design, construction, and maintenance to develop innovative solutions to highway structural engineering challenges. Ultimately, the resulting innovations will improve the state of the practice and result in resilient and adaptable systems to mitigate the impact of hurricanes, floods, and other extreme events on bridges and other structures.

Improving Mobility/Preserving the Environment: The Structures R&T Program contributes to improving mobility and preserving the environment since the ability of our highway network to accommodate heavy vehicles is controlled by the capacity of the structural links in the system. Indirectly, it contributes by reducing the frequency and duration of maintenance, repair, and reconstruction through improved durability and resiliency, and increased use of accelerated construction practices.

This program impacts and is of benefit to highway structures throughout the nation, including that in rural communities and the nation's freight infrastructure.

Program Objectives:
FHWA's Structures R & T Program seeks to drive innovation in structural design, construction, inspection, evaluation, and maintenance through the development of best practice guidance and novel solutions to engineering challenges in bridges, tunnels, and ancillary structures, as well as training and technology transfer initiatives directed toward ensuring the safety of the Nation's bridges and structures, and promoting effective management of that infrastructure. The program addresses "weak links" in relevant technologies that cannot or will not be addressed by other organizations, due to lack of capabilities and/or the absence of profit potential required to motivate private investment. The over-arching objectives guiding FHWA's Structures R&T Program are to:

- Achieve and sustain a state of good repair of bridges, tunnels, and other structures.
- Implement and enhance the effectiveness of transportation performance management.
- Deliver projects faster and more efficiently.
- Improve the sustainability and resilience of highway infrastructure.

Key FY19 FHWA Structures R&T Program Activities.

Activity	Period of Performance	Partners/Notes
Advance novel design, fabrication, and construction concepts for bridges	2016-2024	Dozens of State DOTs, Steel and concrete bridge fabricators; Prefabricated bridge elements

Activity	Period of Performance	Partners/Notes
		and systems, New welding processes
Develop degradation resistant solutions for steel and concrete bridges	2019-2023	Structural application of new steel chemistries, Coating/barrier systems
Advance optimized application of ultra-high performance concrete (UHPC) to address bridge engineering challenges	2018-2023	New York State, New Jersey, Pennsylvania, and Iowa DOTs (lead deployment partners); UHPC Connections for Prefabricated Bridge Elements have been advanced through the Every Day Counts Initiative
Identify and develop solutions to address key safety risks in highway tunnels, including natural gas and other alternative fuel vehicles	2018-2022	Department of Homeland Security, Department of Energy
Develop and implement improvements to management and operations of tunnels, including consideration of risk	2018-2022	State DOTs
Technical guidance to improve infrastructure resilience to all hazards such as seismic, hurricane, flood, coastal storms, and tsunami.	2018-2022	State DOTs
Improving infrastructure performance and recovery through post-hazard inspection, engineering investigation, and data collection	2018-2022	State DOTs
Develop guidance and protocols for the application of non-destructive testing technology in assessing the condition of bridge decks with overlays;	2016-2020	State DOTs
Develop and deliver guidance and training in support of effective bridge and tunnel safety inspection practices;	2017-2020	To align with changes in legislation
Investigate and document the reliability and return on investment of practical sensing and nondestructive technologies for condition assessment of highway structures	2019-2021	State DOTs and others interested in effectively using this technology Includes use of unmanned aerial vehicles (UAVs) to carry sensing equipment.
Develop algorithms and guidelines for analysis, visualization, and interoperation of nondestructive evaluation (NDE) field data	2018-2020	Methods to be developed in concert with State DOTs to get their input of what is most effective for them.

Activity	Period of Performance	Partners/Notes
Investigate current state-of-the-art for improving safety and durability related to corrosion of Post Tensioned structures	2018 - 2020	State DOTs, academia, industry
Develop usage guidance related to corrosion durability of stainless steel reinforcement	2018 - 2020	State DOTs, academia, industry
Develop usage guidance related to coating durability over different surfaces/substrates	2018-2020	State DOTs, academia, industry
Develop and deliver guidance and trainings in support of effective design, fabrication, construction, safety inspection, management and preservation practices for bridges tunnels and other structures;	2018-2020	State DOTs, academia, industry

In addition to the role of conducting research and development, through the Structures R&T Program, FHWA provides technical assistance in support of bridge and infrastructure forensic investigations undertaken by the National Transportation Safety Board (NTSB), State Departments of Transportation, FHWA Division Offices, and others. Specific examples of past technical assistance include I-35W bridge collapse in Minnesota, I-93 Tunnel in Boston, MA, and the Wilson Tunnel in Hawaii. Currently, FHWA is supporting the NTSB investigation of the Florida International University pedestrian bridge collapse. Through these forensic services, the Structures Research Laboratories determine the causes of structural failures and develop recommended practices and procedures to help avoid similar failures in the future.

Research Collaboration Partners:
FHWA Structures R&T program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the Precast/Prestressed Concrete Institute, and the National Steel Bridge Alliance, standard-setting organizations such as the American Concrete Institute (ACI) and ASTM International, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site. The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3):

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;

- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA Structures R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
AASHTO Committee on Bridges and Structures	X				X				
State Departments of Transportation	X			X	X				X
National Institute of Standards and Technology (NIST)						X	X		
Precast/Prestressed Institute		X						X	
American Concrete Institute		X							
ASTM International			X						
IFSTTAR						X			
Canadian Standards Association			X						
Research Council on Structural Connections (RCSC)			X						

Acquisition/Assistance:
The Structures R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, a competitive, multi-award task order contract is being used to procure laboratory support services for the intramural elements of the Structures R&T program. Other program needs are met through Blanket Purchase Agreements, competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate.

The Structures R&T program acquisitions are most often multi-year acquisitions, funded over several fiscal years. Multi-year contracts generally include provisions that allow adjustments as circumstances evolve. Single year contracts, or multi-year contracts fully funded in the year of award are occasionally used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. This occurs most frequently in the procurement of maintenance services or repair parts for highly specialized laboratory equipment.

Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies. Specific examples of non-governmental partnerships include work with several universities conducting concrete materials research and private companies collaborating with research and development of alternative cementitious materials. Typical contributions for these collaborations are 20% of total project cost.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA Structures R&T program, and is funded as such. Additionally, some program outputs are advanced through the Every Day Counts initiative. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Structures R&T program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The program's outputs take the form of:

- Research publications, including reports and technical notes;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- New and/or updated technical guidance;
- Training courses;
- Webinars;
- Workshops.

Specific program outputs anticipated in 2019 are identified in the table below.

Key 2019 FHWA Structures R&T Program Outputs

Program Activity	**Key 2019 Outputs**
Develop robust, optimized, cost-effective structural solutions	Advanced connection details for prefabricated bridge elements
Develop robust, optimized, cost-effective structural solutions	Fact-based evidence of true weathering steel performance in environments across the US
Advance optimized application of ultra-high performance concrete (UHPC) to address bridge engineering challenges	Best practices and support for the use of UHPC to rehabilitate bridge decks
Support deployment of safe, reliable bridge structures	Proposed bridge design specification revisions to address shortcomings in existing reinforced concrete design provisions
Identify and develop solutions to address key safety risks in highway tunnels, including natural gas and other alternative fuel vehicles	Collaboration with other federal agencies to define the risks and gaps, and initiation of research program
Develop and implement improvements to management and operations of tunnels, including consideration of risk	Principles and guidelines for risk-based management of tunnels, and explore development of a virtual simulation training tool
Technical guidance to improve infrastructure resilience to all hazards such as seismic, hurricane, flood, coastal storms, and tsunami.	DOT peer exchange to share experience and gain concurrence on national needs. Publication of research report on multi-hazard design of bridges.
Improving infrastructure performance and recovery through post-hazard inspection, engineering investigation, and data collection	Synthesis of literature, guiding principles, definitions, and framework.
Develop guidance and protocols for the application of non-destructive testing technology in assessing the condition of bridge decks with overlays	Construction, accelerated loading and testing of a bare bridge deck.
Develop and deliver guidance and training in support of effective bridge and tunnel safety inspection practices	Updated suite of bridge and tunnel safety inspection courses to align with the changes in legislation
Investigate and document the reliability and return on investment of practical sensing and nondestructive technologies for condition assessment of highway structures.	Data to develop guidance and methodology on the effectiveness and value of sensing and nondestructive evaluation techniques for highway structures.
Develop algorithm and guidelines for analysis, visualization, and interoperation of NDE field data	A framework for consistent nondestructive evaluation data collection, analysis, visualization, interpretation and storage for highway structures.
Investigate current state-of-the-art for improving safety and durability related to corrosion of Post Tensioned structures	Promising areas of research for both corrosion and coatings to be further expanded.
Develop usage guidance related to corrosion durability of stainless steel reinforcement	Data to develop guidance and methodology on the usage and efficacy of stainless steel reinforcement.

Program Activity	Key 2019 Outputs
Develop usage guidance related to coating durability over different surfaces/substrates	Data to develop guidance and methodology on the application of high-performing coatings over different surfaces/substrates.
Develop and deliver guidance and trainings in support of effective design, fabrication, construction, safety inspection, management and preservation practices for bridges tunnels and other structures;	Updated training course "Inspection and Maintenance of Ancillary Highway Structures"

The predominant measures for the program's T2 activities are output measures, for example, number of workshops delivered. Audience assessments of effectiveness are obtained for some webinars and formal classroom training.

The benefits to be accrued by FHWA Structures R&T Program stakeholders include improvements in the quality, durability, speed of construction and life-cycle cost of highway structures, and more effective life-cycle management of highway structures.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of FHWA's structures R&T program takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity? When such outputs are produced, they are included in the agency's Annual Performance report. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
Program performance is assessed primarily on the basis of project milestones. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Outputs of this program will assist State and local highway agencies in more effectively managing the performance of highway structures. Accordingly, this program contributes toward achievement of the Department's goal to Improve Conditions of America's Transportation-Related Infrastructure. Achievement of this goal is tracked through the bridge condition as reported under the National Bridge Inspection Standards, and the processes put into place in support of the Transportation Performance Management regulations.

Pavement & Materials Research & Development
$4,720,000

Program Description/Activities:
Together, the Pavement & Materials Research and Development (R&D) Program and the Accelerated Implementation and Deployment of Pavement Technologies (AIDPT) Program provide a coordinated and cohesive approach to research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, durability, sustainability and cost-effectiveness of highway pavements, and the materials from which highway infrastructure is constructed. Activities in the Pavement & Materials Research & Development Program include research and development of material test methods and specifications to improve the durability of both virgin and recycled materials used in highway construction, with a focus on advancing performance-related specifications that provide a fair and rational basis for linking payment to the expected performance of the as-constructed product, while giving contractors the freedom to innovate. Activities also include the development of methods and best practices to encourage effective decision making in the assessment and management of pavements.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, **improve infrastructure integrity**, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Pavement & Materials R&D Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Pavement & Materials R&D Program will contribute directly to highway safety and the Department's Systematic Safety Approach through work to advance improved pavement friction characteristics. Indirect contributions will be made through durability improvements that reduce the frequency and duration of construction work zones for maintenance and repair.

Infrastructure/Improving Infrastructure: The Pavement & Materials R&D Program supports the Life Cycle and Preventive Maintenance objective by providing best practices, developing recommendations and demonstrating analysis methodologies for identifying an optimized

sequence of treatment actions that considers both structural and functional condition over the life cycle.

Innovation: The Pavement & Materials R&D Program supports the Department's Innovation Goal by undertaking research and development in the advancement and development of fundamental tests and protocols for improved selection and prediction of materials performance. Activities also advance the development of rapid tests for quality control of materials during construction.

Improving Mobility/Preserving the Environment: The Pavement & Materials R&D Program contributes to improving mobility and preserving the environment indirectly, by reducing the frequency and duration of maintenance, repair, and reconstruction through improved durability and resiliency. Additionally, by developing pavement performance related specifications, the program enables Federal-aid recipient to better ensure that they are paying for quality pavement construction that require less frequent repairs due to increased design durability. Activities that advance the effective use of recycled materials and industrial byproducts in pavements also support this goal.

This program impacts and is of benefit to highway infrastructure throughout the nation, including that in rural communities, and the nation's freight infrastructure.

Program Objectives:
FHWA's Pavement & Materials R & D Program seeks to drive innovation in pavement materials, design, construction, evaluation and management practices, with a focus on advancing performance-related specifications. Performance Related Specifications (PRS) compare design expectations to what was constructed, and pay for the product accordingly. Over the last 30 years FHWA, State DOTs, and the pavement industry have performed a significant amount of research to improve pavement evaluation tests and models that now make it viable to move PRS to implementation. PRS provides predictive pavement performance tool that enable defensible and rational mechanisms for acceptance and payment and allows for greater risk sharing between contractor and owner agency. At the same time, PRS provide contractors the flexibility to select materials, techniques, and procedures to improve the quality, economy, or both, of the end product. Furthermore, PRS links material design, construction, quality, payment, and long-term pavement performance. PRS provides tools to the industry for "raising the bar" on performance for longer lasting, durable, and innovative pavements while shifting some of the risk and rewards for performance.

Key FY19 FHWA Pavement & Materials R&D Program Activities.

Activity	Period of Performance	Partners/Notes
Develop and enhance tests and processes to advance pavement performance related specifications (PRS).	2005-2020	State DOTs and toll authorities are assessing the PRS approach and using what is being developed as shadow specifications.
Develop and enhance tests and processes to advance Performance	2017-2021	SHAs, academics, ACPA and consultants assisting Pooled Fund TPF-5(368) to provide input.

Activity	Period of Performance	Partners/Notes
Engineered Mixtures (PEM) for Concrete		
Develop and enhance tests and processes to advance PEM for Asphalt	2017-2020	State DOTs, academics and consultants assisting Asphalt Mixture Performance Test (AMPT) Users Group and FHWA Asphalt Expert Task Group (ETG) will provide input.
Assessment of durability of recycled materials and industrial byproducts in pavements	2013-2020	New protocols advanced through collaboration with NCHRP projects. Asphalt ETG provided input to experimental design
Development and analysis of new concrete durability tests	2017-2020	Working with State DOTs and academic institutes to advance new ASR tests and procedures
Enable external access to FHWA pavement data	2017-2022	Building the database and working with FHWA labs and research contractors to ensure data is in a format that can be publicly shared and the database populated.
Demonstrate improved pavement durability through increased asphalt pavement compaction	2017-2022	Supports AIDPT Program Density Initiative
Advancement of analytical tools for quality control and forensic activities	2015-2020	Working with State DOTs to develop tools for characterizing asphalt binders, mixes and RAP and advancing use of handheld spectroscopic devices.
Condition assessment of pavement foundations by using nondestructive evaluation (NDE) technologies	2019-2020	Working with State DOTs to seek input and obtain information on current technologies and practices.
Advance effective decision-making in pavement management	2018 - 2021	Working with State DOTs and State DOTs pavement management system data to develop and validate effective concepts and analysis methodologies to help pavement investment decisions for long-term cost effectiveness
Advance effective decision-making for various treatments for pavement preservation	2019-2020	Working with AASHTO Committee on Maintenance, Pavement Preservation ETG, Emulsion Task Group, and state DOT stakeholders to identify needs
Developing/enhancing methodologies for conducting pavement life-cycle cost analysis (LCCA) and life-cycle assessment (LCA)	2019 - 2021	SHAs, academics, consultants supporting State DOTs and industry. other federal agencies (USDA, NIST, ANL and Federal LCA Commons.

Activity	Period of Performance	Partners/Notes
Improve quality assurance practices through the development of risk-based analysis	2018-2021	FHWA is scoping out what is needed to develop web-based next generation risk based Quality Assurance Software
Development of a Unified Pavement Distress Analysis and Prediction System (UPDAPS) for Federal Highway Administration	2017 - 2019	A joint effort between FHWA's Infrastructure and Policy offices.
Improve methods to assess pavement structural capacity	2017 - 2021	Exchange data and analysis methodologies with VA DOT and VA Tech, and proposed new pooled fund study states to be led by VDOT. Information sharing through TRB and with DaRTS
Advance management practices and materials to improve pavement friction for pavement safety.	2019-2020	In conjunction with AIDPT program and in collaboration with State DOTs advance friction management practices. Initiate work toward high friction surface treatments to improve pavement friction characteristics.

In addition to the role of conducting research and development, through the Pavement & Materials R&D Program, FHWA provides technical assistance in support of infrastructure forensic investigations undertaken by the National Transportation Safety Board (NTSB), the Inspector General, State Departments of Transportation, FHWA Division Offices and Federal Lands, and others. Examples of forensic activities include: investigations of premature failures, assistance in fraud cases, and assistance in identifying reasons for low pavement friction that have resulted in crashes.

Research Collaboration Partners:

FHWA Pavement & Materials R&D program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the American Concrete Pavement Association (ACPA) and the National Asphalt Pavement Association (NAPA), standard-setting organizations such as the American Concrete Institute (ACI) and ASTM International, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site. The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3):

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA Pavement & Materials R&D Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
AASHTO Committee on Materials and Pavements	X		X		X				
State Departments of Transportation	X			X	X	X		X	X
National Institute of Standards and Technology (NIST)						X	X		
National Asphalt Pavement Association		X						X	
American Concrete Pavement Association		X							
ASTM International			X						
Pavement Preservation Expert Task Group[1]	X	X							
Asphalt Expert Task Group[2]	X	X				X			

[1] The Pavement Preservation Expert Task Group provides a forum for State highway agency representatives, academia, and industry stakeholders to discuss experiences and best practices for implementing pavement preservation techniques. This group will also develop a roadmap of research needs in this area.
[2] The existing Asphalt Expert Task Group will be restructured to meet current Agency goals and direction, and will focus on implementation of technologies and innovations to improve pavement performance and advance performance related specifications specifically for asphalt pavements.
[3] A Concrete Expert Task Group will be created to balance industry and technical input to pavement technologies and innovations. This group will also focus on the implementation of technologies and innovations to improve pavement performance and performance related specification specifically for concrete pavements.

Universities				X	X	X	X		
Concrete Expert Task Group[3]	x	x							
Sustainable Pavements Working Group[4]	x	x				x			

Acquisition/Assistance:
The Pavement & Materials R&D program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, a Service disabled, veteran-owned, small business currently provides laboratory support services for the intramural elements of the Pavement & Materials R&D program. The contract is structured to allow both the level of effort and labor mix provided to be adjusted as needs and priorities change. Other program needs are met through, competitively procured contracts, project-specific competitive procurements, and small purchases. GSA schedule procurements are used where appropriate.

The Pavement & Materials R&D program acquisitions are most often multi-year IDIQ contracts, incrementally funded over several fiscal years through award of shorter-term Task Orders. Single year contracts, or multi-year contracts fully funded in the year of award are used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance (less than 1% of program) where there truly is only one source for the item or service being procured. This occurs most frequently in the procurement of maintenance services or repair parts for highly specialized laboratory equipment.

Opportunities to leverage non-Federal funds are predominantly with State and local highway agencies. One example is the pooled fund program where State DOTs and others contribute research funds to address an issue they jointly would like to solve. FHWA is participating in pooled fund TPF-5(345), Managing Pavement Properties for Improved Safety to demonstrate the use of network level friction and macrotexture data collection and analysis. FHWA is also working with State DOTs and industry as a part of pooled fund TPF-5(368) to advance performance engineered mixes for concrete pavements.

Technology Transfer (T2):
Technology transfer for the FHWA Pavement & Materials R&D program is provided for through the Accelerated Implementation and Deployment of Pavement Technologies Program. Within the broader AIDPT program, some program outputs are advanced through the Every Day Counts initiative. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Pavement & Materials R&D program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

[4] The Sustainable Pavements Technical Working Group consists of technical experts from State DOTs, industry, and academia that provide technical assessments and input regarding the sustainability considerations for pavements and materials related to the FHWA Sustainable Pavements Program.

The program's outputs take the form of:

- Research publications, including peer reviewed papers, reports and technical briefs;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- Field demonstrations;
- New tools;
- Webinars;
- Workshops.

Key 2019 FHWA Pavement & Materials R&D Program Outputs

Program Activity	**Key 2019 Outputs**
Develop and enhance tests and processes to advance pavement performance related specifications (PRS)	AASHTO adoption of a provisional standard for a fundamentally based rut test developed via FHWA research. Shadow projects with State DOTs demonstrating how the specifications work and how they impact project operations and contractor pay.
Develop and enhance tests and processes to advance PEM – Concrete	Identification of key steps to continue advancement of new PEM durability tests that can be used during design and pavement construction for PRS. Initial validation of PEM-related testing of transport property methodologies.
Develop and enhance tests and processes to advance PEM – Asphalt	Identification of key steps needed to develop a fundamentally based test that can be used during pavement construction and initiate work on those steps to support PRS.
Assessment of durability of recycled materials and industrial byproducts in pavements	Technical guide to improve high RAP/RAS mix designs. Inputs to aging and performance testing of PRS.
Development and analysis of new concrete durability tests	Testing methodologies that address shortcomings of existing test methods. Reports on the complex chemistry of alkali-silica reactive (ASR) gels. Demonstration of correlation of lab results with MASSDOT and other concrete field exposure blocks. Initial assessment of radically new approach to ASR characterization of materials.
Enable external access to FHWA pavement data	Initial Population of the Pavement Research Database System (PRDS) with pavement research data and demonstration of capabilities to the public through FHWA and TRB webinars.
Demonstrate improved pavement durability through increased asphalt pavement compaction	Report on impact of density on rutting and fatigue performance of newly constructed sections.

Program Activity	Key 2019 Outputs
Advancement of analytical tools for quality control and forensic activities • Asphalt • Concrete	• Demonstration of new test methods at various SHAs and through webinars • New testing methodologies for assessing air void parameters of fresh concrete and adsorption capacity of fly ash.
Condition assessment of pavement foundations by using nondestructive evaluation (NDE) technologies	Establish a methodology to assess the effectiveness and value of nondestructive evaluation technologies to determine the condition of pavement foundations.
Advance effective decision-making in pavement management	Case studies based on LTPP data to demonstrate Remaining Service Interval (RSI) concept to support Life-Cycle Planning that is part of the recently enacted FHWA Transportation Asset Management Plans requirements rule.
Advance effective decision-making for various treatments for pavement preservation	Identification of the best returns-on-investment for pavement preservation methods and materials. Identification of best practices for pavement preservation use for a wide range of pavement types and conditions.
Developing/enhancing methodologies for conducting pavement life-cycle cost analysis (LCCA) and life-cycle assessment (LCA)	Prioritized list of enhancements to be included in the next version of FHWA's Real Cost LCCA tool founded on stakeholder feedback. Mapping unit/system processes for pavement LCA compatible with Federal LCA Commons.
Improve quality assurance practices through the development of risk-based analysis	Investment Review Board (IRB) approval to initiate the development of web based next generation risk based Quality Assurance(SpecRisk) Software
Development of a Unified Pavement Distress Analysis and Prediction System (UPDAPS) for Federal Highway Administration	Development or identification of 1) technical requirements for UPDAPS; 2) Potential data sources and limits of data; 3) Computer implementation approach; and 4) Framework and software requirements specification document.
Improve methods to assess pavement structural capacity	Temperature correction methodology for pavement structural condition data and validation with data from national and international data collection efforts.
Advance materials and practices to improve pavement friction for pavement safety.	In cooperation with Florida, Indiana and Texas DOTs, complete the development of Pavement Friction Management Programs that are based on continuous network level data.

The predominant measures for the program's T2 activities are output measures, for example, number of standards developed, or reports or papers published.

The benefits to be accrued by FHWA Pavement & Materials R&D Program stakeholders include improvements in the quality, durability, and life-cycle cost of highway pavements, and more effective life-cycle management of highway pavements.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of FHWA's Pavement & Materials R&D program takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity. When such outputs are produced, they are included in the agency's Annual Performance report. We are working to trademark the software suite that supports the performance related specifications that are being developed and demonstrated.

Evaluation / Performance Measurement:
Program performance is assessed primarily on the basis of project milestones. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Outputs of this program will assist State and local highway agencies in more effectively managing the performance of highway pavements. Accordingly, this program contributes toward achievement of the Department's goal to Improve Conditions of America's Transportation-Related Infrastructure. Achievement of this goal is tracked through the pavement condition measures as reported through the Highway Performance Monitoring System, and the processes put into place in support of the Transportation Performance Management regulations.

Accelerated Implementation and Deployment of Pavement Technologies
$12,000,000

Program Description/Activities:
Together, the Pavement & Materials Research and Development (R&D) Program, the Long-Term Pavement Performance (LTIP) research, and the Accelerated Implementation and Deployment of Pavement Technologies (AIDPT) Program provide a coordinated and cohesive approach to research, development, technology and deployment activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, durability, sustainability and cost-effectiveness of highway pavements, and the materials from which highway infrastructure is constructed. The AIDPT program serves as the implementation and deployment mechanism for innovations coming out of the Pavement & Materials and LTIP research. Activities in the AIDPT program include advancement of performance engineered mix design for both asphalt and concrete pavements. Providing guidance and tools to optimize mixture designs for States environmental conditions, materials availability, durability requirements is a high priority program area.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The AIDPT program is authorized in section 503(c)(3) of title 23, United States Code, which requires the Secretary to establish and implement a program under the technology and innovation deployment program to promote, implement, deploy, demonstrate, showcase, support, and document the application of innovative pavement technologies, practices, performance, and benefits. The program, as defined in the FAST Act, will "promote, implement, deploy, demonstrate, showcase, support, and document the application of innovate pavement technologies, practices, performance, and benefits."

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's AIDPT Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The AIDPT Program will contribute directly to highway safety and the Department's Systematic Safety Approach by supporting activities to better analyze pavement surface condition and characteristics such as pavement friction and faulting.

Infrastructure/Improving Infrastructure: The AIDPT Program supports the Infrastructure goal through technology transfer, training and technical support addressing the Life Cycle Cost Analysis and Preservation for pavements.

Innovation: The AIDPT Program supports the Department's Innovation Goal by accelerating the deployment of innovative pavement technologies. For example, the Real-Time Smoothness product out of the SHRP 2 program, is an innovative tool that is used to evaluate concrete pavement smoothness in real-time, increases concrete pavement durability and performance, can be used for Quality Control, and reduces the need for timely and expensive grinding operations. This innovation is now available for demonstrations and for loan through the AIDPT program.

Improving Mobility/Preserving the Environment: The AIDPT Program contributes to improving mobility and preserving the environment indirectly, by advancing implementation of technologies that will reduce the frequency and duration of maintenance, repair, and reconstruction through improved durability and resiliency. Additionally, the AIDPT Program includes a Sustainable Pavement Program that supports the advancement of concepts that educate and encourage the consideration of environmental impacts to pavement design, construction, and preservation.

This program impacts and is of benefit to highway infrastructure throughout the nation, including those in rural communities and the nation's freight infrastructure.

Program Objectives:
FHWA's AIDPT Program seeks to accelerate the adoption of innovative pavement technologies, with a focus on advancing performance-related tests and specifications. Performance Related Specification (PRS) compare design expectations to what was constructed, and pay for the product accordingly. It is the link between design, construction, quality, payment, and long-term pavement performance. Now that research has been completed, we are implementing various tests technologies to further improve pavement durability. Implementation activities include providing education and guidance on the use of new tests, demonstration and shadow projects (where new technologies are used side-by-side with existing technologies), and other information sharing opportunities such as peer exchanges and workshops.

Key FY19 FHWA AIDPT Program Activities.

Activity	Period of Performance	Partners/Notes
Deployment and Implementation of Performance Engineered Mixtures for Concrete Mixes*	2017-2023	Participation in national pooled fund TPF-5(368); technical guidance and implementation support through concrete cooperative agreement (award anticipated 6/2018)
Deployment and Implementation of Performance Engineered Mixtures for Asphalt*	2017-2023	Participation in national pooled fund TPF-5(178); technical guidance through asphalt cooperative agreement (award anticipated 5/2018)
Provide technical guidance on the use of recycled materials and industrial byproducts in pavements	2018-2023	Technical guidance and implementation support through concrete cooperative agreement (award anticipated 6/2018) and asphalt cooperative agreement (award anticipated 5/2018)

Activity	Period of Performance	Partners/Notes
Demonstrate improved pavement durability through increased asphalt pavement compaction	2015-2019	National Center for Asphalt Technology, National Asphalt Pavement Association
Deploy and deliver workshops and supporting materials to advance "best practices" pavement technology	2016-2024	Technical guidance and implementation support through a concrete cooperative agreement (award anticipated 6/2018) and an asphalt cooperative agreement (award anticipated 5/2018); State DOT, industry outreach through stakeholder forums
Expert and Technical Working Groups to gather stakeholder feedback on technical topics	2018-2023	State DOTs, industry associations, academia specializing the technical program areas
Mobile Concrete Testing Trailer to deploy Performance Engineered Mix Design for concrete, deploy new test and technologies, and provide national leadership for concrete materials	2019-2025	Deploy research, new test, and implementation of performance engineered concrete mixes
Mobile Asphalt Testing Trailer to deploy Performance Engineered Mix Design for asphalt, deploy new tests and technologies, and provide national leadership for asphalt materials	2019-2025	Deploy research, new test, and implementation of performance engineered asphalt mixes
Provide technical guidance to support implementation of improved pavement management systems and pavement performance measures	2018-2023	Participation in national pooled fund TPF-5(299); technical guidance and implementation support
Provide technical support and develop resources for pavement sustainability considerations	2017-2022	Deploy research and implementation support for life cycle cost analysis; develop resources such TechBriefs and webinars
Develop and deploy techniques to improve pavement design practices	2019-2022	Develop design guidelines for evaluating pavement foundation; host pavement design peer exchanges
Provide technical support and develop resources for pavement preservation considerations	2018-2023	Technical guidance and implementation support
Advance key concepts and tools for Quality Assurance	2019-2022	Develop and deploy training; technical guidance

***** Items marked with an asterisk are activities that are implementing FHWA Pavement & Materials R&D program outcomes.

Collaboration Partners:
FHWA AIDPT program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State DOTs, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the American Concrete Pavement Association (ACPA) and the National Asphalt Pavement Association (NAPA), standard-setting organizations such as the American Concrete Institute (ACI) and ASTM International, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

FHWA has several technical working groups and expert task groups as a means of gathering stakeholder input on feedback on technical topics specific to pavements and materials. The groups are composed of a mix of representatives from State Departments of Transportation and other public agencies, related industry groups (such as asphalt and concrete paving industries, contractors, etc.), and academia.

The input obtained through these interactions is considered by program staff as they identify and formulate a program of initiatives that, in accordance with 23 USC 503(c)(3),

- the deployment of new, cost-effective designs, materials, recycled materials, and practices to extend the pavement life and performance and to improve user satisfaction;
- the reduction of initial costs and lifecycle costs of pavements, including the costs of new construction, replacement, maintenance, and rehabilitation;
- the deployment of accelerated construction techniques to increase safety and reduce construction time and traffic disruption and congestion;
- the deployment of engineering design criteria and specifications for new and efficient practices, products, and materials for use in highway pavements;
- the deployment of new nondestructive and real-time pavement evaluation technologies and construction techniques; and
- effective technology transfer and information dissemination to accelerate implementation of new technologies and to improve life, performance, cost effectiveness, safety, and user satisfaction.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA AIDPT Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
AASHTO Committee on Materials and Pavements	X		X		X				
State Departments of Transportation	X			X	X				X
National Institute of Standards and Technology (NIST)						X	X		
National Asphalt Pavement Association		X						X	
American Concrete Pavement Association		X							
ASTM International			X						
Pavement Preservation Expert Task Group[4]	X	X				X			
Asphalt Expert Task Group[5]	X	X				X			
Concrete Expert Task Group[3]	X	X				X			
Sustainable Pavements Technical Working Group[6]	X	X				X			

[4] The Pavement Preservation Expert Task Group provides a forum for State highway agency representatives, academia, and industry stakeholders to discuss experiences and best practices for implementing pavement preservation techniques. This group will also develop a roadmap of research needs in this area.

[5] The existing Asphalt Expert Task Group will be restructured to meet current Agency goals and direction, and will focus on implementation of technologies and innovations to improve pavement performance and advance performance related specifications specifically for asphalt pavements.

[3] A Concrete Expert Task Group will be created to balance industry and technical input to concrete pavement technologies and innovations. This group will also focus on the implementation of technologies and innovations to improve pavement performance and performance related specifications specifically for concrete pavements.

[6] The Sustainable Pavements Technical Working Group consists of technical experts from State DOTs, industry, and academia that provide technical assessments and input regarding the sustainability considerations for pavements and materials related to the FHWA Sustainable Pavements Program.

Acquisition/Assistance:
The AIDPT program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, the AIDPT program supports an IDIQ contract that provides technical support. The contract is structured to allow both the level of effort and labor mix provided to be adjusted as needs and priorities change. Other program needs are met through, competitively procured contracts and cooperative agreements, project-specific competitive procurements, and small purchases. GSA schedule procurements are used where appropriate.

The AIDPT program acquisitions are most often multi-year IDIQ contracts, incrementally funded over several fiscal years through award of shorter-term Task Orders. Single year contracts, or multi-year contracts fully funded in the year of award are used for projects and activities of limited scope, and are rarely used. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. This occurs most frequently in the procurement of maintenance services or repair parts for highly specialized laboratory equipment.

There are opportunities to leverage non-Federal funds predominantly through Cooperative Agreements and the Transportation Pooled Fund Program. In late FY 2018 the award of two new cooperative agreements, one for asphalt pavements and materials and one for concrete pavements and materials, are anticipated. These awards were competitively procured and cost sharing at a minimum of 20 percent is required. Work plans aimed at addressing AIDPT goals will be developed for each Cooperative Agreement and will be initiated in FY 2019. There are also other opportunities to leverage State and Local highway agency funds through the Transportation Pooled Fund Program which pools funding from multiple State agencies, FHWA, and sometimes industry to address projects of shared interest. Currently, there are pooled fund projects in areas such as pavement design, performance testing, and pavement preservation.

Technology Transfer (T2):
The FHWA AIDPT program is the primary technology transfer mechanism for the FHWA Pavement R&D program, and also supports technology transfer for innovative pavement technologies developed by other public and private sector organizations. Within the broader AIDPT program, some innovations are advanced through the Every Day Counts initiative. For example, pavement preservation activities were included in EDC-4. These activities provided peer exchanges, technical assistance, and other resources for implementing pavement preservation techniques. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA AIDPT program, such that their personnel are the primary audience for the program's outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The program's outputs take the form of:

- Training;
- Technical guidance;
- Hands-on technical assistance;
- Webinars;

- Workshops.

Key 2019 FHWA AIDPT Program Outputs

Program Activities	**Key 2019 Outputs**
Deployment and Implementation of Performance Engineered Mixtures for Concrete Pavements	Report from shadow demonstration projects (7 States); Revisions to AASHTO PP 84-17; Draft technical guidance and deployment of AASHTO PP 84-17 tests and Quality Plan
Deployment and Implementation of Performance Engineered Mixtures for Asphalt	Draft national performance standards and equipment specifications (6); Draft guidance on use of performance tests
Provide technical guidance on the use of recycled materials in pavements	Draft deployment plan for use of recycled materials and industrial byproducts in concrete pavement; Draft deployment and implementation plan for use of recycled asphalt binder and recycling agents in asphalt pavements
Demonstrate improved pavement durability through increased asphalt pavement compaction	Reports from 10 demonstration projects
Deploy and deliver workshops and supporting materials to advance "best practices" pavement technology	2 videos; Tech Brief documents; Case Studies; Peer Exchange meetings
Expert and Technical Working Groups to gather stakeholder feedback on technical topics	Documentation of feedback from stakeholder meetings
Mobile Concrete Testing Trailer	4 State site visit reports; 4 "Quality in the Concrete Paving Process Workshops" delivered; 4 Technical Summary Documents
Mobile Asphalt Testing Trailer	4 State site visit reports
Provide technical guidance to support implementation of improved pavement management systems and pavement performance measures	Peer exchanges, technical documents, training
Provide technical support and develop resources for pavement sustainability considerations	Tech Brief documents; draft life cycle assessment benchmarking tool
Develop and deploy techniques to improvement pavement design practices	Draft protocols for evaluating pavement foundation condition; draft pavement design catalog
Provide technical support and develop resources for pavement preservation considerations	Peer exchanges, technical documents, training
Advance key concepts and tools for Quality Assurance	Training

The predominant measures for the program's T2 activities are output measures, for example, number of workshops delivered, or guidance documents published.

The benefits to be accrued by FHWA AIDPT Program stakeholders include improvements in the quality, durability, and life-cycle cost of highway pavements, and more effective life-cycle management of highway pavements.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of FHWA's AIDPT program takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity. When such outputs are produced, they are included in the agency's Annual Performance report. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances.

- An annual report highlighting AIDPT Program outcomes is produced and posted at: https://www.fhwa.dot.gov/pavement/index.cfm

- Program performance is assessed primarily on the basis of project milestones. In addition, the new Cooperative Agreements noted in the Acquisitions Section will include performance measures and metrics, which will be identified upon award and acceptance of the Agreement Work Plan.

- Outputs of this program will assist State and local highway agencies in more effectively managing the performance of highway pavements. Accordingly, this program contributes toward achievement of the Department's goal to Improve Conditions of America's Transportation-Related Infrastructure. Achievement of this goal is tracked through the pavement condition measures as reported through the Highway Performance Monitoring System, and the processes put into place in support of the Transportation Performance Management regulations.

Transportation Performance Management and Asset Management
$3,800,000

Program Description/Activities:
The Transportation Performance Management (TPM) and Asset Management (AM) Research and Technology (R&T) Program is a coordinated and cohesive program of research, development and technology deployment activities focused on providing tools, innovations, technologies and on developing guidance and policies to advance the effective management of highway infrastructure and system performance. Research development and deployment activities include: identification and advancement of specific strategies to enhance TPM; the improvement of AM, preservation and maintenance practices and the development and deployment of TPM and AM training, technology transfer and support initiatives.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others. In particular, this program supports implementation of other statutory mandates, specifically, TPM, AM, and pavement and bridge preservation and maintenance [23 USC 150 and 23 USC 119 implemented through 23 CFR 490 and 23 CFR 515].

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's TPM and AM R&T Program supports: the efficient investment of Federal transportation funds across national transportation goals; the increase in accountability and transparency of the Federal-aid highway program; and the improvement of program and project decision-making through performance-based planning and programming. TPM and AM supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

> Safety/Promoting Safety: The TPM and AM R&T Program will contribute directly to highway safety and the Department's Systematic Safety Approach by providing tools, technologies, training and guidance to support infrastructure owners in effectively managing highway bridges, tunnels and other structures, so that such infrastructure is resilient and can safely carry traffic loads and withstand natural disasters. This also includes safety TPM data contributions to the overall Department's Data strategy.

Infrastructure/Improving Infrastructure: The TPM and AM R&T Program supports the Life Cycle and Preservation/Preventive Maintenance objective through research development and deployment strategies designed to foster more effective management of highway infrastructure assets. A major objective is to advance TPM practices; including the development of risk-based AM plans for developing investment strategies to achieve system performance effectiveness and State DOT targets for asset condition, while managing the risks, in a financially responsible manner, at a minimum practicable cost over the life cycle of its assets. A focus of the State DOT AM plans is the State DOT's long-term state-of-good-repair (SOGR) objectives for the NHS. FHWA works with State DOTs and MPOs to increase the health and longevity of the Nation's highways by assessing vulnerabilities, considering communities and resilience in the transportation planning process, incorporating resilience in AM plans, and addressing resilience in project development and design.

Innovation: The TPM and AM Program supports the Department's Innovation Goal by undertaking research and development toward providing critical data needed for improved decision-making, developing analytic tools to address critical performance gaps, and providing for a greater level of transparency in communicating transportation performance. The TPM and AM R&T Program is also focused on advancing the use of Building Information Modeling (BIM) for highway infrastructure to enable a life cycle approach to leveraging and integrating data as projects move from planning to design to construction and finally to operations and maintenance, after which the cycle begins again. Lastly, work will be conducted so that agencies can be prepared for autonomous vehicles from a design, maintenance and AM perspective.

Improving Mobility/Preserving the Environment: The TPM and AM R&T Program contributes to improving mobility and preserving the environment indirectly. By advancing more effective management of the transportation system and by advancing a performance-based Federal-aid highway program (that includes targets focused on system reliability, congestion, and emissions) the program will reduce the occurrence of impaired mobility and activities that are detrimental to the environment.

This program impacts and is of benefit to the highway system in its entirety, including the portion serving rural communities.

Program Objectives:

FHWA's TPM and AM R&T Program seeks to advance timely and effective implementation of TPM including AM. The research and development components of the program address "weak links" in relevant technologies and innovations that cannot or will not be addressed by other organizations, due to lack of capabilities or the absence of profit potential required to motivate private investment.

Key FY19 FHWA TPM&AM R&T Program Activities.

Activity	Period of Performance	Partners/Notes
Design and implement a comprehensive TPM & AM capacity building program that includes the development and delivery of training, TPM and Transportation Asset Management Plan (TAMP) workshops, and peer exchanges, support FHWA disciplines, and supports the deployment of targeted technical assistance, and delivery of workshops and analysis tools.	2019-2020	State DOTs are a key consumers of deployment activities; AASHTO and RI DOT are partners in pooled fund study to build capacity for TPM amongst State DOTs and MPOs
Conduct needs assessments, policy and impact analysis research, case studies and surveys	2019-2020	States and MPOs and their program implementation will be studied and assessed for identification of improvements
Develop and enhance transportation performance website, enhance internal business applications to provide FHWA staff key information, and continue development of State's progress reporting portal.	2019-2020	State DOTs and their constituents will benefit from the sharing of performance data portal for facilitating data collection and analysis
Develop analytical tools that are needed by States and MPOs for TPM implementation, e.g., trade off analysis, calculating benefit costs, project and program prioritization, etc.	2019-2020	State DOTs and MPOs will benefit from new and better analytical tools
Develop a series of technical informational resources and guidebooks that can be used by State DOTs and MPOs to assist them in carrying out the practice of performance and AM including undertaking performance gap analysis, setting State of Good Repair Goals, developing AM plan investment strategies, etc.	2019-2020	State DOTs and MPOs are key consumers of guidebooks and guidance
Employ innovative approaches to providing internal and external communication. Activities include development of website content, online periodicals, webinar support and management, and development of marketing and communication products.	2019-2020	State DOTs, MPOs, APTA are key consumers of online and other virtually delivered content

Activity	Period of Performance	Partners/Notes
TPM and AM Distance Learning and Development. Employ new and innovative methods to design, develop and deliver training and educational materials, such as online modular, videos, and web-conference training needed to support TPM and AM implementation	2019-2020	AASHTO and RI DOT are key partners in pooled fund study to build capacity for TPM amongst State DOTs and MPOs
Develop bridge preservation best practices case studies, develop and deliver training such as online modular, videos, and web- conference training to promote bridge preservation	2019-2020	Bridge Preservation Expert Task Group guides the effort. State DOTs, MPOs, Local Agencies are key consumers
Providing technical assistance and expertise to advance new practices in TPM, AM and preservation at national meetings and conferences.	2019-2020	State DOTs
Research and advance best practices for pavement utility cuts	2016-2020	State and local highway agencies
Develop and deploy assessment methods for resilient pavements	2017-2019	Working with States to analyze past flooding data
Data Integration Best Practices: Promote data integration by advancing the use of Building Information Modeling (BIM) for highway infrastructure	2015-2020	Showcasing innovate approaches by States and industry via webinars and peer exchanges; collaborating with EU countries that share similar goals
Undertake study to summarize the State DOT's 10-year investment strategies and projected condition of the Interstate system and NHS pavements, bridges, and other assets based on review, compiling, and analysis of the 52 State DOT AM plans submitted to FHWA for certification. This study is to also include analysis of the State DOT freight plans and safety plans to reach conclusions on the NHS in 2030.	2019-2020	State DOTs
AM informational resources and Guidebooks focused on AM and Automated Vehicles: Develop case study on AM data exchange, data needs and strategies for maintaining and managing highway assets related to automated vehicles.	2019-2020	State DOTs, MPOs, and other asset owners

Activity	Period of Performance	Partners/Notes
Develop informational resources on developing life-cycle plans for assets other than pavements and bridges	2019-2020	State DOTs, MPOs, and other asset owners
Develop Pocket Guide on Preservation of Deck, Superstructure and Substructure components of a bridge	2019-2020	State DOTs, MPOs, Local Agencies and other asset owners
Develop and Implement Analytical Approach/Decision-Making Process for Bridge Preservation	2018-2020	State DOTs
Develop a Transportation Asset Preservation Portal. This web-based portal will be developed to foster consistency among state and local agencies in preserving and maintaining their assets.	2019-2020	Iowa DOT under technical guidance from FHWA Bridge Preservation Expert Task Group will lead the effort of developing a first phase of the portal focusing on preservation of concrete bridge decks. Subsequently, a pooled fund project will be initiated to add other bridge components.
Identification of Effective Next Generation Performance Measures and Asset and Performance Management Methodologies to Support MAP-21 Performance Management Requirements Phase II: 2019	2019-2020	State DOTs
Capacity building for risk analysis and implementation of investment strategies to address, resilience, operations, and maintenance related to asset condition and system performance resulting from extreme weather and other risks.	2019-2020	State DOTs, MPOs, and other asset owners
Updating of NHI-134063, Maintenance Leadership Academy, for modules A, B, C	2019-2020	State DOTs, MPOs and other asset owners

Research Collaboration Partners:

FHWA TPM and AM R&T program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB), industry organizations such as Association of Metropolitan Planning Organizations (AMPO), American Public Transportation Association (APTA)and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA TPM & AM R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
AASHTO Committees on Maintenance, AM, Performance and Data	X	X			X			X	
AASHTO Joint Technical Committee on Electronic Engineering Data	x	x					x		
AASHTO Committee on Bridges and Structures	X		X		X	X			
State Departments of Transportation	X			X	X				X
AMPO	X	X			X			X	
APTA	X	X			X			X	
AASHTO TSP2	X	X			X	X			
National Institute of Standards and Technology (NIST)						X	X		

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
American Concrete Institute		X							
ASTM International			X						
European Union BIM Task Group	x	x	x				x		
Conference of European Directors of Roads (CEDR)						X			
Canadian Standards Association			X						
TRB	X	X				X			

Acquisition/Assistance:
The TPM and AM R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, cooperative agreements with universities are used to procure products and services to support activities, such as policy and programmatic research.

Other program needs are met through Blanket Purchase Agreements, competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate.

The TPM R&T program acquisitions are most often multi-year acquisitions, funded over several fiscal years. Single year contracts, or multi-year contracts fully funded in the year of award are occasionally used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. This often occurs most frequently in the procurement of maintenance services or repair parts for highly specialized laboratory equipment.

Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies. Specific examples of non-governmental partnerships include work with several universities conducting concrete materials research and private companies collaborating with research and development of alternative cementitious materials. Typical contributions for these collaborations are 20% of total project cost. Other examples are pooled fund studies that leverage State and local agency, as well as private sector funding for research, development and technology transfer-type activities.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA TPM and AM R&T program and is funded as such. Additionally, some program outputs such as 3D engineering models may be advanced through the Every Day Counts initiative. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State, MPO and local highway agencies are the primary stakeholders and beneficiaries of the FHWA TPM and AM R&T program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The program's outputs take the form of:

- Research publications, including reports and technical notes; case studies and noteworthy practices documents.
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- New and/or updated technical guidance;
- Training courses and workshops;
- Targeted technical assistance
- Live Webinars;
- Self-Paced Webinars
- Peer exchanges
- Videos.

Key 2019 FHWA TPM & AM R&T Program Outputs.

Program Objective	**Key 2019 Outputs**
Design and implement a comprehensive TPM & AM capacity building program	Forums for conducting and facilitating customer and stakeholder outreach, training, workshops, and peer exchanges, support for FHWA disciplines; support partner capacity building activities; and support the deployment of targeted technical assistance, workshops and seminars, as well as industry sponsored conferences and events.
Conduct needs assessments, policy and impact analysis research, case studies and surveys	TPM Implementation survey on internal and external stakeholder readiness and needs; research and analysis on target setting accuracy and methods to improve state of the practice in this area and on forecasting of future performance. Research and synthesis studies of organizational structure and management for improved performance. Support for related pooled fund studies and other industry supported research and development

Program Objective	Key 2019 Outputs
Develop and make accessible a TPM performance website and online portal for reporting performance data and information, and, develop enhanced internal business applications to provide FHWA staff key information.	Online website of performance reports and a portal for collecting biennial report information, e.g., targets and performance and condition data; Standard Operating Procedures on internal business procedures, such as how FHWA will calculate performance measures and make significant progress determinations for target achievement.
Provide analytical tools to support States' and MPOs' TPM & AM implementation	Analysis tools, such as those related to calculating performance metrics, trade off analysis, benefit costs analysis, project and program prioritization, etc.
Develop a series of technical informational resources and guidebooks that can be used by State DOTs and MPOs to assist them in carrying out the practice of TPM & AM	TPM informational resources and guidebooks on subjects ranging from development of investment strategies and target setting collaboration to models for developing performance-based planning agreements.
Employ Innovative Communication and Outreach Activities	Activities include development of website content, delivery of a bimonthly electronic digest, webinar support and management, development of marketing and communication products and meeting support.
Employ innovative approaches and methodologies for training development and delivery	Modular training and educational materials, such as video and web-based and web-conference training needed to support TPM & AM implementation for both internal and external customers.
Develop and deploy Bridge Preservation best practices	Development of bridge preservation apps to be used by onsite field staff
Providing technical assistance and expertise to advance new practices in TPM, AM and preservation at national meetings and conferences	Technical advice and expertise to AASHTO member states and co-sponsorship of events such as the National AM Conference
Research and advance best practices for pavement utility cuts	Development of an app for utility cut best practices
Develop and deploy assessment methods for more resilient pavements	Development of a flooded pavement decision tool to assess the damage to infrastructure vs the economic impact of road closures
Promote data integration by advancing the use of Building Information Models (BIM) for highway infrastructure	Development of a framework for data integration and identification of data standards and gaps in the standards

Program Objective	Key 2019 Outputs
Undertake study to summarize the State DOT's 10-year investment strategies and projected condition of the Interstate system and NHS pavements, bridges, and other assets based on review, compiling, and analysis of the 52 State DOT AM plans submitted to FHWA for certification. This study is to also include analysis of the State DOT freight plans and safety plans to reach conclusions on the NHS in 2030.	A final report that would capture the compiled investment strategies of State DOTs with the projected condition and performance based on each State DOT TAMPs.
Develop case study on AM data exchange, data needs and strategies for maintaining and managing highway assets related to autonomous vehicles.	Identification of key design considerations and maintenance strategies that are impacted by an autonomous vehicle fleet. Developed guidance and case studies on AM data needs and strategies for managing highway assets as related to autonomous vehicles and related technologies.
Develop informational resources for assets other than bridge and pavements	Resource guidebooks for States to use for the development of life-cycle plans for non-traditional highway assets
Develop Pocket Guide on Preservation of Deck, Superstructure and Substructure components of a bridge	Publish a pocket guide on Thin Polymer Overlays for Concrete Deck and Bridge Painting
Develop Analytical Approach/Decision-Making Process for Bridge Preservation	An analytical tool to assist states in determining the cost effectiveness of bridge preservation actions
Identification of Effective Next Generation Performance Measures and Asset and Performance Management Methodologies	Series of case studies and research related development of more effective measures for determining and predicting system performance; demonstration the use of tools and integration of them into the SHA business practices
Capacity building for risk analysis and implementation of investment strategies to address, resilience, operations, and maintenance related to asset condition and system performance resulting from extreme weather and other risks.	Case studies, criteria and other guidance material and delivery of training and education material
Updating of NHI-134063, Maintenance Leadership Academy	Draft training course

The predominant measures for the program's T2 activities are output measures, for example, number of workshops delivered. Audience assessments of effectiveness are obtained for some webinars and formal classroom training.

The benefit to be accrued by FHWA TPM and AM R&T Program stakeholders is more effective management of our highway transportation system.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of FHWA's TPM and AM R&T program takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity. When such outputs are produced, they are included in the agency's Annual Performance report. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
Program performance is assessed primarily on the basis of project milestones. Survey results and web data analytics are other key determinants for programming investments and determining metrics for monitoring programs' progress. For example, a comprehensive survey was conducted in 2016 to evaluate FHWA Division Offices readiness to support a myriad of roles identified for TPM implementation. Based on survey results, two areas were identified for focused support; roles associated with supporting target setting and ensuring pavement data quality. Related measures and strategies were incorporated into the Agency's Strategic Implementation Plan to ensure a corporate response to meeting the respective targets. A follow up survey will be conducted in 2019 to gauge progress in these and other areas assessed; the results from which will again be used to target specific areas for improvement. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Outputs of this program will assist State and local highway agencies in more effectively managing the performance of highway infrastructure. Accordingly, this program contributes toward achievement of the Department's goal to Improve Conditions of America's Transportation-Related Infrastructure and Alleviate Urban Congestion. Achievement of these goals is tracked through the processes put into place in support of the Transportation Performance Management regulations.

Construction and Project Management Research and Technology
$1,100,000

Program Description/Activities:
The Construction and Project Management Research and Technology (R&T) Program is a coordinated and cohesive program of research, development and technology activities focused on providing tools, technologies and guidance, and supporting updated policies, to improve highway construction and project management practices. Activities include research and development to advance technologies and practices that accelerate highway construction, improve the quality (and therefore durability) of the end product, improve project efficiencies, and ensure effective management of construction projects.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Construction and Project Management R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Construction and Project Management R&T Program will contribute directly to highway safety and the Department's Systematic Safety Approach by providing tools, technologies, guidance and training to support infrastructure owners in accelerating highway construction, thereby reducing highway users' exposure to construction work zones. In addition, the use of automated machine guidance on projects reduces worker exposure to hazards.

Infrastructure/Improving Infrastructure: The Construction and Project Management R&T Program supports the Life Cycle and Preventive Maintenance objective through research and technology initiatives that improve the quality (and therefore durability) of highway infrastructure. For example, the program is developing training on bridge construction inspection and carrying out research to demonstrate best practices for quality assurance on accelerated bridge construction (ABC) projects.

Innovation: The Construction and Project Management R&T Program supports the Department's Innovation Goal by advancing innovative highway construction and project management practices. For example, the program will assess technologies to non-destructively locate utilities on projects to avoid disruptions and conflicts during construction. In addition, work is ongoing to advance the use of Building Information Modeling (BIM) for highway construction and promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection.

Improving Mobility/Preserving the Environment: The Construction and Project Management R&T Program contributes to improving mobility and preserving the environment indirectly, by reducing the frequency and duration of maintenance, repair, and reconstruction through increased use of accelerated construction practices and improved durability.

This program impacts and is of benefit to highway construction projects throughout the nation, including those in rural communities.

Program Objectives:
FHWA's Construction and Project Management R & T Program seeks to advance innovations in highway construction and project management practices that accelerate construction and improve the quality of the constructed product. The program addresses critical knowledge gaps that cannot or will not be addressed by other organizations. Major focus areas of the program are construction management (including scope, schedule, cost and quality), construction risk management, and construction innovation leadership.

Key FY19 FHWA Construction and Project Management R&T Program Activities

Activity	Period of Performance	Partners/Notes
Assess and enhance technologies to non-destructively locate utilities	2019-2021	State DOTs, third party utilities
Develop and demonstrate the return on investment of Building Information Modeling (BIM) for highway construction	2019-2020	AASHTO, AGC, ARTBA, State DOTs, highway construction contractors, software vendors
Develop and share construction management best practices	2011-2020	TPF-5(260) members
Develop training on bridge construction inspection	2018-2020	State DOTs, MPOs
Develop an updated and innovative web-based schedule management course	2019-2020	State DOTs
Conduct probabilistic, risk-based cost estimate reviews to validate major project cost and schedules	2018-2020	State DOTs and project sponsors
Promote best practices for quality assurance on accelerated bridge construction (ABC)	2018-2020	State DOTs

Activity	Period of Performance	Partners/Notes
Evaluation of FHWA's Major Projects Program for improved delivery and performance	2019-2020	State DOTs and project sponsors
Development of a risk based method for increased assumption of State DOT authorities on major projects	2019	
Promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection	2018-2021	State DOTs, FAA, industry
Develop and consolidate major project information systems to facilitate monitoring of major projects requirements	2018-2019	

Research Collaboration Partners:
FHWA Construction and Project Management R&T program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State DOTs, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry organizations such as the Associated General Contractors (AGC) and the American Road and Transportation Builders Association (ARTBA), standard-setting organizations such as AASHTO, and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized below.

Benefits of Partnership and Partner Contributions to FHWA Construction and Project Management R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Specialized Expertise or	Funding
AASHTO Committee on Construction	X				X		
State Departments of Transportation	X			X	X		X
Associated General Contractors (AGC)		X					
American Road and Transportation Builders Association (ARTBA)		X					
International Intelligent Construction Technologies Group (IICTG)		X			X		
AASHTO Joint Committee on Electronic Engineering Data	X	X	X				
International Highway Engineering Exchange Program (IHEEP)	X	X			X		
FAA			X			X	

Acquisition/Assistance:
The Construction and Project Management R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. Program needs are met through, competitively procured contracts, project-specific competitive procurements, and small purchases. GSA schedule procurements are used where appropriate.

The Construction and Project Management R&T program acquisitions are most often multi-year acquisitions, funded over several fiscal years, often through shorter term task orders. Single year contracts, or multi-year contracts fully funded in the year of award are occasionally used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured.

Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies. Specific examples of non-governmental partnerships include work with several universities conducting construction management research and private companies collaborating with research and development of alternative cementitious materials. Typical contributions for these collaborations are 20% of total project cost.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA Construction and Project Management R&T program, and is funded as such. Additionally, some program outputs are advanced through the Every Day Counts initiative. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Construction and Project Management R&T program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The program's outputs take the form of:

- Research publications, including reports and technical briefs;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- New and/or updated technical guidance;
- Training courses and informational videos;
- Webinars;
- Workshops
- Peer exchanges
- Direct technical assistance.

Key 2019 FHWA Construction and Project Management R&T Program Outputs

Program Objective	**Key 2019 Outputs**
Assess and enhance technologies to non-destructively locate utilities	Identification of feasible technologies
Develop and demonstrate the return on investment of Building Information Modeling (BIM) for highway construction	Development of methodology to assess ROI for BIM
Develop and share construction management best practices	Webpages, reports and guidebooks
Develop training on bridge construction inspection	Development of draft training course
Develop an updated and innovative web-based schedule management course	Development of web-based, 'gamified' schedule management course
Conduct probabilistic, risk-based cost estimate reviews to validate major project cost and schedules	Independent validation of cost estimates on 10 -15 major projects
Promote best practices for quality assurance on accelerated bridge construction (ABC)	Sharing of best practices
Evaluation of FHWA's Major Projects Program for improved delivery and performance	Develop an approach to assess major projects for potential improvements in delivery and performance
Development of a risk based method for increased assumption of State DOT authorities on major projects	Establishment of a process for risk based oversight of major projects

Program Objective	Key 2019 Outputs
Promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection	Sharing of best practices; input to FAA on UAS experience in highway construction
Develop and consolidate major project information systems to facilitate monitoring of major projects requirements	Approval by the Investment Review Board and initiation of contract

The predominant measures for the program's T2 activities are output measures, for example, number of workshops delivered. Audience assessments of effectiveness are obtained for some webinars and formal classroom training, with the ultimate goal of field implementation across the nation.

The benefits to be accrued by FHWA Construction and Project Management R&T Program stakeholders include improvements in the quality, durability, speed of construction and increased efficiency of projects with improved worker safety.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of FHWA's Construction and Project Management R&T program takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity. When such outputs are produced, they are included in the agency's Annual Performance report. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
Program performance is assessed primarily on the basis of project milestones. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Construction and Project Management Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Outputs of this program will assist State and local highway agencies in improving the speed and efficiency of highway construction while improving the quality of the end product.

Geotechnical and Hydraulics Research & Technology
$3,100,000

Program Description/Activities:
The Geotechnical and Hydraulics Research and Technology (R&T) Program provides a coordinated and cohesive approach to research, development and technology activities to improve the geotechnical and hydraulic performance (safety, efficiency, durability, resiliency and cost-effectiveness) of the highway and transportation system.

The composition and focus of the Geotechnical and Hydraulics R&T Program (Program) reflects how our nation's transportation system spans and includes widespread and diverse geological, riverine, and coastal environments and features. The Program aligns with needs and requirements associated with public safety, statutory and regulatory requirements, and other elements of transportation.

The program is organized under several functional areas, under the geotechnical and hydraulic engineering disciplines. Geotechnical functional areas include Earth and Rock Works; Earth Retaining Structures; Geohazards; Ground Improvement; Structural Foundations; Subsurface Investigation. Hydraulic functional areas include Hydrology (including floodplains), Highway Drainage, Bridges and Culverts; Scour; and Coastal Engineering. Additionally, the Program provides flexibility and interchangeability that recognizes conditions and circumstances might incorporate and employ multiple functional areas. This multi-faceted Program yields an effective, crosscutting approach to addressing the hydraulic and geotechnical challenges of highway infrastructure.

Examples of Program activities include research of slope stability and geotechnical properties to protect and mitigate effects of landslides (Geohazards); investigating hydroplaning to reduce risk to the public while optimizing drainage approaches (Drainage); or reducing sizes and costs of bridge foundations through developing safe yet effective bridge scour estimates (Geohazards/Scour).

Program activities and outcomes include research, development, outreach, deployment, guidance efforts and technical products. To accomplish these outcomes, the Program gains valuable insights and information through partnerships and collaboration with other governmental entities, industry, associations, academia, and other colleagues and stakeholders in the transportation community.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. Portions of the Program directly support the requirements and auspices of Title 23, United States Code (USC) §144. "National bridge and tunnel inventory and inspection standards." Additionally, the May 1977 EO 11988 "Floodplain Management" serves as impetus for other Program functional areas.

USC sections 502 and 503 provide important Program authorizations, including requiring the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas. 23 USC §503(b)(2)(C)((xii) authorizes research and technology activities that include *"(xii) hydraulic, geotechnical, … aspects of infrastructure."*.

The Program seeks to align with the following 23 USC §503 Objectives:

#	§503 Objectives	Citation
O-1	*Improving Highway Safety*	*§503(b)(2)*
O-2	Reduce the number of fatalities and serious injuries on public roads	*§503(b)(2)(B)(ii)*
O-3	*Improving Infrastructure Integrity*	*§503(b)(3)*
O-4	Reduce the number of fatalities attributable to infrastructure design characteristics and work zones	*§503(b)(3)(B)(i)*
O-5	Improve the safety and security of highway infrastructure	*§503(b)(3)(B)(ii)*
O-6	Improve the ability of transportation agencies to deliver projects that meet expectations for timeliness, quality, and cost	*§503(b)(3)(B)(vi)*
O-7	Improve highway condition and performance through increased use of design, materials, construction, and maintenance innovations	*§503(b)(3)(B)(vi)*
O-8	Reduce the environmental impacts of highway infrastructure through innovations in design, construction, operation, preservation, and maintenance	*§503(b)(3)(B)(vii)*
O-9	Study vulnerabilities of the transportation system to … extreme events and methods to reduce those vulnerabilities.	*§503(b)(3)(B)(viii)*
O-10	*Strengthening Transportation Planning and Environmental Decision-making*	*§503(b)(4)*
O-11	Minimize the cost of highway infrastructure and operations	*§503(b)(4)(B)(i)*
O-12	Reduce the potential impact of highway infrastructure and operations on the environment	*§503(b)(4)(B)(ii)*
O-13	Advance improvements in environmental analyses and processes … for transportation decision-making	*§503(b)(4)(B)(iii)*
O-14	Improve construction techniques	*§503(b)(4)(B)(iv)*
O-15	Accelerate construction to reduce congestion and related emissions	*§503(b)(4)(B)(v)*
O-16	Reduce the impact of highway runoff on the environment	*§503(b)(4)(B)(vi)*

Knowing and understanding the Program's statutory (and regulatory) requirements and authorities assures we remain focused on efforts and outcomes support those objectives[7]. Finally, the Program has or shares responsibility for the following elements and requirements contained within the March 22, 2018 Transportation Appropriation Bill, including producing a report on Resilient Infrastructure (Senate report page 53) and supporting Geosynthetic Reinforced Soil-Integrated Bridge Systems (Senate report page 54).

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

[7] As appropriate, we will relate any activities or examples to these objectives by using a "O-n" nomenclature. For example, O-9 would indicate support of the §503(b)(3)(B)(viii) objective.

The Program aligns with and supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics.

The following sections provides some specific contributions for these goals and topics. For each section, we may provide examples that provide context of our approaches and contributions or relate the sections or examples to associated statutory objectives .

Safety/Promoting Safety: The Program contributes directly to highway safety through research of the interactions of water sheet flow, pavement systems, and vehicle stability (Hydroplaning)with a goal of improving driver and vehicle safety and stability. Such efforts will become even more relevant with the introduction and increasing numbers of autonomous (driverless) vehicles and how environmental factors (e.g., rain on pavements) may impact their safe operation.

As will be described in more detail later, the Program directly and indirectly supports safety agencies on an on-going basis. For example, scour is a leading cause of bridge failure, sometimes leading to tragic loss of life. The Program focuses on means to predict, prevent, and mitigate scour. This is not only a safety concern, scour induced failures or closures causes disruption to traffic and wastes taxpayers funds. Similarly, failure of geotechnical features is most often the result of corrosion/deterioration, or damage as the result of extreme events or other geohazards. Ensuring safety and serviceability of aging infrastructure necessitate strategies and technologies to evaluate the integrity of geotechnical features hidden from sight (in the soil).

The Program also works to mitigate geohazards with the development of better design guidance to protect geotechnical assets against extreme events. Additionally, the program is working to develop protocols for the inventory and evaluation of geotechnical highway features (embankments, slopes, walls, rock cuts, bridge foundations, bridge approaches, etc.) necessary for life cycle assessments to equip transportation agencies to better manage these assets to ensure serviceability and safety.

Infrastructure/Improving Infrastructure: The Program functional areas of Geotechnical and Hydraulics either directly or indirectly involves almost every aspect of our nation's transportation Infrastructure. From highway embankments to bridge foundations; coastal highway protection to slope stabilization; soil strength and hydraulic analyses. The Program supports Infrastructure and Infrastructure Improvements through a variety research and development efforts.

For example, the Program is leading the next generation of science and engineering research related to scour resistant bridge foundation design. The Program recognizes that current scour prediction approaches are potentially too conservative under certain site conditions, increasing construction cost and time. The Program applies geotechnical and hydraulic engineering principles to develop more accurate prediction tools, taking advantage of erosion resistant soils below riverbeds to reduce foundation depth (e.g. using in-situ erosion testing). The proposed guidance developed through research will result in safe and more economical design, especially relevant as many aging bridge foundations have exceeded their service life and may require replacement in the near future.

Innovation: The Program supports the Department's Innovation Goal by undertaking research and development in technologies and tools that provide more reliable and cost-effective project designs. Technologies developed or supported by the Program through the agency's Every Day Counts (EDC) program include the Geosynthetic Reinforced Soil-Integrated Bridge (GRS-IBS) and Collaborative Hydraulics: Advancing to the Next Generation of Engineering (CHANGE). The GRS-IBS was developed by the Office of Infrastructure R&D at the Turner-Fairbank Highway Research Center (TFHRC) to serve as a cost and time effective solution to simple bridge construction, saving transportation agencies up to 60 percent compared to their conventional practice. CHANGE provides a better representation of flow data for planning and design teams leading to improved project quality. The Program supports use of advanced geotechnical exploration techniques for cost effective project delivery and improved risk management.

The Program also continues to advance best practice technologies to address a significant number of construction claims in highway projects by maintaining the Geo-Construction Information and Technology Selection Management System "GeoTechTools"; used throughout the project delivery process to identify appropriate geotechnical solutions to promote improved infrastructure performance. The Program takes advantage of using supercomputing clusters at the Department of Energy's (DOE's)/Argonne National Laboratories (ANL) / Transportation Research Analysis and Computing Center (TRACC) to more effectively and efficiently conduct research studies. Computer modeling reduces the need for expensive physical experimental work and permits more efficient management of research projects.

Improving Mobility: The Program has long recognized and supported efforts to improve mobility, especially after the nation experiences extreme events such as flooding or geohazards such as landslides. For example, will use the information learned from the recent landslide in Pittsburgh on Route 30, along with other failures on the highway system to identify and define metrics that correlate to earth work performance, and to refine/develop protocols for assessment and repair of roadway cuts and embankments. Additionally, during Hurricane Harvey, many of the Houston area bayous experienced flooding that impacted roads, highway bridges and railroads. The Program's next generation of hydraulic engineering tools with graphical visualization features will provide the city and state design teams with better data to evaluate flood impacts. The technology can be used to illustrate patterns of flow discharge, water surface elevations, depth, and velocity. The results allow for more accurate estimations of flow conditions and better evaluations of the impacts to transportation assets.

Preserving the Environment: Providing efficient and effective project delivery is and remains an important component of the FHWA mission. A major element of that component are activities and programs that preserve and protect the natural and human environment. More so than many other disciplines, the Program functional areas support goals of preserving the environment throughout the entire project delivery process (planning, the National Environmental Policy Act (NEPA) process, Right of Way (RoW), design, construction, and emergency relief). In achieving this, the Program seeks to provide and support the science and engineering necessary to produce understandable, defensible, and effective decisions. For example, the Program provides 3-D hydraulic modeling tools and

resources to help stakeholders overcome environmental regulatory impediments that slow down project delivery. For example, the Program developed innovative streambank protection solutions for Hoh River (Olympic National Park, WA) to ensure regulatory approvals balanced with reasonable project costs. In FY 2019 and the future, initiatives such as the Administration's Infrastructure vision and plan, as well as recent Appeals and Supreme Court decisions, will only make such support and activities more salient and imperative.

The Program also helps coordinate and support efforts to provide precipitation and streamflow information used for environmental analyses and engineering design and practice. For example, coordinating efforts to allow State DOTs pool their resources and fund updates to 1960 era rainfall maps and estimates.

Program Objectives:
As described earlier, the Program aligns our objectives with statutory, regulatory, and DOT Strategic goals and objectives.

Some critical questions the Program asks of any objective: Is the issue of national importance? and Who else can perform these efforts? The Program also develops any objectives with the questions such as: how will these support the FHWA's mission and public safety, reflect the needs of and interactions with our partners and stakeholders, and be consistent with and produce effective and efficient outcomes? The Program purposely avoids any replication or usurpation of efforts by our academic and industry partners.

The Program also considers input obtained through stakeholder interactions to identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Therefore, within the functional areas of both disciplines the Program Objectives are, , to engage in activities and efforts that:

(1) lead research in areas of new or compelling needs of the transportation system,
(2) enhance the efforts of other research, as appropriate, and
(3) adapt innovation to suit our transportation systems.

Key FY19 FHWA Program activities

Activity	Period of Performance	Partners/Notes
Advance Reliability Based Design and Construction of Geotechnical Structures – Foundation Elements, Construction Materials, Design Methods, and QA Procedures	FY14-FY19	State DOTs, Industry, and Academia
Develop design specifications for pavement hydraulics and highway drainage to mitigate hydroplaning	FY16 – FY22	State DOTs, Department of Energy/Argonne National Lab (DOE/ANL)
Develop solutions and design guidelines for hydrological (changes in rain fall and flood frequency) impacts on highway infrastructure	FY16 – FY22	State DOTs, National Oceanic and Atmospheric Administration (NOAA), United States Geological Survey USGS)
Develop solutions to key challenges associated with flow modeling for bridge and culvert hydraulics.	FY16 – FY23	State DOTs, DOE/ANL
Develop the next generation design tools for bridge scour, stream stability and scour protection/countermeasures.	FY16 – FY24	State DOTs, DOE/ANL, USGS, Federal Lands Highway Division (FLHD)
Evaluate Geotechnical Performance Measures and Risk Management	FY17-FY20	FHWA, State DOTs, Industry, Academia
Advanced Automated Geotechnical Data Collection and Instrumentation	FY17-FY20	Federal Lands Highway Division (FLHD), State and local transportation agencies, and Federal, State, and local natural resource and land management agencies.
Evaluate Geosynthetics for Use in Pavement Design	FY17-FY20	State and local transportation agencies, Academia
Develop design specifications for coastal highways and bridges impacted by extreme events	FY17 – FY23	State DOTs, DOE/ANL
Site and Laboratory Characterization and Transformations of Geotechnical Materials	FY17-FY24	Industry and Academia
Assessment of Corrosion for Buried Metallic Foundations and Elements	FY18-FY21	National Academies of Sciences, Engineering, and Medicine (NASEM), State DOTs, Industry, Academia
Road Foundation Contamination and Drainage: In-Service Evaluation and Best Practice Recommendations	FY19-FY24	FHWA, State and local transportation agencies

Support of Special Situations

In addition to the role of conducting research and development, when called upon, the Program provides technical assistance in support of infrastructure forensic investigations undertaken by the National Transportation Safety Board (NTSB), the Inspector General, State Departments of Transportation, FHWA Division Offices, and others. For example, the Program investigated the foundation failures of the Leo Frigo Bridge (Wisconsin), the I-495 Bridge (Delaware), and the I-65 Bridge (Indiana) to evaluate the cause, ensure safety, review mitigation design, and assist with construction and opening of the bridges to the public; protocols have since been developed for response to these types of events. The Program has also participated in MSE wall failure investigations (New York and Indiana), landslide and slope failures (North Carolina, Colorado, Tennessee, and Washington), and construction issues (California, Texas, and Washington). In addition, the program provided design recommendations for rebuilding highway infrastructure after Hurricane Katrina (2005) and the Colorado flooding (2013).

Research Collaboration Partners:
The Program regularly engages with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally and internationally. As depicted in Table 2, partners and stakeholders include representatives of Governmental entities, Professional Organizations, Industry, Academia, and other Organizations. They range from individual highway agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), professional and industry organizations such as the American Society of Civil Engineers, the Deep Foundations Institute, the National Concrete Masonry Association, and the International Association for Foundation Drilling, and other Federal agencies.

As depicted in Table 2, the breadth of the Program functional areas results in interactions and involvement with stakeholders not typically encountered in other research areas. For example, working with the Departments of the Navy and U.S. Coast Guard on navigability issues (and resolutions) or engaged in National Academies of Sciences, Engineering, and Medicine (NASEM) on research outside of TRB auspices.

Additionally, the Program works through FHWA's International Program Office to engage in international activities and coordination. For example, supporting the Department of State on providing technical assistance on transportation issues to other nations or leveraging knowledge and expertise of other National Governments on new challenges facing the USA.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

Benefits of Partnership and Partner Contributions to FHWA Geotechnical and Hydraulics R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
Government									
State Departments of Transportation	X			X	X				X
Local Public Agencies (LPA) and Metropolitan Planning Organizations (MPO)	X			X	X				X
AASHTO Committee on Bridges and Structures	X		X		X				
AASHTO Committee on Hydraulics and Hydrology	X		X		X	X			
US Army Corps of Engineers (USACE)	X		X	X		X			X
Department of Energy (DOE)/ Argonne National Lab (ANL)	X					X	X		
Department of Interior (DOI)/ US Geological Survey (USGS)	X			X		X	X		
Department of Commerce (DOC)/ National Oceanic and Atmospheric Administration (NOAA)	X			X		X	X		
Federal Aviation Administration (FAA)	X		X		X	X	X	X	
Federal Railroad Administration (FRA)	X	X	X		X	X	X	X	
Professional Organizations									
American Society of Civil Engineers		X			X		X	X	
Geo-Institute		X		X	X	X	X	X	
Deep Foundations Institute (DFI)		X		X	X	X	X	X	
The International Association of Foundation Drilling (IAFD)		X		X	X	X	X	X	
ASTM International			X						

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
Industry									
National Concrete Masonry Association (NCMA)		X		X	X	X	X		
Geosynthetic Manufactures Association (GMA)		X		X	X	X	X		
Academia									
United States University Council for Geotechnical Education and Research (USUGER)		X		X		X	X	X	
Other									
Transportation Research Board (TRB)					X	X			
National Academies of Sciences, Engineering, and Medicine (NASEM)		X			X	X	X		
National Science Foundations	X		X	X		X	X		X
International Programs	X		X	X	X	X	X		

Acquisition/Assistance:
The Program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, the program maintains competitive Indefinite Delivery, Indefinite Quantity (IDIQ) contracts, Requesting Interagency Agreements, and Servicing Interagency Agreements to provide support for research, development, and deployment of innovation and technology. Contracts are structured to allow both the level of effort and labor mix provided to be adjusted as needs and priorities change. Other Program needs are met through competitively procured contracts, project-specific competitive procurements, and small purchases. GSA schedule procurements and small-business set asides are used where appropriate.

The Program's acquisitions are most often multi-year IDIQ contracts, incrementally funded over several fiscal years through award of shorter-term Task Orders. Single year contracts, or multi-year contracts fully funded in the year of award are used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. This occurs most frequently in the procurement of maintenance services or repair parts for highly specialized laboratory equipment.

Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies. The following are several examples to advance the efforts of the Program. Examples:

- The program leads Transportation Pooled Fund (TPF) solicitations/studies: (1) *Road Foundation Contamination and Drainage: In-Service Evaluation and Best Practice Recommendations*, (2) *In-situ Scour Testing Device*, (3) *Bridge Pier Scour Research*, *High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics*.
- Additionally, the Program, through the National Academies of Sciences, Engineering, and Medicine, is aiming to partner with other organizations to conduct research on the *Assessment of Corrosion for Buried Metallic Foundations and Elements*.
- The Program leveraged industry (ADSC) for work on two phases of post-grouted drilled shaft work. Provided equipment, labor and materials for shaft construction and load tests.
- The Program leveraged G-I, and state DOTs (pooled-fund) for DIGGS development and deployment. Pooled fund for development, G-I for data dictionary development and infrastructure refinement. Eventually, we will leverage industry for development of commercial products to read and use data.
- Leveraging industry (DFI and ADSC) for High Performance Concrete work. DFI and the European Federation of Foundation Contractors (EFFC) summarizing best practices, ADSC providing materials, equipment and labor for field testing.

Technology Transfer (T2):
The Program does not consider research and development as an outcome, but rather as the beginning of a means to support our transportation partners and stakeholders in managing our nation's highways. That is why technology transfer is an integral part of the Program, and is funded as such. Additionally, some program outputs are advanced through the Every Day Counts initiative. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State and local highway agencies are the primary stakeholders and beneficiaries of the Program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The Program's primarily products for T2 take the form of:

- Geotechnical Engineering Circulars (GEC);
- Hydraulic Engineering Circulars (HEC);
- National Highway Institute (NHI) training manuals and materials
- Research publications, including peer reviewed papers, reports and technical briefs;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- Webinars;
- Workshops.

Key 2019 FHWA Program Outputs.

Program Activities	Key 2019 Outputs
Advance Reliability Based Design and Construction of Geotechnical Structures – Foundation Elements, Construction Materials, Design Methods, and QA Procedures	Research report and dissemination of the calibrated bearing resistance factors for large diameter steel pipe piles for consideration as proposed revisions to FHWA design guidance and AASHTO specifications.
Develop design specifications for pavement hydraulics and highway drainage to mitigate hydroplaning	Research report summarizing Computational Fluid Dynamics modeling of water film thickness on multi-lane pavements and proposed revisions to FHWA design guidance and associated NHI training courses.
Develop solutions and design guidelines for hydrological impacts (changes in rain fall and flood frequency) on highway infrastructure	Research report on NOAA Atlas 14 precipitation frequency updates for the state of TX and proposed revisions to FHWA design guidance and associated NHI training courses.
Develop solutions to key challenges associated with flow modeling for bridge and culvert hydraulics	Research report that documents advancements to FHWA's recommended flow modeling analysis tool and proposed revisions to FHWA design guidance and associated NHI training courses.
Develop the next generation design tools for bridge scour, stream stability and scour protection/countermeasures	Research report summarizing the next generation scour prediction tools that compare hydraulic erosion forces with the resistance of bed materials (soils) and proposed revisions to FHWA design guidance and associated NHI training courses.
Evaluate Geotechnical Performance Measures and Risk Management	Research report on the analysis of data related to the bump at the end of the bridge and identification of trends related to bridge foundation type and design details.
Advanced Automated Geotechnical Data Collection and Instrumentation	Peer-reviewed papers and a research report on the results and interpretation of the data collected on bridges built throughout the FHWA's Every Day Counts initiative.
Evaluate Geosynthetics for Use in Pavement Design	Established sampling protocols, and a report on the evaluation of the use of geosynthetics as a separator in a 23-year case study.
Develop design specifications for coastal highways and bridges impacted by extreme events	Research report estimating wave forces on bridge substructures. This will allow proposed revisions to FHWA technical references and associated NHI training courses.
Site and Laboratory Characterization and Transformations of Geotechnical Materials	Research report and dissemination of the measured strength and variability of commonly used open-graded structural backfills for retaining walls and bridge foundations and abutments. In addition, the establishment of a work group to synthesize available transformation methods and identify gaps in practice

Program Activities	Key 2019 Outputs
Assessment of Corrosion for Buried Metallic Foundations and Elements	A final Statement of Work and initiation of the study
Road Foundation Contamination and Drainage: In-Service Evaluation and Best Practice Recommendations	Identification of sites for evaluation, in partnership with state agencies.

While the entire Program aligns with and supports goals of safety and resiliency, associated benefits accrued by Program stakeholders also include better solutions to design and construction of geotechnical and hydraulic features. The benefits of the Program will result in a more economical bridge foundation design and more accurate prediction of geotechnical and hydraulic design parameters.

The Program is represented in the USDOT Research Hub and the National Transportation Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of a Program takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity. When such outputs are produced, they are included in the agency's Annual Performance report. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
Program performance is assessed primarily on the basis of project milestones. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities based on progress and evolving circumstances. Outputs of this program will assist State and local highway agencies in more effectively managing the performance of highway pavements.

Long-Term Infrastructure Performance
$8,620,000

Program Description/Activities:
The Long-Term Infrastructure Performance (LTIP) Programs include the Long-Term Pavement Performance (LTPP) Program and the Long-Term Bridge Performance (LTBP) Program. These programs, conducted in collaboration with the State DOT infrastructure owners, provide for characterization and monitoring of in-service highway pavement test sections (LTPP) and bridges (LTBP) to assemble the data needed to improve infrastructure design and advance the understanding of highway infrastructure performance necessary to effectively manage transportation assets. The collected data are disseminated to the public through web-based portals. FHWA's investment in obtaining and disseminating the data is leveraged by both public and private sector research organizations that apply the data to address a variety of infrastructure performance needs of local, State, regional, and national interest.

Historically, LTPP and LTBP have been managed and pursued as independent research efforts. In 2017, in recognition of opportunities for synergy and improved efficiency, FHWA transitioned to an integrated approach to managing the two programs.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others. Both long-term research programs were provided for through previous highway authorization legislation (LTPP was authorized by the 1987 Surface Transportation and Uniform Relocation Assistance Act and LTBP was authorized by the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)) and were intended to span multiple decades. As these programs continue to develop, they are supporting the implementation of the Transportation Performance Management (TPM) requirements that were included in the last two bills: MAP-21 and FAST-Act. The pavement performance data collected as part of the LTPP program are being used to validate and calibrate transportation performance measures.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the Environment

FHWA's LTIP Programs support the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The LTIP Programs contribute indirectly to highway safety and the Department's Systematic Safety Approach through contributions to improved design and more effective infrastructure management, resulting in reduced risk of failure and work zone exposure.

Infrastructure/Improving Infrastructure: The LTIP Programs supports the Life Cycle and Preventive Maintenance objective by enabling more effective management of infrastructure performance.

Innovation: The LTIP Programs supports the Department's Innovation Goal through development of innovations needed to support data collection that have broader applicability, and by providing data to support development of improved design procedures and other solutions to pavement and bridge engineering challenges.

Improving Mobility/Preserving the Environment: The LTIP Programs contribute to improving mobility and preserving the environment indirectly, by enabling improved design and more effective infrastructure management, thereby reducing the frequency and duration of maintenance, repair, and reconstruction, and reducing the risk of failure.

These programs impact and are of benefit to highway pavements and bridges throughout the nation, including those in rural communities.

Program Objectives:
FHWA's LTIP Programs seek to advance understanding of how and why highway pavements and bridges perform as they do, in support of improved design and more effective infrastructure management.

Key FY19 FHWA LTIP Programs Activities

Activity	Period of Performance	Partners/Notes
Collect Long-Term Pavement Performance (LTPP) data from in-service highway test sections representing the most commonly used pavement types and designs and the range of traffic and climatic conditions on the National Highway System.	Overall: 1989 – 2026 Current: 2018 -	State Departments of Transportation (DOTs), TRB, and AASHTO. At the height of the program, approximately 2500 test sections were actively monitored. That number has diminished to 437 (as of March, 2018), and will further diminish as additional test sections are reconstructed or rehabilitated, marking the end of their performance period.
Store, manage, and provide easy access to LTPP data, reports, tools, and products.	Overall: 1989 – TBD Current: 2018 -	Data and documentation available at: https://infopave.fhwa.dot.gov
Apply the LTPP data to enhance the understanding of pavement performance.	2019 - TBD	Additional application of the LTPP data has been and will be undertaken by State DOTs, Universities, NCHRP, etc. An LTPP Data Analysis Plan listing past, current, and future research studies can be accessed at: https://infopave.fhwa.dot.gov/Analysis/InteractiveDataAnalysis
Collect Long-Term Bridge Performance (LTBP) data on most common bridge types within the U.S.	Overall: 2013 – TBD Current: 2018 -	State Departments of Transportation (DOTs), TRB, and AASHTO.
Store, manage, and provide easy access to LTBP data, reports, tools, and products.	2016 - TBD	In 2018, the LTBP Bridge Portal is being migrated to the cloud and rebranded InfoBridge to achieve better consistency between the two programs (LTPP and LTBP) and to realize cost saving.
Apply the LTBP data to enhance the understanding of bridge performance.	2019 - TBD	State DOTs, Universities, NCHRP, etc.

Research Collaboration Partners:
The individual State DOTs owners of the pavements and bridges under study are actively engaged in supporting data collection efforts. Due to the importance of their active engagement, FHWA contracts with the TRB for a Federal Advisory Committee Act (FACA) compliant Long-Term Infrastructure Performance Committee that provides consensus stakeholder advice on the conduct of the program via letter reports addressed to the Administrator. In addition, FHWA LTIP Program staff regularly engage with stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on related work undertaken by other organizations both nationally, and internationally. Each of the two programs has implemented a state coordinators group to manage and strengthen the partnership between the FHWA

and the state DOTs. Other stakeholders include the American Association of State Highway and Transportation Officials (AASHTO) and its Committees on Materials and Pavements (LTPP) and Bridges and Structures (LTBP), the Transportation Research Board (TRB), industry organizations such as the National Asphalt Pavement Association and the American Concrete Paving Association, Institute of Steel Construction, National Concrete Bridge Council (NCBC), and university faculty engaged in related work.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually), but are not formally tracked or measured. Ad hoc interactions in the form of technical assistance requests are logged on an internal SharePoint site.

The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Benefits of Partnership and Partner Contributions to FHWA Structures R&T Program.

Partner Organization	User Perspective on Needs	Consensus Stakeholders Advice	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
State Departments of Transportation	X	X		X	X	X	X	X	X	X
AASHTO Special Committee on Research and Innovation	X						X			
AASHTO Committee on Materials and Pavements	X	X		X		X		X		
AASHTO Committee on Bridges and Structures	X	X		X		X		X		
Universities			X				X	X		
University Transportation Centers			X				X	X		
National Academy of Sciences (TRB)	X	X	X				X	X		
Industry Associations*.	X		X	X		X	X	X		

* Examples include, but are not limited to: National Asphalt Pavement Association, American Concrete Paving Association, American Concrete Institute, American Institute of Steel Construction, and the American Society of Civil Engineer.

Acquisition/Assistance:
The LTIP Programs make use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, a competitive, single-award full and open task order contract is being used to procure data collection services for the LTBP Program. Other program needs are met through competitively procured small business contracts, broad agency announcements and small purchases. GSA schedule procurements are used where appropriate. Due to the ongoing nature of the required data collection, the LTIP Programs acquisitions are most often multi-year acquisitions, funded over several fiscal years. Contracts include provisions that allow for requirements and budget adjustments from year to year. Single year contracts, or multi-year contracts fully funded in the year of award are occasionally used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. This occurs most frequently in the procurement of maintenance services or repair parts for highly specialized data collection equipment.

Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies, individually, or collectively. Most DOTs provide maintenance of traffic during the Programs data collection activities, resulting in cost savings to the government of around 15% per

site data collection visit. In 2018, $1.85 million in NCHRP funding was invested in six LTPP data analysis projects.

Technology Transfer (T2):
Technology transfer for the FHWA LTPP Program is pursued primarily through the AIDPT program, and through integration of LTPP findings into performance and asset management policy and guidance. Technology transfer for the LTBP program is pursued as part of the Bridge and Structures R&T Program. Technology transfer efforts are typically lead by FHWA staff in the Office of Infrastructure and/or the Resource Center, with support from the Office of Infrastructure R&D and contractors as required.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA LTIP Programs, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The programs' outputs take the form of:

- Research publications, including reports and technical briefs;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- Tools and products that facilitate performance data collection, pavements and bridge design, and more efficient management of highway assets using deterioration and life cycle models generated either as a direct result of these programs or indirectly through others who use the knowledge accumulated by these programs;
- New and/or updated technical guidance;
- Training courses;
- Webinars;
- Workshops.

Key 2019 FHWA LTIP Programs Outputs

Program Objective	**Key 2019 Outputs**
Collect Long-Term Pavement Performance (LTPP) data from in-service highway test sections representing the most commonly used pavement types and designs and the range of traffic and climatic conditions on the National Highway System.	Progress toward full characterization of pavement performance for test sections remaining under study through data that have been collected and stored in the pavement Information Management System.
Store, manage, and provide easy access to LTPP data, reports, tools, and products.	Continued support and enhancement of InfoPave (the FHWA web portal that serves as a window into the pavement performance data).
Apply the LTPP data to enhance the understanding of pavement performance.	It is expected that intermediate results from five NCHRP studies based on LTPP data will be available during FY19. Draft pavement transverse profiling standards based for AASHTO's consideration. An LTPP newsletter will be published.

	Program staff will present findings during the Annual TRB meeting in January.
Collect Long-Term Bridge Performance (LTBP) data on most common bridge types within the U.S.	Progress toward full characterization of bridge performance through data that have been collected and stored in the Information Management System.
Store, manage, and provide easy access to LTBP data, reports, tools, and products.	Rebrand and move the FHWA LTBP Bridge Portal to the cloud to enable easier and wider access of the bridge performance data. Improved bridge Information Management System design.
Apply the LTBP data to enhance the understanding of bridge performance.	Initiate data analysis studies.

The benefits to be accrued by FHWA LTIP Programs stakeholders include improvements in the quality, durability, speed of construction and life-cycle cost of highway structures, and more effective life-cycle management of highway structures.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

It is relatively rare that an output of FHWA's LTIP Programs takes a form that is reportable as T2 Annual Performance (Intellectual Property) activity. When such outputs are produced, they are included in the agency's Annual Performance report. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
Internally, program performance is assessed primarily on the basis of project milestones. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances.

The progress of the FHWA LTIP Programs is also reviewed externally on an annual basis by the TRB LTIP Advisory Committee and two Expert Task Groups that report to the Committee. The Committee is chaired by a state DOT CEO and its voting members consist of state DOT Chief Engineers, state DOT Chief Bridge Engineers, and University Professors. Industry representatives serve as liaisons to the Committee and Expert Task Groups.

Outputs of this program will assist State and local highway agencies in more effectively managing the performance of highway structures. Accordingly, this program contributes toward achievement of the Department's goal to Improve Conditions of America's Transportation-Related Infrastructure. Achievement of these goals is tracked through the bridge condition as reported in compliance with the National Bridge Inspection Standards and pavement condition as reported to the Highway Performance Monitoring System, and processes put into place in support of the Transportation Performance Management regulations.

Safety Program Delivery
$2,500,000

Program Description/Activities:
The FHWA Office of Safety, Office of Safety Research and Development and the Resource Center Safety and Design Technical Service Teams work alongside the safety specialists in the Division offices on a "Focused Approach to Safety". This approach focuses our resources on activities that address the Nation's most critical safety challenges through providing new tools and innovations, research, and training. This approach increases awareness on critical severe crash types, leads to key safety infrastructure improvements, assists in prioritizing limited resources, and creates positive organizational changes in safety culture, policies and procedures. The three critical areas identified as providing the greatest potential to reduce highway fatalities using infrastructure-oriented improvements are namely:

- roadway departure,
- intersection crashes, and
- pedestrian/bicycle crashes.

These three focus areas encompass almost 90% of the traffic fatalities in the U.S.
The Safety Program Delivery research focuses on reducing highway related fatalities and serious injuries on the Nation's roadways by:

- Implementing FHWA safety programs legislative requirements
- Informing Congress; State DOTs; other Federal, State, and local government agencies; Tribes; academia; and the public about how FHWA safety resources are invested and the safety improvements achieved from FHWA efforts.
- Strengthening States' abilities to implement a performance driven safety program by sharing information, training, and assistance
- Improving technical capacity of transportation safety professionals at all levels of government to advance safety programs
- Fostering a safety culture not only thru technical assistance but thru marketing and communications programs; and
- Promoting an integrated, multidisciplinary (4E's) approach to safety in all phases of program and project development including transportation planning.
- Evaluation and assessment of road owners' capabilities which enable target training and technical assistance to fill gaps.

Through the Safety Program Delivery program, FHWA assists partners and stakeholders in making the best use of the programs and services available to them to optimize their safety investments and to maximize their safety contributions to realize the vision.

The Safety Program Delivery Research Program provides support for the $2.6 billion Highway Safety Improvement Program (HSIP) -a core Federal-aid highway program with the purpose to achieve a significant reduction in fatalities and serious injuries on all public roads. The program assists states with the administration of the HSIP program by providing needed information, training, and technical assistance; providing formal and informal technical guidance and policies to FHWA's partners and the public on proven, efficient, cost effective safety programs and activities; encouraging and supporting partnerships with private and public safety stakeholders; and

continuously communicating the necessity and available tools to utilize a data driven system approach to saving lives on all public roads.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas in order to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

The HSIP is legislated under Section 148 of Title 23, United States Code (23 U.S.C. 148) and regulated under Part 924 of Title 23, Code of Federal Regulations (23 CFR Part 924). This program also supports implementation of other statutory mandates, such as National Performance Management Measures (23 CFR 490).

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety

FHWA's Safety Program Delivery primarily supports the Department's Safety goal and the RD&T Critical Transportation Topic of Promoting Safety. FHWA Safety Program Delivery secondarily addresses the Department's Infrastructure, Innovation and Accountability Goals and contributes secondarily to the RD&T Critical Transportation Topics of improving infrastructure and improving mobility.

Safety: The Safety Program Delivery research focuses on strengthening States' abilities to implement a performance driven safety program by sharing information, training, and assistance. The program seeks to increase technical capacity of transportation safety professionals at all levels of government to advance safety programs. The program fosters a safety culture not only thru technical assistance but thru marketing and communications programs.

Infrastructure – The Safety Program Delivery research promotes an integrated, multidisciplinary (4E's) approach to safety in all phases of program and project development including transportation planning. It includes evaluation and assessment of road owners' capabilities which enable target training and technical assistance to fill gaps. It includes providing technical assistance and training to State DOTs to insure effective, data driven infrastructure safety projects that lead to alternative infrastructure designs.

Innovation – The Safety Program Delivery research promotes the development and use of innovative tools to support decisions using a data-driven approach in managing highway safety.

Improving Mobility – The Safety Program Delivery research program supports efforts that reduce crashes which in turns improves the mobility of all people on our public roads.
Accountability – The Safety Program Delivery research program includes evaluation of various safety programs such as the SHSP and HSIP as well as the tracking and support of Safety Transportation Performance Management. The program provides support for states in developing targets and assistance to states that fail to meeting targets.

Rural impact – The Safety Program Delivery research program develops tools and technical assistance of great value to rural areas. Examples include rail highway grade crossing technical assistance, marketing and communication materials specifically for local public agencies, working with local associations such as the National Association of County Engineers (NACE) to identify needs and provide technical assistance as well. For states that trigger the high risk rural road (HRRR) rule, the safety program can delivery assistance.

Program Objectives:
FHWA's Safety Program Delivery Program ensures stakeholders have the tools and resources needed to address emerging and existing roadway safety issues. The program identifies the following objectives:

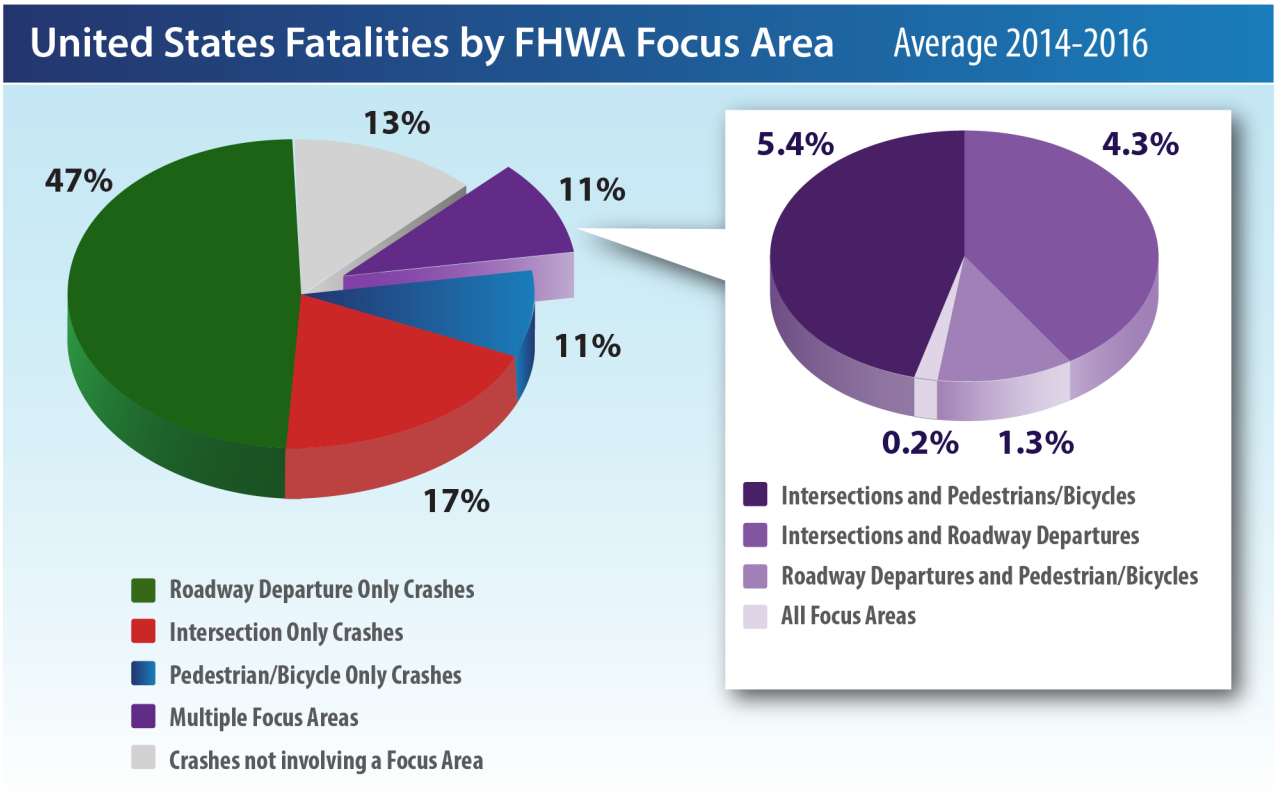
- Implement FHWA Safety Programs Legislative Requirements.
- Strengthen States' abilities to implement a performance driven safety program by sharing information, training, and assistance
- Improve technical capacity of transportation safety professionals at all levels of government to advance safety programs
- Evaluate the results of FHWA Safety Program Delivery implementation efforts

FHWA Safety Program Delivery R&T Program Activities.

Program Objectives	Period of Performance	Partners/Notes
Implement FHWA Safety Program legislative requirements	On-going	Communicate the laws, regulations and funding eligibility for the HSIP (23 USC 148 and 23 CFR 924). Ensure oversight and stewardship for the HSIP: • Strategic Highway Safety Plan (SHSP) • State Highway Safety Improvement Program • High Risk Rural Roads Program • Rail-Highway Grade Crossing Safety Improvement Program (23 USC 130 & 23 CFR 646 Subpart B) Communicate the governing laws, regulations, policy guidance and funding eligibility and provides oversight and stewardship for the following statutory programs: • 402 Program (23CFR 1200.12) – NHTSA • Other Grant Programs 23 USC 406 & 408 • Penalty Transfers – NHTSA • Open Container Law (23 USC 154/23 CFR 1270) • Repeat Offender Law (23 USC 164/23 CFR 1275) • Other Penalty Transfers 23 USC 153, 158, 159, 161 • Driver Licenses for Drug Offenders Certification (23 USC 159 & 23 CFR 192) • Safety Incentives to Prevent Operation of Motor Vehicles by Intoxicated Persons (23 USC Sec. 163 & 23 CFR 1225) Implement the Safety-Related Planning Regulations - 23 USC 134 and 135 and 23 CFR Part 450

Improve stewardship and oversight of FHWA Safety Programs	On-going	Communicate the policies and guidance for the HSIP and other safety programs. Communicates Federal safety policy and guidance. Provides technical assistance to stakeholders on policy and guidance. Support and educate the State Departments of Transportation, Metropolitan Planning Organizations, and other safety stakeholders on national safety goals, policies and strategic plans.
Improve the technical capacity of transportation professionals at all levels of government	On-going	Supports State and local agencies with the implementation of the HSIP. Provides technical assistance to help State and local agencies effectively manage and administer the HSIP, Strategic Highway Safety Plan (SHSP), High Risk Rural Roads Program (HRRRP), and Railway-Highway Grade Crossing Safety Improvement Program (RHGCP). Provide training and assistance with tools to support decisions using a data-driven approach in managing highway safety. Provides technical assistance for the integration of SHSP strategies into the planning processes for increasing safety for all transportation facility users including the following planning documents: • Long range transportation plans. • Statewide/Transportation Improvement Plan (S/TIP). • Highway Safety Plan (HSP).
Evaluate FHWA Safety Program Delivery Efforts	On-going	Performs program assessments, prepare annual reports, evaluate safety products and tool to identify gaps in existing safety efforts and opportunities for improvement.

Research Collaboration Partners:
FHWA's Safety Program Delivery Research Program is built upon focus areas identified from safety data provided by States, as well as stakeholder input and assessment of stakeholder capabilities. Our focused approach to safety research is directed to providing information to transportation practitioners, decision makers, and others to assist in preventing and reducing these severe crashes.



NOTE: The total in the secondary pie chart does not exactly add up to 11% due to rounding.

FHWA gains input on research needs from our stakeholders using a multitude of vehicles including but not limited to:

- Peer exchanges provide opportunities to identify technical skill gaps in evaluating and deploying life-saving countermeasures and advancing the use of scientific methods and data-driven decisions.
- HSIP assessments are conducted regularly in the States and these evaluations identify opportunities to enhance HSIP implementation efforts thru research and technical assistance.
- HSIP reports, due annually facilitate the documentation of stakeholder input and are used to improve products, tools and grow existing services.
- Annual 23 USC Section 130(g) reports from each state documenting the progress being made to implement the railway-highway crossings program, the effectiveness of such improvements, an assessment of the costs of the various treatments employed, and subsequent crash experience at improved locations.
- Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms proposed activities through a pooled fund study.

Coordinating across modes within DOT is vital to ensuring our roads are safe. FHWA works closely with FMCSA, NHTSA, FTA and FRA to address multiple dimensions of roadway safety. FHWA concentrates on improvements to roadway infrastructure upon which vehicles and users operate. There are many places where the safety mission of other modes overlaps and require coordination to achieve success.

- The US DOT Safety Council serves to tackle the most critical transportation safety issues we face in a coordinated fashion.
- The DOT Traffic Records Coordinating Committee (TRCC) is an interagency group charged with coordinating the support and improvement of safety data collection, management and analysis within DOT, among State and Federal partners, and across different State-level traffic records systems.
- The intermodal Managers' Safety Meeting, with senior managers from FHWA, NHTSA, FMCSA, FTA and FRA meets regularly to discuss common issues and opportunities to coordinate strategies and program activities.

In addition, the FHWA Safety Delivery Program coordinates with other FHWA program offices (e.g. Planning, Policy, Infrastructure) to advance safety program delivery initiatives.

Making dramatic improvements in national, State, and local safety performance depends upon building effective external partnerships with a wide range of safety stakeholders, including national safety organizations, State and local transportation professionals, and the private sector. To build effective national safety partnerships, FHWA actively engages in a broad range of external coordination. FHWA meets regularly to share information with a host of our safety partners. The purpose of these meetings is to strengthen FHWA's relationship with its safety partners to better leverage resources and be more aggressive in accomplishing our mutual safety goals. Discussions with these groups have provided valuable insights into FHWA's safety program research activities.

External Partners include but are not limited to:

- **American Association of State Highway and Transportation Officials** –Collaborates on research problem statements and various outreach projects, in addition to participating on various committees that focus on highway safety policy.
- **American Traffic Safety Services Association** - Represents the road safety, traffic safety, and highway safety industry and collaborates on RTZ initiatives.
- **American Road & Transportation Builders Association (ARTBA)** – partners with us on a variety of program activities including training on Safe Guardrail Installation & Maintenance and collaborates on RTZ initiatives.
- **Transportation Research Board –** The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. FHWA coordinates on research problem statements and safety program staff participates on various safety related research projects and committees.
- **National Association of County Engineers** – Collaborates on evaluating and deploying life-saving countermeasures and advancing the use of scientific methods and data-driven decisions to address safety on local and rural roads.
- **Roadway Safety Foundation** - Collaborates with this organization to educate the public on road hazards, and promoting roadway research and technical transfer activities. The RSF cosponsors the National Roadway Safety Awards with FHWA.
- **Road to Zero** – A national safety coalition formed by the National Safety Council in partnership with the National Highway Traffic Safety Administration, the Federal Highway Administration and the Federal Motor Carrier Safety Administration. We collaborate with the National Safety Council and representatives from over 650 multi-disciplinary organizations to help achieve the RTZ vision of zero traffic fatalities by 2050. Coalition

brings together multiple stakeholders including not only representatives of roadway, behavioral and vehicle safety, but also nonprofit groups, public health officials and technology companies. Thru the NSC and the Coalition, grants are used to fund safety projects that show evidence of effectiveness of proven countermeasures, have measurable objectives and have innovative approaches that could be replicated in other locations.

- **Institute of Transportation Engineers** – FHWA partners with ITE on various products and services such as identification of necessary research, technical resources and exchange of professional information.
- **Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms -** Collaborate with FHWA on solving transportation-related problems, research, planning, and technology transfer activities thru jointly funded the Transportation Pooled Fund (TPF) Program.

Benefits of Partnership and Partner Contributions to FHWA Safety Program Delivery.

Partner Organization	Safety Coordination and	Data Analysis and Coordination	Advancing Safety Initiatives	Safety Deployment	Research Collaboration	Stakeholder Professional	Safety Outreach and Education
AASHTO	X		X	X	X	X	X
State Departments of Transportation	X	X	X	X	X	X	X
Transportation Research Board	X		X		X	X	X
American Traffic Safety Services Association	X			X			X
American Road and Transportation Builders Association	X					X	X
National Association of County Engineers	X	X	X	X		X	X
Road Safety Foundation	X		X				X
Road to Zero Coalition	X		X	X			X
Institute of Transportation Engineers	X		X		X	X	X
Federal, state, regional and local transportation agencies, academic institutions, foundations and private firms	X	X	X	X	X	X	X

Acquisition/Assistance:

The Safety Program Delivery research program makes use of a variety of acquisition methods, with the specific method depending upon the need to be met. This program includes contract support delivered through competitive procured contracts. This contracting approach enables the program to minimize risk and remain nimble as the program changes over time. Most contracts are Indefinite Delivery Indefinite Quantity (IDIQ) contracts with various consultants.

No sole source acquisitions are applied to this program and no non-Federal funds are used.

The Safety Program Delivery program use single year and multi-year acquisitions depending upon the scope and delivery timeframe. For example, a project with limited scope and short period of performance would serve best as a single year acquisition. A project that involves an array of deliverables and requires a longer lifespan would best be served on a multi-year contract.

The Safety Program Delivery research program leverages non-federal funds through a variety of vehicles. Pooled Fund Studies, combine resources from Federal, State, regional and local transportation agencies, academic institutions, foundations and private firms to solve transportation related challenges. For instance, the Evaluations of Low Cost Safety Improvements Pooled Fund Study has developed reliable estimates of the effectiveness of the safety countermeasures that can be replicated across the country to improve safety. This study has the participation of 40 States, totaling $4.38 million dollars over 5 years. Cooperative agreements are also utilized to advance safety and leverage non-federal funds. The Safety Program Delivery research program utilizes various cooperative agreements with not for profit organizations to strengthen safety activities. The Road Safety Foundation and FHWA's Office of Safety work collaboratively to promote strategic, data-driven approaches to improving highway safety through the implementation of the National Roadway Safety Awards. This biennial competition is sponsored with research dollars and non-Federal funds to recognize successful engineering safety achievements that aid in reducing fatalities and serious injuries on the Nation's roadways. The National Safety Council contributes $1M of their funds to support the Road to Zero Coalition, a cooperative agreement between NHTSA and FHWA. This effort has led to deploying safety countermeasures quickly throughout the United States and assembling a diverse group of over 650 organizations to rally for safer roads.

Technology Transfer (T2):

Technology Transfer is an integral part of FHWA's Safety Program Delivery program. State and local highway agencies are the primary stakeholders and beneficiaries of the program. These representatives serve as champions to safety programs, policies and processes.

Everyone in the FHWA Safety Discipline as well as many others in FHWA are involved in one way or another in safety technology transfer. Division Offices are on the front line day-to-day and routinely support the State in identifying and implementing new or different technologies or applications. In doing their jobs, they tap into the resources in the Resource Center (RC) Safety Technical Services Team, Headquarters Office of Safety (HSA) and Office of Safety Research and Development (R&D). The RC is the primary unit in the FHWA charged with technology deployment and technical assistance. The Safety and Design Team works closely with Headquarters and R&D to ensure that the T2 that takes place is alignment with our priorities as spelled out in FHWA's Joint Safety Strategic Plan. HSA has the primary responsibility for program and policy leadership. They support T2 efforts through the development and dissemination of useful safety products that address specific needs of States and other customers. They work closely with the RC and R&D in defining these products and in ensuring resources are adequately available to optimize dissemination as needed. At times, HSA is a direct contributor to T2 because their staff may have unique knowledge and skills in a specific area. R&D has the primary responsibility for developing new products through research efforts. For new products that have little or no field experience or for highly complex topics, R&D is a valuable partner to support T2 efforts. They bring detailed and high-level experience to bear as need to support States and other customers address highly complex challenges, often in partnership with HSA and the RC who may be the primary point of contact for the T2 effort. Other partners come to play in varying roles depending on the topic and the challenge

faced by the State in question. For example, the Federal Lands Highway Office is sometimes tapped to support T2 efforts because of their unique experience on Park Lands and Tribal Lands. Sometimes LTAP centers are engaged. Sometimes we bring other State partners on board to support T2 effort related to a challenge that has already been successfully addressed in their State.

Program outputs take the form of:

- Publications, including reports, assessments, FAQs, manuals, tools, case studies, fact sheets and noteworthy practices
- Technical guidance, policy and regulation activities
- Training course design, development and delivery in partnership with the National Highway Institute
- Webinars, Workshops, Peer to Peer Exchanges.

A few ways T2 is monitored.

- Annual roadmap meetings convened by the Office of Safety bring together HSA, R&D and the RC to focus on accomplishments from the previous year and plans for the coming year. T2 is an element of both the past and future discussions.
- The RC maintains a system to track all requests for all disciplines. Employees are expected to document each request, its completion status and meaningful outcomes as appropriate.
- Training evaluations are used to obtain knowledge gains that have been accomplished during the training effort.
- Periodic program assessments to track how the States' capability is improving over time.

Key 2019 FHWA Safety Program Delivery R&T Program Outputs

Program Objective	**2019 Outputs**
Implement FWHA's Safety Program legislative efforts	• Regulatory Reform proposals • Develop or update final rule Q&A's • Track SHSP update status, special rules, serious injury reporting and penalty status annually
Strengthen States' abilities to implement a performance driven safety program by sharing information, training, and assistance	• Complete HSIP assessments • Enhance HSIP On-line Reporting Tool • Develop and share new SHSP resources to assist with strategy selection and evaluation • Develop and promote noteworthy practices for local agencies to administer federal-aid safety projects • Sponsor statewide Transportation Safety Planning workshops and zero deaths coordination workshops • Implement a 2019 Safety and Operations boot camp
Improve technical capacity of transportation safety professionals at all levels of government to advance safety programs	• Host/facilitate State/regional Peer to Peer exchanges • Update the HSIP manual • Conduct SHSP evaluation workshops • Update and enhance the NHI SHSP course • Develop products that promote HSIP/SHSP/Railway -Highway Crossing related work • Host a National Safety Professional Summit • Provide technical assistance to MPOs and cities to develop and implement Vision Zero plans • Promote the Road Safety Fundamentals textbook to universities and professional organizations
Evaluate Implementation Efforts	• Publish annual HSIP National Summary Report for 2018 • Prepare 2018 Report to Congress on the Railway-Highway Crossings Program as required by 23 U.S.C. 130(g). • Publish quarterly obligation reports • Report on outputs (number of peer to peer exchanges, number of webinars, etc) • Evaluate the effectiveness of TSP workshops

Evaluation / Performance Measurement:
The Safety Program Delivery addresses the USDOT Strategic Goal of reducing transportation related fatalities and serious injuries across the system. The Safety Program Delivery program evaluates the results of FHWA safety program implementation efforts by monitoring and assessing national and State safety program implementation efforts and encouraging States to conduct evaluations of the various safety programs. Annual HSIP reports are submitted, reviewed, and featured on a data dashboard to illustrate the progress of implementation of safety countermeasures.

The following milestones relate to the Safety Program Delivery program and are tracked by FHWA leadership on an annual basis:

- Number of States with at least an 80% HSIP Obligation Rate
- Number of HSIP assessments completed
- States at Demonstration or above for data driven safety analysis and states at demonstration or above for safe transportation for every pedestrian.

In addition, the following outputs are achieved annually from the safety program delivery activities:

- Guidance documents and outreach activities on legislative requirements (as needed)
- Webinars/trainings and technical assistance
- P2P events and noteworthy practices
- Promotional products and marketing activities
- Increased Percent of HSIP funds obligated for local road safety improvement project
- Submit Reports to Congress
- Increase # agencies developing Local Road Safety Programs (LRTP)
- All State LRTPs coordinate with State safety plans
- All States and MPOs set safety performance targets for 2018 and each year thereafter
- Increase # States that include local participation in development and implementation of SHSPs

The program improves stewardship and oversight of FHWA Safety Programs by promoting the use of HSIP assessments and other resources to support stewardship and oversight responsibilities; encouraging States to document HSIP processes; promoting consistent HSIP reports; enhancing partnerships with other modes to advance safety program implementation efforts; facilitating safety program technology transfer/information exchange across the safety discipline; ensuring tribal and local roads are addressed through the HSIP; and institutionalizing safety performance management in the HSIP.

One of FHWA's primary safety achievements in recent years has been implementing the new performance management standards for the Federal-aid highway program, mandated by Congress in MAP-21 and continued in the FAST Act. These changes increase the program's accountability and transparency and provide a framework to improve investment decision making by focusing on performance outcomes for key national transportation goals. State DOTs are now required to establish performance targets and assess performance in key areas. The FHWA has been implementing the performance management directives from Congress through a series of inter-related rulemakings and other actions including a suite of training courses, technical tools, and guidance to educate our State and local partners. Safety performance management will assist the Safety Programs Delivery Program with additional evaluation mechanisms. FHWA will work with States that are not successful in meeting their annual targets through the application of a decision support framework and planning process.

Safety Design and Operations
$4,290,000

Program Description/Activities:
The Safety Design & Operations program encompasses core safety engineering work that overlaps traffic engineering, roadway geometric design, transportation planning, and system management and operations, and aims to help stakeholders reduce fatalities and serious injuries on all public roadways. The program focuses on three critical areas identified as providing the greatest potential to reduce highway fatalities using infrastructure-oriented improvements, as follows:

- roadway departure,
- intersection crashes, and
- pedestrian/bicycle crashes.

These three areas account for over 90% of roadway fatalities. Through this program, we:

- conduct research on safety improvements (e.g., to reduce roadway departure crashes in rural communities),
- evaluate, document and promote noteworthy practices,
- provide technical expertise and leadership,
- support professional capacity building internally and externally, and
- monitor and encourage innovative, infrastructure-based approaches to improving safety performance.

These activities aim to ensure that FHWA assists partners and stakeholders in making the most effective safety investments and reduce fatalities and serious injuries on rural and urban roadways.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety

FHWA's Safety Design and Operations program supports the Department's Safety, Infrastructure, Innovation and Accountability Goals and contributes to the RD&T Critical Transportation Topics of promoting safety, improving infrastructure and improving mobility. Clearly, the primary strategic focus is on Safety. Specific contributions are as follows:

Safety/Promoting Safety: The Safety Design and Operations program develops infrastructure-related research to improve the safety of the Nation's roadways by focusing on priority technical areas to address National safety data trends and Departmental/Agency policy initiatives. This includes research promoting safer roadway design by evaluating, documenting and promoting new approaches to road design that enhances road safety through proven safety countermeasures – many of which are developed to address the disproportionate risk of fatal and injury crashes in rural communities.

Infrastructure/Improving Infrastructure: The Safety Design and Operations program examines the interrelationships among the roadway, road users, and roadway context to determine effective ways to improve the safety performance of the physical infrastructure. The program identifies low cost safety infrastructure improvements that reduce crashes by improving infrastructure performance and reduce project delivery time and project costs.

Innovation: The program supports demonstrations of advanced vehicle automation technologies to assess existing infrastructure design and operation practices and considering the value of current infrastructure safety strategies and treatments for the future. The Safety Design & Operations program also seeks to ensure that Automated Vehicles do not negatively affect other road users, namely pedestrians, bicyclists, and motorcyclists. The program develops innovative safety countermeasures to reduce fatalities on all public roads.

Improving Mobility: The Safety Design and Operations program aims to reduce crashes and consequently improve mobility for all road users, including pedestrians and bicyclists.

Accountability: The Safety Design and Operations program advances a data-driven systemic approach to reduce highway fatalities. The program provides tools for transportation agencies to analyze safety data, develop safety implementation plans, and to identify and implement cost effective safety countermeasures.

Rural impact: The Safety Design and Operations program develops tools and technical assistance that are tailored to the needs of rural roadways and their owners. Such work is coordinated through a Local and Rural Road Safety working group.

Program Objectives:
The main purpose of the Safety Design & Operations program is to improve safety and, ultimately, to save lives. Because the Federal-aid program is a State-administered and Federally-assisted program, the success of our efforts depends on working with stakeholders (e.g., State Departments of Transportation and local road owners). The program identifies the following objectives:

- Implement FHWA Safety Legislative Requirements;
- Strengthen States' abilities to implement a performance-driven safety program by sharing information, training, and assistance;
- Improve technical capacity of transportation safety professionals at all levels of government to advance safety programs;
- Evaluate the results of FHWA Safety Implementation efforts.

Key FY19 FHWA Safety Design and Operations R&T Program Activities

Activity	Period of Performance	Partners/Notes
Identify innovative road safety solutions and develop effective safety countermeasures	2019-2024	Develop data-driven safety plans to reduce rural roadway departures. • Partner with States, LTAP Centers and Counties Establish an Intersection Safety Pooled Fund Project to address driver behavior at Multilane Roundabouts to counteract an unexpected rise in crashes. • Partnering with 7 states (GA, IL, ME, MN, MT, WA, WI) and more under a new Pooled Fund Study
Strengthen States' abilities to implement a performance-driven safety program by sharing information, training, and assistance	2019-2024	Enhance State knowledge and processes for reviewing crash testing and conducting in-service performance evaluation of roadside safety hardware • Partner with State DOT's and AASHTO Enhance knowledge to reduce the severity of run-off-road incidents and advance crash analyses to improve highway safety and infrastructure security. • Provide objective, independent, technical support, and non-competitive assistances program partners Development of Crash Modification Factors for estimating pedestrian injuries and fatalities at intersections • Enable forecast of known safety countermeasures so that cost-effective design solutions are made to benefit vulnerable road users.

Improve technical capacity of transportation safety professionals at all levels of government to advance safety programs	2019-2020	Naturalistic Driving Data Analysis for Curves • Rely on the 2nd Strategic Highway Research Program Roadway Information Database to identify geometric factors in curve related crashes. Support for Roadway Departure, Intersections, and Pedestrian/Bicyclist Safety Focus States and Cities • Provide technical assistance to designated states and cities based on fatalities (e.g., develop action plans) to address Focus areas. Partners include State and local transportation agencies.
Evaluate the results of FHWA Safety Implementation efforts	2019-2022	Adaptation of Safe Systems Approach by evaluating roads and roadsides, vehicles, road users, and speed to identify and mitigate intersection crash threats • Objective is a national strategy for improving intersection design and safety. Partners could include State DOTs and other transportation agencies. Demonstrate crash reduction potential of network-level pavement friction measurement on a continuous rather than sampling basis. • Partner with State DOTs to compare friction and crash data at high-risk locations for roadway departure, intersection, and pedestrian crashes.

Research Collaboration Partners:

The Safety Design and Operations program relies on its established network of partners in other public agencies, membership organizations, and in academia. Some technical areas have used stakeholder input to develop strategic plans (e.g., a strategic plan to improve pedestrian safety based on stakeholder-identified gaps and needs). FHWA also gains input on research needs from our stakeholders using a multitude of vehicles including but not limited to peer exchanges, conducting presentations and webinars that are open to the public, and seeking other means of sharing information with Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms. Stakeholder input from these entities helps shape roadmaps and other strategic planning documents as the Safety Design and Operations program activities are planned and implemented.

Non-government groups have been and continue to be collaborators. For example, FHWA worked with the National Association of Counties to conduct outreach on rural road safety to county officials. FHWA also works closely with the Institute of Transportation Engineers to learn of and disseminate noteworthy practices with this key constituency.

Key internal partners include but are not limited to:

- **Office of the Secretary ITS Joint Program Office** – ensures that safety needs are addressed in activities related to automated and connected vehicles.
- **Federal Railroad Administration** –to address safety issues at rail-grade crossings.
- **Federal Motor Carrier Safety Administration –** to address infrastructure issues related to large truck crashes.
- **National Highway Traffic Safety Administration –**to ensure that a holistic 4 Es (Engineering, Education, Enforcement, and Emergency Services) approach is used to address safety.

In addition, the FHWA Safety Design and Operations Program coordinates with other FHWA program offices (e.g. Operations, Planning, Policy, Infrastructure), the Resource Center, and Federal Lands to advance safety delivery initiatives.

External partners include but are not limited to:

- **American Association of State Highway and Transportation Officials** –Collaborates on research problem statements and various outreach projects, in addition to participating on various committees that focus on highway safety policy.
- **American Traffic Safety Services Association** - Represents the road safety, traffic safety, and highway safety industry and collaborates on Road to Zero initiatives.
- **American Road & Transportation Builders Association** – partners with us on a variety of program activities including training on Safe Guardrail Installation & Maintenance and collaborates on RTZ initiatives.
- **Transportation Research Board –** The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. FHWA coordinates on research problem statements and safety program staff participates on various safety related research projects and committees.
- **National Association of County Engineers** – Collaborates on evaluating and deploying life-saving countermeasures and advancing the use of scientific methods and data-driven decisions to address safety on local and rural roads.
- **National Association of Counties –** Collaborates to engage their members, county officials, in the safety conversation.
- **Roadway Safety Foundation** – Collaborates with this organization to educate the public on road hazards, and promoting roadway research and technical transfer activities. The RSF cosponsors the National Roadway Safety Awards with FHWA.
- **Road to Zero Coalition** – A national safety coalition formed by the National Safety Council in partnership with the National Highway Traffic Safety Administration, the Federal Highway Administration and the Federal Motor Carrier Safety Administration. We collaborate with the National Safety Council and representatives from over 650 multi-disciplinary organizations to help achieve the RTZ vision of zero traffic fatalities by 2050. Coalition brings together multiple stakeholders including not only representatives of roadway, behavioral and vehicle safety, but also nonprofit groups, public health officials and technology companies. Thru the NSC and the Coalition, grants are used to fund safety projects that show evidence of effectiveness of proven countermeasures, have measurable objectives and have innovative approaches that could be replicated in other locations.
- **Institute of Transportation Engineers** – FHWA partners with ITE on various products and services such as identification of necessary research, technical resources and exchange of professional information.

- **Operation Lifesaver –** helps FHWA and other USDOT modes promote rail crossing safety.
- **Local Technical Assistance Program –**works with FHWA to ensure that local and rural safety stakeholders are part of the conversation.
- **Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms -** Collaborate with FHWA on solving transportation-related problems, research, planning, and technology transfer activities thru jointly funded the Transportation Pooled Fund (TPF) Program.

Benefits of Partnership and Partner Contributions to FHWA Safety Design and Operations R&T Program

Partner Organization	Coordination/ Collaboration	Data Analysis / Coordination	Advance Safety Initiatives	Safety Innovation Activities	Safety Deployment	Research Collaboration	Nationwide Goal Setting	Professional Development	Public Education
American Association of State Highway and Transportation Officials	x	x	x	x	x	x	x	x	
American Traffic Safety Services Association			x		x			x	x
American Road & Transportation Builders Association	x		x					x	
Transportation Research Board	x	x		x		x	x	x	
National Association of County Engineers	x		x	x	x		x	x	
National Association of Counties	x		x	x	x				x
Roadway Safety Foundation	x		x		x		x	x	x
Road to Zero			x	x	x			x	x
Institute of Transportation Engineers	x		x	x	x	x	x	x	
Operation Lifesaver			x					x	x
Local Technical Assistance Program	x				x			x	
Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms	x	x	x	x	x	x	x	x	x

Acquisition/Assistance:
The Safety Design and Operations program relies mostly on IDIQ task orders for completing work. The IDIQs are composed of pre-selected contractor teams with expertise in safety pertaining to the

technical areas within the Safety Design and Operations program. Such task orders are competitive but are limited to competition among a small number of pre-selected teams; these projects vary in length and some may be multi-year. The IDIQ task orders are conducted with 100 percent federal funds. Some program funding goes to safety-related Transportation Pooled Fund projects. These projects receive at least half of their funding from other transportation agencies (mainly State DOTs). Sole source arrangements are rare but do occur, primarily for conducing technical activities at specific conferences; the sole source arrangements are necessary to convene these events at the conference (e.g., an ITE annual meeting).

Technology Transfer (T2):
Technology Transfer is an integral part of FHWA's Safety Design and Operations program. State and local highway agencies are the primary stakeholders and beneficiaries of the program. These representatives serve as champions to safety programs, policies and processes.

Everyone in the FHWA Safety Discipline as well as many others in FHWA are involved in one way or another in safety technology transfer. Division Offices are on the front line day-to-day and routinely support the State in identifying and implementing new or different technologies or applications. In doing their jobs, they tap into the resources in the Resource Center (RC) Safety Technical Services Team, Headquarters Office of Safety (HSA) and Office of Safety Research and Development (R&D). The RC is the primary unit in the FHWA charged with technology deployment and technical assistance. The Safety and Design Team works closely with Headquarters and R&D to ensure that the T2 that takes place is alignment with our priorities as spelled out in FHWA's Joint Safety Strategic Plan. HSA has the primary responsible for program and policy leadership. They support T2 efforts through the development and dissemination of useful safety products that address specific needs of States and other customers. They work closely with the RC and R&D in defining these products and in ensuring resources are adequately available to optimize dissemination as needed. At times, HSA is a direct contributor to T2 because their staff may have unique knowledge and skills in a specific area. R&D has the primary responsibility for developing new products through research efforts. For new products that have little or no field experience or for highly complex topics, R&D is a valuable partner to support T2 efforts. They bring detailed and high-level experience to bear as need to support States and other customers address highly complex challenges, often in partnership with HSA and the RC who may be the primary point of contact for the T2 effort. Other partners come to play in varying roles depending on the topic and the challenge faced by the State in question. For example, the Federal Lands Highway Office is sometimes tapped to support T2 efforts because of their unique experience on Park Lands and Tribal Lands. Sometimes LTAP centers are tapped. Sometimes we bring other State partners on board to support T2 effort related to a challenge that has already been successfully addressed in their State.

Program outputs take the form of:

- Publications, including reports, assessments, FAQs, manuals, tools, case studies, fact sheets and noteworthy practices
- Technical guidance, policy and regulation activities
- Training course design, development and delivery in partnership with the National Highway Institute
- Webinars, Workshops, Peer to Peer Exchanges.

A few ways T2 is monitored.

- Annual roadmap meetings convened by the Office of Safety bring together HSA, R&D and the RC to focus on accomplishments from the previous year and plans for the coming year. T2 is an element of both the past and future discussions.
- The RC maintains a system to track all requests for all disciplines. Employees are expected to document each request, its completion status and meaningful outcomes as appropriate.
- Training evaluations are used to obtain knowledge gains that have been accomplished during the training effort.
- Periodic program assessments to track how the States' capability is improving over time.
- Number of technical, peer reviewed articles published via the Transportation Research Board and other technical journals.

Materials are developed and shared with stakeholders as they are completed. The program encompasses numerous reports, guide, and other resources each year; we generally do not track metric specific to individual products. There are no T2 Annual Performance activities related to intellectual property for this program.

Key 2019 FHWA Safety Design and Operations R&T Program Outputs

Program Objective	Key 2019 Outputs
Roadway Safety – Preventing and/or mitigating roadway departure crashes.	• Preliminary guidance on applications of High Friction Surface Treatment (HFST) to reduce the likelihood of a vehicle slipping off a roadway. • Preliminary recommendations to update design guidance on slopes to reduce the likelihood of rollovers based on current vehicle fleet. • Training on guardrail design, installation, inspection, and maintenance. • Standards for minimum levels of pavement marking retroreflectivity.
Intersection Safety – Mitigate the crashes at intersections by reducing the number of conflict points, positive guidance of the driver through the intersection, alternative intersection design with safer vehicle flows, etc.	Initiate an Intersection Safety Pooled Fund Project with State Partners
Optimize the safety of vehicle and hardware designs, formulate guidelines for more effective deployment of safety features, and develop innovative safety treatments to avoid or minimize impact of crashes	Establish supporting mechanism for the FHWA Federal Outdoor Impact Laboratory (FOIL) and perform advanced crash analysis
Update infrastructure design and operation practices to address the needs of automated and connected vehicles.	Preliminary recommended revisions to pavement markings, signs, and other traffic control devices to improve capabilities of automated and connected vehicles to prevent or reduce roadway departures.

Evaluation / Performance Measurement:
The Safety Design and Operations Program addresses the USDOT Strategic Goal of reducing transportation related fatalities and serious injuries across the system. The program analyzes the impacts of these research products and further promotes them as part of the program's initiatives, such as Proven Safety Countermeasures and Every Day Counts (EDC). In 2008, FHWA began promoting certain infrastructure-oriented safety treatments and strategies, chosen based on proven effectiveness and benefits, to encourage widespread implementation by State, tribal, and local transportation agencies to reduce serious injuries and fatalities on American highways. This became known as the Proven Safety Countermeasures initiative. The list was updated in 2012 and again in 2017.

This list of Proven Safety Countermeasures has now reached a total of 20 treatments and strategies that practitioners can implement to successfully address roadway departure, intersection, and

pedestrian and bicycle crashes. Among the 20 Proven Safety Countermeasures are several crosscutting strategies that address multiple safety focus areas. FHWA initiated a baselining effort in 2018 to track implementation of the newest Proven Safety Countermeasures. Many of the countermeasures offer safety benefits for rural roadways. Some of the Proven Safety Countermeasures receive further attention in FHWA's EDC initiative. State implementation of safety countermeasures promoted through EDC are tracked over time to gauge their use (after establishing an initial baseline).

Although there is some implementation tracking through EDC, The Safety Design and Operations program does not maintain long-term trend performance tracking data (e.g., of five or more years). In addition, targets established through EDC are set by the States rather than by FHWA.

In addition, the following outputs are tracked annually may be tracked for activities subsumed under the Safety Design and Operations program:

- Guidance documents and outreach activities developed
- Webinars/trainings and technical assistance
- P2P events and noteworthy practices
- Promotional products and marketing activities
- Increase number of agencies developing Local Road Safety Plans (LRSPs)

Safety Data and Analysis
$3,920,000

Program Description/Activities:
The Safety Data and Analysis program area focuses on the use of safety data to inform highway investment decision making based on crash experience, crash potential, crash rate, or other data-supported means. The scope of the program includes research, development, and technology (RD&T) to improve State and local safety data systems commonly record crash, roadway inventory, and traffic volume data. The program enhances our State and local partners' capability to use safety data systems for analysis and evaluation supporting highway investment decision making. The program also includes analyses supporting FHWA safety policy decision making. This is reinforced via the Roadway Safety Data Program, which helps States and local agencies advance their data capabilities through resource development, technical assistance, data management and data analysis.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas in order to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety

FHWA's Safety Data and Analysis program supports the Department's Safety, Infrastructure, Innovation and Accountability Strategic Goals, and contributes to three DOT RD&T Critical Transportation Topics. Specific contributions as follows:

> Safety/Promoting Safety: Through the Safety Data and Analysis Program, FHWA has lead Federal responsibility to encourage and support State and local highway agencies in the improvement of roadway inventory and traffic volume components of safety data systems, and supporting crash data improvement. The program also establishes processes for integrating roadway inventory and traffic volume data with crash data through geolocation to a highway basemap that provides a geospatial referencing system for all public roads. Improved data on all roads, whether urban or rural, leads to accurate problem identification, analysis, and effective safety countermeasure development. Much of the safety research stems from detailed analysis on the causal factors for crashes. The Highway Safety Information System (HSIS) provides a detailed crash data coupled with high resolution roadway characteristics to enable such analyses.

Infrastructure/Improving Infrastructure: The program advances tools in safety data analyses that lead towards improving the infrastructure. The program supporting Highway Safety Improvement Program (HSIP) planning, implementation and evaluation efforts through the analysis of safety data available through various partners, establishing national level benchmarks. The program also performs data analysis that benefits the explicit, quantitative consideration of safety in planning, programming, project development, and operations decision making. The program established the Model Inventory of Roadway Elements (MIRE) as a guideline to help state agencies improve their roadway and traffic data inventories.

Innovation: The evaluation focus of the Safety Data and Analysis program advances the state-of-practice in safety evaluation. These analyses lead to countermeasure evaluation and crash modification factor (CMF) development, delivery, and use. This leads to making effective decisions, particularly on rural roads where safety deficiencies are more pronounced, about how to obtain more reliable data on the effectiveness of crash countermeasures. The program continually evaluates programs and processes for improving safety data, and enhancing the analysis and evaluation capabilities at the State and local levels. Recently the Safety Training and Analysis Center (STAC) was created to study Naturalistic Driving Study data collected through the second Strategic Highway Research Program (SHRP2). This data captured the driver behavior and the movement of vehicles through everyday driving experiences, enabling new research into how crashes can be avoided.

Improving Mobility: The Safety Data and Analysis program focus on improving geospatial resolution of data, and general description of the roadway network so that it can be analyzed through reliable statistical methods, has led to the creation of information descriptors that are valuable for improving mobility.

Accountability: As road owners and operators gather and use more data and information for decision making, they will become more accountable to the public.

Rural Communities: with a disproportionate rate of fatalities in rural areas, any activities to promulgate the scientific, data-driven approach to safety will save lives in those areas. Several emphasis areas in the Safety Data and Analysis program are highly relevant to rural safety, including a special set aside in the MIRE FDE for describing rural roads, and the use of the Systemic Approach to Safety.

Program Objectives:

Data driven technologies and decision making is a key theme to all FHWA programs. This is especially true for Safety. The Safety Data and Analysis Program reflects this priority for supporting highway infrastructure investment decision making. The main goal of the program is to discover new ways to use data and analysis tools to save lives, and improve the ability of road owners and operators to make science based safety decisions.

The Safety Data and Analysis Program identifies five primary objectives to address the broad challenge:

- Research and develop new methodologies and tools for safety data collection, management, analysis, and evaluation.
- Increase the utilization of proven methodologies and tools for safety data collection, management analysis, and evaluation.
- Broaden the integration of safety data and analysis into planning, programming, and project development processes.
- Improve understanding of the benefits of safety data-driven decision making.
- Advance safety data and evaluation as a means of supporting Transportation Performance Management.

Existing gaps in safety data systems and in analysis and evaluation capabilities limit the effectiveness of investment decisions at the Federal, State, and local levels. An investigation in 2012 for the US Roadway Safety Data Capabilities Assessment estimated an overall national average capability level of 3.34 on a scale of 1 (ad hoc) to 5 (optimized). The capability level is below 3 in several key subareas: completeness of data collection, analyses supporting countermeasure selection, and the people and technology supporting data management. The national average of States' desired capability level is 4.2, i.e., States wish to improve, on average, by almost 1 full capability level.

Key FY19 FHWA Safety Data and Analysis Program R&T activities

Activity	Period of Performance	Partners/Notes
Research and develop new methodologies and tools	2016-2022	Develop new safety countermeasures based second Strategic Highway Research Program (SHRP2) Roadway Inventory Database (RID) analyses. Evaluate potential motorcycle crash countermeasures identified through analysis of Motorcycle Crash Causation study data and input from motorcycle safety stakeholders
Increase the utilization of proven methodologies and tools	2014-2024	Update the Interactive Highway Safety Design Model (IHSDM) tool to provide decision makers better information so that they can make cost effective decisions • Work with Every Day Counts -Data-Driven Safety Analysis Initiative program participating agencies
Broaden the integration of safety data and analysis into all processes	2017-2026	Maintain and operate the Highway Safety Information System VI for roadway safety analysis Define concept for Highway Safety Information System VII applying new big data analytics
Improve understanding of the benefits of safety data-driven decision making	2016-2023	Partner with the agencies participating in Evaluation of Low Cost Safety Improvements Pooled Fund Study to evaluate the safety effectiveness of unproven safety countermeasures and to identify and addresses methodological issues with the development, application, and assessment of CMFs

Advance safety data and evaluation as a means of supporting Transportation Performance Management.	Ongoing	Administer the Roadway Safety Data Program to include roadway safety data collection, analysis and management • States identified through the Roadway Safety Data Capabilities Assessment

Research Collaboration Partners:
The Safety Design and Operations program relies on its established network of internal and external partners in other public agencies and in academia. The FHWA staff engaged in this program are active participants in national and international committees such as the World Road Association, the Transportation Research Board, the Institute of Transportation Engineers, and the American Association of State Highway and Transportation Officials. We track the input from partners through regular reporting on program status at meeting (DOT-TRCC; TRB) and other venues.

The Safety Design and Operations program frequently interacts with the following internal Department partners:

- **DOT Traffic Records Coordinating Committee (DOT|TRCC), Federal Motor Carrier Safety Administration, National Highway Traffic Safety Administration, Office of The Secretary** - This multi-modal group works to improve the collection, management, and analysis of traffic safety data at the State and Federal level.
- **FHWA's Safety Performance Measures Management Final Rule (23 CFR 490) and NHTSA's Uniform Procedures for State Highway Safety Grants Program Interim Final Rule (23 CFR 1300)** establish a single, national definition for States to report serious injuries per the Model Minimum Uniform Crash Criteria (MMUCC) 4th Edition.
- **USDOT Safety Data Initiative:** this multimodal initiative, led by OST-P is leapfrogging the department into the next generation of data and tools to inform and improve safety decisions.

Additionally, the Safety Data and Analysis Program coordinates frequently, but not limited to, the following:

- **American Association of State Highway and Transportation Officials (AASHTO)** – Collaborates on research problem statements.
- **Transportation Research Board –** Coordinates on research problem statements. Safety program staff participates on various safety related research projects and committees.
- **National Association of County Engineers** – Collaborates on projects to address safety on local and rural roads.
- **Institute of Transportation Engineers** – Collaborates on an annual Excellence in Highway Safety Data Award Paper Competition to encourage data-driven safety countermeasure development.

Benefits of Partnership and Partner Contributions to FHWA Safety Data and Analytics R&T Program.

Partner Organization	Coordination/ Collaboration	Data Analysis / Coordination	Advance Safety Initiatives	Safety Innovation Activities	Safety Deployment	Research Collaboration	Nationwide Goal Setting	Professional Development	Public Education
American Association of State Highway and Transportation Officials	x	x	x	x	x	x	x	x	
Transportation Research Board	x	x		x		x	X	x	
National Association of County Engineers	x		x	x	x		X	x	
Institute of Transportation Engineers	x		x	x	x	x	X	x	
Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms	x	x	x	x	x	x	X	x	x

The Safety Data and Analysis program collaborates with Planning, Environment, and Realty and the Office of Innovative Program Delivery as safety data and analysis experts in matters relevant to MPO/Planning organizations and local agencies. The program has been instrumental in supporting the Performance Based Practical Design effort led by the Office of Infrastructure.

Safety Data and Analysis program activities rely on strong collaborations with the Office of Highway Policy Information staff members who manage the Highway Performance Monitoring System (HPMS) and the All Road Network of Linear Referenced Data (ARNOLD) requirements and strategic initiative. The Safety Data and Analysis program has developed a cross-cutting SHRP2 Safety Data pooled fund program that will include the Offices of Operations and Planning. Also, the program coordinates with the FHWA Office of Operations on a safety analysis needs assessment for Transportation Systems Management and Operations and a safety analysis of freeway lane narrowing and shoulder use.

The Safety Data and Analysis program is also represented on the FHWA Data Governance and Data Business Planning Committees. At the USDOT level, the Safety Data and Analysis program participates in the USDOT Traffic Records Coordinating Committee and contributes to NHTSA's Minimum Model Uniform Crash Criteria (MMUCC) activities and crash data improvement efforts.

These internal and external partnerships provide many benefits. By collaborating within the USDOT, we assure that the federal safety programs related to data provide coordinated and clear information to our partners. Further, each mode is at a different level of expertise and sophistication with regard to data, and working together allows us all to benefit from the knowledge of the more advanced modes. The collaboration with our external partners improves out outreach and technology transfer with

regard to encouraging road owners and operations to move toward a science based approach for making critical safety decisions.

Acquisition/Assistance:
The Safety Data and Analysis program relies on a range of competitive procurements, to fulfill its mission.

- This program includes multiyear contract support delivered through multiple, pre-competitive indefinite quantity contracts. This contracting approach enables the program to minimize risk and remain flexible to the changes of the program over time. Most contracts are multi-year, and IDIQ contracts are frequently used.
- No sole source acquisitions are applied to this program.

Technology Transfer (T2):
Technology transfer is a critical aspect of the Safety Data and Analysis Program. Results from research activities from the HSIS that identify infrastructure safety improvements are widely shared so that road owners and operators can save lives. A wide range of data-based analysis tools are developed and are used by partners. Because different audiences have very different levels of sophistication with regard to available data and the ability to use tools, we develop and disseminate varying tools. The Crash Modification Factors Clearinghouse can be used to select single infrastructure improvements for a specific crash type at a particular location, while the Highway Safety Manual and IHSDM can be used to analyze the potential safety effects of a wide range of infrastructure decision on an entire corridor.

We use multiple metrics on the dissemination and use of tools and the growth in maturity of our audience. The Roadway Data Capability Assessment determines where each state is with regard to use of data, as well as where the state desire to get to, so assistance can be tailored accordingly. In the Data Driven Safety Analysis Every Day Counts activity, we are measuring the use of safety analysis tools by states.

Everyone in the FHWA Safety Discipline as well as many others in FHWA are involved in one way or another in safety technology transfer. Division Offices are on the front line day-to-day and routinely support the State in identifying and implementing new or different technologies or applications. In doing their jobs, they tap into the resources in the Resource Center (RC), Headquarters Office of safety (HAS) and Office of Research and Development (R&D). The RC is the primary unit in the FHWA charged with technology deployment and technical assistance. The Safety and Design Team works closely with Headquarters and R&D to ensure that the T2 that takes place is alignment with our priorities as spelled out in FHWA's Joint Safety Strategic Plan. HSA has the primary responsible for program and policy leadership. They support T2 efforts through the development and dissemination of useful safety products that address specific needs of States and other customers. They work closely with the RC and R&D in defining these products and in ensuring resources are adequately available to optimize dissemination as needed. At times, HSA is a direct contributor to T2 because their staff may have unique knowledge and skills in a specific area. R&D has the primary responsibility for developing new products through research efforts. For new products that have little or no field experience or for highly complex topics, R&D is a valuable partner to support T2 efforts. They bring detailed and high-level experience to bear as need to support States and other customers address highly complex challenges, often in partnership with HSA and the RC who may be the primary point of contact for the T2 effort. Other partners come to play in varying roles

depending on the topic and the challenge faced by the State in question. For example, the Federal Lands Highway Office is sometimes tapped to support T2 efforts because of their unique experience on Park Lands and Tribal Lands. Sometimes LTAP centers are tapped. Sometimes we bring other State partners on board to support T2 effort related to a challenge that has already been successfully addressed in their State.

Program outputs take the form of:

- Publications, including reports, assessments, FAQs, manuals, tools, case studies, fact sheets and noteworthy practices
- Technical guidance, policy and regulation activities
- Training course design, development and delivery in partnership with the National Highway Institute
- Webinars, Workshops, Peer to Peer Exchanges.

A few ways T2 is monitored.

- Annual roadmap meetings convened by the Office of Safety bring together HSA, R&D and the RC to focus on accomplishments from the previous year and plans for the coming year. T2 is an element of both the past and future discussions.
- The RC maintains a system to track all requests for all disciplines. Employees are expected to document each request, its completion status and meaningful outcomes as appropriate.
- Training evaluations are used to obtain knowledge gains that have been accomplished during the training effort.
- Periodic program assessments to track how the States' capability is improving over time.
- Number of technical, peer reviewed articles published via the Transportation Research Board and other technical journals.

All Safety Data and Analysis program products are made available through the National Transportation Library. All the program activities are searchable through the Research Hub, as well as the TRB TRID database.

Key 2019 FHWA Safety Data and Analysis R&T Program Outputs.

Program Objectives	**Key 2019 Outputs**
Maintain and operate the Highway Safety Information System VI for roadway safety analysis	• Annual HSIS Safety Liaison meeting • Incorporate Artificial Realistic Data (ARD) into HSIS Excellence in Highway Safety Data Award Contest • 4th Annual HSIS Excellence in Highway Safety Data Award Contest • Plan to update and revise Pedestrian and Bicycle Crash Analysis Tool (PBCAT) • Framework to incorporate and disseminate state GIS data

	• Assessment of HSIS Laboratory, skills set, gaps, best practices; and plan for required improvements. • Assessment of analytic tool needs and feasibility of HSIS Laboratory involvement.
Develop safety countermeasures based on analysis of second Strategic Highway Research Program (SHRP2) Naturalistic Driving Study and Roadway Inventory Databases.	Safety countermeasures for • Speed • Enforcement • Rural Intersection Safety • Work Zones • Vulnerable Road Users
Update the Interactive Highway Safety Design Model (IHSDM) tool to provide decision makers better information so that they can make cost effective decisions	Expansion of the scope of the IHSDM Economic Analyses Tool so that it applies to all facility types currently covered by the IHSDM Crash Prediction Module (CPM)
Partner with the agencies participating in Evaluation of Low Cost Safety Improvements Pooled Fund Study under the Development of Crash Modification Factors (CMF) program to evaluate the safety effectiveness of unproven safety countermeasures and to identify and addresses methodological issues with the development, application, and assessment of CMFs.	• Safety Evaluation of High Friction Surface Treatments • Evaluation of: 1. Adaptive Signal Control Technologies; 2. Bicycle lane additions; 3. Variable speed limits; 4. Clear Zone; 5. Guardrail Improvements; 6. Light Pole Improvements. • Highway Safety Performance Function (SPF) Developments using Time Series Methodologies using US Bureau of Census data. • Seasonal adjustment analyses for crash data to identify major contributing variables, and to develop reliable prediction models for: 1. Bicycles crashes 2. Pedestrian crashes 3. Young Drivers crashes 4. Speed Related crashes
The Roadway Data Capability Assessment results must be evaluated to ensure the actionable opportunities to advance safety data and analysis capability are optimized	• Develop a national action plan • Roadway Safety Data Program updates: 1. Technical assistance 2. Training • Case study development
Promote, train and assist States in the development of safety data business plans and advancing States' capabilities for safety data collection, analysis and integration	• Develop tools, resources and materials to advance data driven safety analysis • Training conducted in safety data business planning • Deliver technical assistance to assess and make recommendations to State DOTs for improving roadway data systems • Deliver technical assistance to State and local government agencies on data and analytical needs

	• Develop a guide on the estimation and collection of AADT on non-Federal Aid roads • Develop technical assistance to State, Tribal and Metropolitan Planning Organizations on the estimation and collection of AADT on lower volume roads for use in data driven safety analysis • Develop an informational guide and provide technical assistance to States in the implementation of GIS systems
The Roadway Safety Data and Analysis Technical Assistance Program provides formal and informal technical assistance on roadway safety data issues (e.g. collection, analysis, governance) to practitioners at the State and local levels. This project provides customizable technical assistance based on individual customer needs.	• Develop customized technical assistance from subject matter experts based on individual agency needs • Assist agencies in integrating Model Inventory of Roadway Elements (MIRE) and MIRE Fundamental Data Elements (FDEs) into Safety Management Programs and individual projects
The Roadway Data Extraction Technical Assistance Program (RDETAP) provides technical assistance to state and local agencies as a means to expand and improve the use of MIRE data elements in their roadway inventories to better support their safety programs.	• Customize the Roadway Data Extraction Tool to work with the data sets from State and local agencies. • Provide training to participating agencies in how to use the Roadway Data Extraction Tool
The Roadway Data Improvement Program (RDIP) assesses all aspects (e.g. data collection, analysis, interoperability, management, and local data integration) of a State's roadway inventory database.	• RDIP focuses on the processes and practices of collecting roadway data within a State DOT and also on how the State integrates local data into the State database. • Conducts an assessment of the quality of information with the State roadway inventory database • Review State plans and projects to comply with the MIRE FDE requirement.
MIRE FDE compliance criteria	• Develop guidance on how FHWA will determine if a State meets the MIRE FDE requirement.

Evaluation / Performance Measurement:
The Safety Program Delivery addresses the USDOT Strategic Goal of reducing transportation related fatalities and serious injuries across the system. The Safety Data and Analysis program sets targets for success and regularly assesses progress. At an annual roadmap meeting that includes all relevant FHWA Offices, we analyze where the program is and where it needs to be. The performance goal for all FHWA safety activities is completely in line with the USDOT Strategic Plan – Reduce Surface Transportation Related Fatalities, which is assessed through the annual highway

fatality number and rate. The program also performs periodic assessments to track how the States' capability maturity is improving over time.

Fundamental Data Elements (FDEs) of the Model Inventory of Roadside Elements (MIRE) were created to facilitate State agency adoption of the MIRE and use the subset to improve data collection. FHWA developed a set of interactive graphic images to depict the MIRE FDEs for each of the roadway categories. This facilitates the knowledge transfer, and has improve adoption steadily since implementation in 2016.

For specific activities (like State's use of MIRE FDE) we evaluate annual HSIP reports from the States. For broader initiatives (like the Data driven safety analysis) we work directly with states to assist them in maturing to the level they want to reach, and regularly asses the number of states who are making appropriate steps.

Human Factors Analytics
$1,570,000

Program Description/Activities:
The purpose of the Human Factors Analytics program is to better understand the relationship between roadway users, infrastructure, and vehicles. Human Factor Analytics encompasses human factors research and related activities. Human factors studies consider how drivers, pedestrians and special users' needs can be met through improved roadway designs. HF research looks at how people respond to highly visible, easy to read signs, improved pavement markings, vehicle automation technology, innovative operational changes, and safer streets with improved walkability.

US crash report data identifies human error as a factor in approximately 94% of vehicle crashes (1). Human factors research is a cross–cutting field that routinely conducts both applied and more fundamental investigations for projects in areas such as traffic control device effectiveness, novel intersection designs, and pedestrian & bicyclist safety, to help reduce vehicle crashes resulting from human behavior and error. The Human Factors Analytics program includes the Highway Driving Simulator (HDS), two Field Research Vehicles, the Highway Sign Design Lab, the MiniSim™ driving simulator, and the Virtual Reality Lab.

Some key focus areas for the Human Factors Analytics and the Human Factors Program are the following:

- Connected and Automated Vehicles (CAV)
- Traffic Control Devices
- Safety Data Analyses and Technology Assessment
- Roadway User Behavior (including traveler information research)
- Roadway Design Evaluation (including alternative intersection and interchange evaluation research)

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas in order to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety

FHWA's Human Factors Analytics supports the Department's Safety, Infrastructure, and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Safety/Promoting Safety: Many of our Human Factors research projects promote safer roadway design by evaluating and improving the design of roadway signing, and researching how emerging vehicle technologies can improve roadway safety and decrease crash frequency and severity. Human factors alternative intersection and interchange evaluation research is also focused on improving roadway safety, while simultaneously improving roadway efficiency.

Infrastructure/Improving Infrastructure: All our HF projects collect and analyze human performance and behavior data as a basis for decision making, technology evaluation and implementation, guidelines, recommendations, and policy creation. This includes projects in all our research areas, including Connected and Automated Vehicles (CAV), Traffic Control Devices and signing research, SHRP2 research, roadway user behavior (including traveler information research), and roadway design evaluation (including alternative intersection and interchange evaluation research). Our projects and research studies include a variety of driving performance data including data from the driving simulators, field research vehicles, sign laboratory, and test track that are collected and analyzed to answer specific research questions.

Innovation: Automated Vehicles (as well as Connected Vehicles) are important areas for the Human Factors program and active areas of research. AVs has been an important area in the HF program in the last four years, and this will continue to be a very important and dynamic area for the program. The Human Factors Analytics program is coordinating within the Department on "Driver Acceptance of Vehicle Automation for Function-Specific Automation Applications". This project builds on a previous multi-year program on "Cooperative Adaptive Cruise Control (CACC): Investigation of Key Human Factors Issues".

Improving Mobility / Preserving the Environment: The design enhancements assessed through Human Factors Analytics enabled the rapid deployment of innovative alternative intersection designs. Some of these alternative intersection designs, such as the Restricted Crossing U-Turn specifically helps with high speed rural roadways where vehicles entering on minor roads are at risk of life threating right-angle crashes. Human Factors Analytics supported design evaluations that enabled these alternative intersection designs to be promoted among the FHWA Safety program's Proven Safety Countermeasures.

Rural Impact: Prior research activities looked into the application of alternative intersection designs for rural locations. One design, the Restricted Centerline U-Turn (RCUT), was developed based on simulation work to understand how traffic flows for minor roadways would be affected as they intersect fast moving arterial highways. Visualization work enables roadway designers understand how design choices affect safety while providing valuable tools for building local community support.

Program Objectives:

The Human Factors Analytics program produces valuable research that promotes and improves the safety of our transportation system. The program identifies the following objectives:

- Improve the effectiveness of safety countermeasures as well as tools that promote operational efficiency.
- Improve roadway designs that meet the needs of drivers, pedestrians and vulnerable users.
- Understand how people respond to signs and markings, emerging vehicle technology, innovative operational changes, safer streets with improved walkability, and other new roadside innovations.

The Human Factors Analytics program provides a range of research products and guidance that includes experimental studies that result in informed decision-making to help improve roadway design, evaluate safety countermeasures, and provide technology assessments to improve safety. Human Factors staff have also worked with the Office of Safety staff to help develop Human Factors training, including a course based on the Human Factors Guidelines for Roadway Systems (NCHRP Report 600). The Office of Safety is involved in the current TRB update of the HFG for Roadway Systems. The updated guidelines will be based on roadway research studies.

Key FY19 FHWA Human Factors Analytics Program Activities.

Activity	Period of Performance	Partners/Notes
Improve the effectiveness of safety countermeasures as well as tools that promote operational efficiency	2019-2020	Enhancements to Lane Reduction Transitions through signing and lane markings • Work with over 25 states through Traffic Control Device Pooled Fund Study

Improve roadway designs that meet the needs of drivers, pedestrians and vulnerable users	2018-2022	Partner with industry on developing Virtual Reality Bicycle Simulator for testing bicycle warning applications Create open source module for shared multi-simulator connected simulation Truck Platooning Operations and their effects on passenger car drivers Multi-Driver Interaction using Virtual Reality to allow multiple simulators to interact with one another, facilitating multiple participant experimentation
Understand how people respond to signs and markings, emerging vehicle technology, innovative operational changes, safer streets with improved walkability, and other new roadside innovations	2018-2021	Level 1 Vehicle Automation Applications Collaborate with FHWA Operations R&D on defining Cooperative Automation Research Modeling and Analysis (CARMA) platform Build Level 2 capable Automated Vehicle for field research Upgrade Highway Driving Simulator capabilities to model Level 2 vehicle automation

Research Collaboration Partners:
The Human Factors Analytics program collaborates internally and externally to develop research activities and also to exchange information among peer organizations. Every year the Human Factors Analytics program is actively engaged in human factors workshops convened through the Transportation Research Board Annual Meeting. The research community, including industry partners, have sustained long-lasting relationships with the program and its activities.

The Human Factors Analytics Program most frequently collaborates with internal Department partners indicated below:

- **Office of the Secretary ITS Joint Program Office** – Safety staff serve as project managers on the validation, testing, and evaluation of vehicle to vehicle safety applications. The Safety program attends regular ITS Strategic Planning Group meetings that focus on the progress and identification of new research. Human Factors expertise in Safety enables the ITS program to fully consider the adaptability of vehicle operators responding to dynamic features on the roadway, like adaptive signal systems and changeable message signs.
- **Federal Railroad Administration and Federal Motor Carrier Safety Administration -** collaborates on intelligent transportation systems R&D.
- **National Highway Traffic Safety Administration** – Safety program staff evaluate Cooperative Adaptive Cruise Control (CACC) applications. The collaboration with the Human Factors team with NHTSA and the ITS Joint Program Office explores the adaptability of drivers to new vehicle

technology, and the human response to varying degrees of automation. This has helped to refine automated vehicle following algorithms that can be tolerated by everyday people.

- **U.S. Department of Transportation's Human Factors Coordinating Committee** – representatives from various modal agencies of DOT meet on a monthly basis to coordinate activities and provide updates on human factors projects.

External partners include but are not limited to:

- **American Association of State Highway and Transportation Officials (AASHTO)** – Collaborates on research problem statements.
- **Transportation Research Board –** Coordinates on research problem statements. Safety program staff participates on various safety related research projects and committees.
- **National Association of County Engineers** – Collaborates on projects to address safety on local and rural roads.
- **Trilateral (EU, US, JPN) Human Factors Working Group** - Identifies opportunities for human factors research collaboration, aligns its research, and identifies differences for a broad set of human factors issues, including driver distraction, Human-Machine Interaction (HMI), and human factors for automation.

Benefits of Partnership and Partner Contributions to FHWA Human Factors Analytics R&T Program.

Partner Organization	Coordination/ Collaboration	Data Analysis/Coordinat ion	Advance Safety Initiatives	Safety Innovation Activities	Safety Deployment	Research Collaboration	Nationwide Goal Setting	Professional Development	Public Education
American Association of State Highway and Transportation Officials	x	x	x	x	x	x	x	x	
Transportation Research Board	x	x		x		x	x	x	
National Association of County Engineers	x		x	x	x		x	x	
Trilateral (EU, US, JPN) Human Factors Working Group	x		x	x		x			
Federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms	x	x	x	x	x	x	x	x	x

Acquisition/Assistance:
The Human Factors Analytics program relies on a range of procurements, as well as interactions with internal and external partners, to fulfill its mission.

- This program includes multiyear contract support delivered through a single, award pre-competitive indefinite quantity contract. This contracting approach enables the program to minimize risk and remain flexible to the changes of the program over time. In FY2019 there

will be a new indefinite quantity contract to supersede the incumbent contract that expires in late 2018.

- No sole source acquisitions are applied to this program.

Technology Transfer (T2):

Activities conducted or supported as part of the Human Factors program include improving and maintaining the Human Factors Laboratory at TFHRC as a world-class research facility by providing useful research driven results, guidelines and products that will improve transportation designs and enhance safety by performing the following:

- Conducting critical research on the following topics: Intersection/Interchange; Pedestrian/Bicycle; Traffic Control Devices; Visibility; Analysis of Behavior Data; Connected Vehicle; Vehicle Automation
- Making necessary upgrades to all aspects of the Human Factors Laboratory. Develop potential research on the following topics: Work Zone/Road Weather; Virtual/Augmented Simulation; Older Road Users; Roadway Departure (Monitor and advance new/emerging topics: V2P & V2X; Distributed/Multiple Users Simulation (longer-term opportunity in future years)
- Developing potential research on the following topics: Work Zone/Road Weather; Virtual/Augmented Simulation: Older Road Users; Roadway Departure (Monitor and advance new/emerging topics; V2P & V2X; Distributed /Multiple User Simulation

The Human Factors Analytics program sustains a Traffic Control Device Pooled Fund program in which FHWA collaborates with more than 30 states on matters involving how roadside design can be improved to work with drivers' capabilities.

The program also works with stakeholder organizations like AASHTO and TRB for developing the Human Factors Guidelines for Road Systems, NCHRP Report 600. The guidelines focus on providing specific, actionable design principles, supported by a discussion and review of key research and analyses. Special design issues and considerations are included to help address design constraints and relevant trade-offs.

Every year there is a Human Factors Workshop series at the TRB Annual Meeting. The workshops consider a range of topics relevant to roadway design, safety, and how these are affected by human factors. Well over 100 participants attend these full day workshops to learn among their peers and from FHWA Safety program specialists about how human factors can refine their design and engineering approaches.

Key 2019 FHWA Human Factors Analytics Program Outputs

Program Objective	**Key 2019 Outputs**
Road User Behavior and Performance – through research and development to gain a fundamental understanding of road user behavior and performance, including how drivers perceive, process, and respond to the	Concept of Operations for common simulator interfaces to enable experiments with multiple human participants interacting in virtual environments.

roadway environment, for better roadway designs.	
Roadway Design Evaluations – evaluate new and innovative roadway design in the assessment of drivers and other roadway user's capabilities and limitations.	Develop enhancements to the Human Factors Guide for roadside design.
Establish new modeling to consider human response in vehicle automation.	Collaborate on the Cooperative Automation Research Modeling and Analysis (CARMA) platform development.

Evaluation / Performance Measurement:

The Safety Program Delivery addresses the USDOT Strategic Goal of reducing transportation related fatalities and serious injuries across the system. The program builds and expands knowledge of professionals on human factors topics to improve designs of transportation systems by:

- Establishing partnerships and providing useful resources to other FHWA offices, other DOT modal agencies, state and local DOT agencies, universities and research organizations, professional organizations, and international communities

Providing expertise for the development of new training materials on human factors topics related to transportation

A few ways T2 is monitored.

- Annual roadmap meetings convened by the Office of Safety bring together HSA, R&D and the RC to focus on accomplishments from the previous year and plans for the coming year. T2 is an element of both the past and future discussions.
- The RC maintains a system to track all requests for all disciplines. Employees are expected to document each request, its completion status and meaningful outcomes as appropriate.
- Training evaluations are used to obtain knowledge gains that have been accomplished during the training effort.
- Periodic program assessments to track how the States' capability is improving over time.
- Number of technical, peer reviewed articles published via the Transportation Research Board and other technical journals.

Transportation Systems Management and Operations
$6,000,000

Program Description/Activities:
Transportation Systems Management and Operations (TSMO) was defined in the *Moving Ahead for Progress in the 21st Century Act* (P.L. 112-141), under Section 1103 (a) (30)(A) as "an integrated set of strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system."

There is an increasing focus on TSMO in U.S. urban and rural areas – especially underserved communities - driven by the need for alternatives to capacity projects due to limited resources, growing customer expectations, emergence of real-time decision support systems and on-demand mobility applications, and an emphasis on performance-based programs. Furthermore, given the advancement in consumer technologies (smart phones, apps, GPS, etc.), the traveling public expects that transportation agencies will find creative ways to apply these advances to improve their travel experience.

TSMO can provide solutions using the opportunities created by technology, real-time information, and innovation. TSMO practitioners are using technology and data to monitor travel conditions, enhance real-time traveler information with public data, coordinate incident and emergency response, manage travel demand, operate managed lanes, minimize impacts of work zones, improve signal timing, and manage agency resources with decision-support capabilities. To effectively use technology to achieve better system operations, agencies need a strong foundation for TSMO and tools that they can apply. The second Strategic Highway Research Program (SHRP2), which ended in fiscal year 2017, raised awareness of the benefits of TSMO and provided tools to assist agencies. The activities proposed in this TSMO R&T Program build on that momentum and continue critical research and deployment support to help state and local agency partners realize the true potential of TSMO. Research indicates that today most agencies are only starting to apply these strategies, and opportunities abound to continue to make U.S. transportation systems more efficient, safe and responsive, through TSMO. Work is also needed to account for both long-term and catastrophic impacts to ensure the system is resilient to impacts such as the increasingly common extreme weather events, cybersecurity threats, and natural disasters.

The TSMO Program proposed has three key elements:
- Foundation for Successful Operations
- Data-Driven Operations Decision-Making
- Implementing Operations Strategies.

Foundation for Successful Operations. This element of the program advances state-of-the-art institutional structures and capabilities to ensure that advanced and emerging innovative operational strategies and technologies are successfully delivered and sustained for the benefit of the American public and the business sector. Research done for the SHRP2 Reliability Focus Area revealed that the distinguishing factors between agencies that are more advanced in transportation systems management and operations (TSMO) than other agencies, were not how much technology they had deployed or money they had spent, but how strong their organization's process and institutional elements were for using their technology and facilities effectively. The SHRP2 Reliability effort focused on developing tools to help agencies advance these organizational

capabilities. These tools have received broad support and have established strong momentum for mainstreaming TSMO as a key program in transportation agencies. Funding limitations and space constraints for highway expansion make it critical that agencies have a strong foundation of TSMO capabilities so they can effectively operate their system to get the most out of current capacity. As our transportation challenges increase, and the available technology and data tools grow, managing and operating the transportation system gets more complex. A strong foundation for successful operations is critical to both handle these challenges and leverage the power of the new tools.

Given the legacy of transportation agencies in delivering traditional road and bridge infrastructure with long time horizons from planning to completion, this element of the program will provide the tools and organizational support to enable agencies to evaluate, plan, fund, design, and quickly capitalize on emerging cost-effective transportation technologies and operational strategies to improve reliability, mobility, safety, and economic competitiveness. Research and technology transfer will be conducted to determine effective means to structure organizations and carry out organizational functions to successfully deploy and sustain innovative operational strategies. This program leverages the momentum gained by SHRP2 efforts to continue support for mainstreaming TSMO and professional capacity building of agencies and the TSMO workforce to meet the transportation needs of today and tomorrow. It will help agencies capitalize on efforts for performance management, including through better understanding of the causes of congestion and other operational issues, benefit-cost analysis of potential investments in transportation system improvements, and planning and design that includes consideration of TSMO strategies and use of emerging technologies and approaches.

Research and develop resources on operations program delivery options, including public private partnerships, shared use mobility providers, multi-agency consortia, and risk sharing, will be produced as part of this element of the program. This element will also serve as the key link between the research programs of other FHWA Offices (such as Safety, Planning, and Infrastructure) and Operations to ensure broad support and to leverage related work being led by others.

This element of the program will provide the foundation to enable the successful implementation of other Operations Programs Areas (Managing Disruptions to Operations and Connected and Automated Vehicles) and the other elements within this Program.

This element of the program will ensure delivery of successful and on-going SHRP2 work, work and products related to operations benefit/cost analysis, operations asset management, planning and organizing for operations, designing for operations, active traffic management (ATM) and integrated corridor management (ICM), shared use mobility, and active transportation and demand management (ATDM).

Data-Driven Operations Decision-Making. This element of the program estimates and evaluates the transportation impacts of operations strategies using data management and analytics; analysis modeling and simulation (AMS) tools; and transportation performance management techniques. Activities in this element include: developing tools for researchers and practitioners; providing tools on innovative strategies and technologies to improve data and performance measures and management practices that lead to improved transportation operations; collaborating with industry partners to adopt newly developed tools and capabilities in commercial software, agency processes and procedures, and industry-wide state of practice; developing management support systems to

improve the efficiency and effectiveness of both operational and organizational performance; developing data business planning assistance; developing congestion reporting and operations performance measures and management tools; and improving both planning-level and real-time operational decision-making. These research, development, and deployment efforts will help make more effective use of scarce transportation resources by helping agencies determine:

- more effective and suitable strategies for efficient operations of our existing facilities, and
- where and how to make future transportation investments based on a better understanding of the causes of mobility and safety issues and what solutions will be efficient and effective.

This program element will also support the storage and documentation of data acquired from operations projects and making them accessible to the public. It includes developing and supporting advanced data storage, management, and analytics practices.

Implementing Operations Strategies. The U.S. has invested billions of dollars in building our existing transportation infrastructure. Once facilities are built, our role as stewards of this system is not done. The facilities need to be operated well so that we use them efficiently and effectively. This element of the program supports the use and deployment of operational strategies and practices to improve the performance of existing transportation infrastructure.

This element of the program targets a range of traffic, demand, and parking management tools and strategies that agencies can employ (largely with existing resources) to reduce congestion, improve safety, and improve travel time reliability. Its core mission is to more effectively apply and integrate readily available (but perhaps underutilized) and innovative operational strategies, practices, and technologies for more efficient day-to-day management of the surface transportation system.

The operational strategies and tools include traffic control, traveler information, pricing, shared use mobility, ICM, ATDM, traffic control device application, traffic management centers, and parking management systems. This program will enable agencies to advance their current state of operations to a more proactive, integrated, performance-driven, and holistic approach to traffic management and operations.

TSMO has the potential to make significant improvements in safety, expand mobility services to underserved communities, and improve the convenience of travel. TSMO approaches have the potential to reduce congestion and fuel consumption, allow better management of the road network, and stimulate the economy through improved freight movement.

For example, effective signal timing enables us to get more vehicles through our existing infrastructure, while improving safety and reliability at the same time. Traveler information, congestion and parking pricing, ATDM, and ICM can dynamically spread demand to use more facilities at a wider range of time by giving travelers choices, incentivizing them to smarter use of facilities, and enabling agencies to adjust operations in real-time as needed. Clear, easy to understand signage reduces confusion and smooths traffic flow, leading to reduced congestion and improved safety. Fixing bottlenecks means that one chokepoint does not reduce capacity along a whole corridor, enabling more efficient use of the entire facility. This program element enables FHWA to address needs of agencies in using our transportation assets by developing strategies, policies, resources, and training; compiling best practices; organizing peer exchanges; and

conducting applied research that help agencies more effectively manage their facilities using proactive, dynamic, and performance-driven approach to traffic management and operations.

This program is synergistic with other proposed Operations-related research programs areas, including Managing Disruptions to Operations, Connected and Automated Vehicles, and Freight Management and Operations.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes

The following statutory requirements apply:

- The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, **reduce congestion**, **improve highway operations and enhance freight productivity**, among others. This research supports areas of research identified in section 503 part (5) Reducing Congestion, Improving Highway Operations, and Enhancing Freight Productivity.
- This program supports implementation of other statutory mandates, specifically, the National Performance Management Measures (23 CFR 490).
- This research also provides administration, evaluation and results dissemination of the Surface Transportation System Funding Alternatives (STSFA) Program, required under Section 6020 of the Fixing America's Surface Transportation (FAST) Act. No administrative funds were provided under the STSFA legislative language, requiring the use of alternative research and deployment funds to support the program.
- The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is the national standard for traffic control devices on any street, highway, bikeway, or private road open to public travel, in accordance with 23 U.S.C. §§ 109(d) and 402(a). It is incorporated by reference in 23 CFR Part 655, Subpart F. The MUTCD is administered by FHWA, which issues revisions and updated editions through the Federal rulemaking process. The last edition was published in 2009, with two revisions in 2012.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure

Infrastructure: FHWA's TSMO R&T Program closely supports the Department's Infrastructure Strategic Goal, and aligns with the DOT RD&T Critical Transportation Topics of Improving System Management and Operations. The TSMO Research Program improves system reliability and enhances performance of the transportation system. Particularly, the research supports strategies

that focus on operational improvements intended to maintain and, in some cases, restore the performance of the existing transportation system before extra capacity is needed. This may enable transportation agencies to "stretch" their funding to benefit more areas and customers. The TSMO research also helps agencies to balance transportation system supply and demand, provides flexible solutions to match changing conditions, and reduces the need for excess infrastructure capacity during non-peak times. Finally, it helps agencies make informed decisions about the management of infrastructure related resources, such as snow and ice treatments, and how to plan for future system needs using performance metrics that account for travel conditions on specific route segments and from a systems perspective, including the potential for travel mode shift.

Innovation: TSMO applications rely heavily on technology and innovation, taking advantage of new data sources and advances in consumer applications, as well as innovations in traffic assets, such as traffic signal controllers, sensors, and communication devices.

Program Objectives:
The objectives of the Foundation for Successful Operations element include:

- Mainstreaming TSMO as a core function in state and local transportation agencies.
- Enhancing planning and operations functions to improve and strengthen the key institutional underpinnings and linkages that are needed for effective TSMO.
- Enhancing the Performance-Based Planning and Programming process (as defined by the FHWA Office of Planning), including Transportation Performance Management (TPM) implementation, so that investments in operations provide regional and multi-modal benefit.
- Providing technical assistance to implement and make routine use of SHRP2 Reliability products.
- Providing information to support the objective analysis of benefits and costs of potential operational improvements.
- Incorporating risk management and scenario planning principles to operations technology deployments.
- Supporting agencies with objectively assessing organizational capabilities and developing targeted action plans for improvement to build strong foundations for operations.
- Providing training and technical assistance resources to prepare the transportation workforce to effectively manage and operate the transportation system and leverage emerging technologies and data.
- Enhancing systems engineering capabilities, regional ITS Architectures, and supporting industry-developed ITS standards to improve planning and deployment of technologies and operational strategies, and interoperability of equipment across jurisdictional boundaries
- Providing mechanisms to assess and programmatically address emerging multi-modal, mobility on demand, mobility as a service, and shared use mobility services.
- Providing resources to advance the state-of-practice in operations-related system resiliency.
- Providing support and collaboration with the National Operations Center of Excellence (NOCoE) and the American Association of State Highway and Transportation Officials (AASHTO) Committee on Transportation Systems Operations (TSO) Committee.
- Support delivery of the Surface Transportation Systems Funding Alternatives program.

The objectives of the Data-Driven Operations Decision-Making element include:

- Supporting agencies use of analysis, modeling and simulation tools to find the best solutions for their unique transportation problems and to improve decision-making.
- Utilizing data, analysis tools, and performance management to quantify the benefits of operational solutions of sophisticated and complex transportation systems.
- Providing the appropriate data and analysis tools for agencies to effectively assess the performance of their transportation systems.
- Helping partner agencies to implement data-driven decision making.
- Supporting successful implementation of the MAP-21 performance measures for system performance and Congestion Mitigation and Air Quality (CMAQ) traffic congestion (PM3).

The objectives of the Implementing Operations Strategies element include:

- Providing resources and technical support to achieve greater benefits from arterial operations, existing traffic signal infrastructure, freeway operations, existing ITS infrastructure, and traffic management center (TMC) systems.
- Providing resources and technical support to achieve improved performance of managed lanes through pricing, vehicle eligibility, time of day use, active traffic management, integrated corridor management, part-time shoulder use or other operational strategies.
- Determining and sharing best practices in implementing integrated corridor management and effective and low-cost bottleneck reduction treatments.
- Advancing the state-of-the practice in TMC operations.
- Ensuring that the MUTCD is maintained and is updated in a timely manner to reflect current and forthcoming needs of practitioners and road users, and that it accommodates automated driving systems.
- Providing resources and technical support to make more efficient use of transportation systems through traveler information, travel demand management, and shared use mobility services.
- Identifying system cybersecurity vulnerabilities related to technology-based deployments and transportation operations assets, such as traffic signals and traffic management centers, and working with partner agencies, associations and system manufacturers to define systematic strategies to address them and advance the state-of-the-practice.
- Helping partner agencies understand potential benefits and apply real-time parking management strategies to reduce congestion.

Key FY19 FHWA TSMO R&T Program Activities.

Activity	Period of Performance	Partners/Notes
Delivering Effective Operations Programs		
Conduct targeted outreach and technology transfer of reliability measurement tools, SHRP 2 reliability products, the application of organizational capability maturity assessments, and transportation performance data to support planning for operations.	2018-2020	State DOTs, National Operations Center of Excellence (NOCoE), AASHTO and Transportation Research Board (TRB) Regional TSMO and Performance Management Committees

Develop tools and support resources to monitor national transportation system performance and conduct outreach and technology transfer to advance state and local agency performance management capabilities.	2018-2020	AASHTO, Metropolitan Planning Organizations (MPOs), State DOTs, Local Agencies, TRB Regional TSMO and Performance Management Committee
Conduct targeted outreach and technology transfer, including peer-to-peer learning opportunities and technical assistance and resources to advance the state-of-the-practice and improve the capabilities of agencies for developing and delivering TSMO programs.	2018-2023	AASHTO, MPOs, State DOTs, Local Agencies, TRB Regional TSMO and Performance Management Committee
Develop implementation resources for emerging trends including mobility-on-demand, shared use mobility, public and private incentives, and other transportation demand and parking management strategies.	2018-2022	State DOTs, MPOs, Local Agencies
Research, develop, and share resources and best practices on transportation technology, including artificial intelligence, transportation systems cybersecurity, and next generation decision support systems.	2018-2020	MPOs, State DOTs, Local Agencies, Transit Agencies
Surface Transportation Systems Funding Alternatives Program		
Administer and support the delivery of the STSFA grant program, evaluate program outcomes, and conduct outreach and technology transfer.	2018-2023	MPOs, State DOTs, Local Agencies
Traffic Analysis Tools and Improving Reliability		
Develop and disseminate resources to enable holistic analyses of operational improvement benefits at system, network, and facility levels. Utilize the methods to develop tools and decision support systems to enable agencies to address both operational/tactical and executive/organizational decisions. Share results of reliability data and analysis tool deployment projects and grow deployment of reliability evaluations in systems planning and operational activities. Provide technical assistance to advance the practice on data analytics/business intelligence, post project evaluation using empirical data, and multi-objective tradeoff analysis.	2018-2022	MPOs, State DOTs, Local Agencies, Universities
Active Transportation and Demand Management/Integrated Corridor Management		

Develop the capabilities, tools, and guidance to enable more proactive, dynamic, integrated and performance-driven management and operations.	2017-2022	MPOs, State DOTs, Local Agencies
Research and document best practices and conduct targeted outreach and Technology transfer to share early deployer lessons learned and to proactively advance the adoption of ATDM and ICM solutions and strategies. Support related pooled fund initiatives.	2018-2023	MPOs, State DOTs, Local Agencies
Managed Lanes and Bottleneck Reduction		
Develop tools and strategies to devise and evaluate remedies to promote congestion management and mitigation under recurring congestion.	2018-2023	MPOs, State DOTs, Local Agencies
Support and manage the High Occupancy Vehicle (HOV)/Managed Lane and TMC Pooled Fund study efforts to advance the state-of-the-practice.	2018-2023	MPOs, State DOTs, Local Agencies
Conduct targeted outreach and technology transfer on best practices for improving the usage of HOV lanes and aid support state and local agency programs with localized congestion reduction.	2018-2023	MPOs, State DOTs, Local Agencies
Arterial Management and Signal Systems		
Conduct targeted outreach and technology transfer on best practices and lessons learned to promote and advance automated traffic signal performance measures and provide assistance and resources to support state and local agency Traffic Signal Management Plans. Deliver training that addresses workforce capability and objectives and performance-based approaches to managing traffic signal systems.	2017-2021	MPOs, State DOTs, Local Agencies, TRB, ITE, AASHTO, NOCoE
Manual on Uniform Traffic Control Devices (MUTCD)		
Develop revisions/updates to 2009 MUTCD, manage technical corrections, and support the administration of MUTCD statutory requirements and implementation support activities. Support pooled fund studies that contribute to the manual's development.	2018-2023	MPOs, State DOTs, Local Agencies, AASHTO

Research Collaboration Partners:
The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in Table 2.

Benefits of Partnership and Partner Contributions to FHWA Transportation Management and Operations R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or	Funding
State DOTs	X			X	X	X		X	X
MPOs	X			X	X	X		X	X
Local Agencies	X			X	X			X	
Universities and other Research Organizations				X		X	X	X	X
Engineering Associations		X	X				X		
Roadway Technology Developers		X	X	X	X	X	X		
Analysis, Modeling and Simulation (AMS) Developers		X	X		X	X	X		
Information and Data Developers		X	X	X	X	X	X		
AASHTO	X	X	X	X	X	X		X	X
TRB	X	X				X	X		
National Operations Center of Excellence (NOCoE)	X	X					X		
Mileage-Based User Fee Alliance	X	X					X		

Acquisition/Assistance:
The Transportation Systems Management and Operations R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. Program needs are met primarily through competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate. Cooperative agreements are sometimes used with key partners when the partner organization provides valuable contributions such as specialized expertise, collaborative opportunities, or matching funding or in-kind services to the arrangement. The program also provides deployment grants for demonstrating new tools and strategies to offset the risks of being an early adopter. These cooperative agreements and deployment grants are usually competitively awarded.

- This program includes many projects. Most are bid using multi-year IDIQ contracts. The period of performance for individual task orders varies based the time required to complete a set of defined deliverables. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. Most projects are competitively bid. This program occasionally awards cooperative agreements where the recipient puts up some cost matching. An example would be cooperative agreements with trade associations to complete a defined set of tasks, which require in-kind matching. A sole source procurement with the Volpe National Transportation Systems Center is anticipated to support the inherently governmental functions associated with administering the congressionally designated Surface Transportation System Funding Alternatives (STSFA) Program.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA TSMO R&T program, and is funded as such. Additionally, some program outputs are advanced through the Every Day Counts initiative, SHRP2 program, AASHTO Committees, TRB, and the National Operations Center of Excellence.

State and local highway agencies and MPOs are the primary stakeholders and beneficiaries of the FHWA Transportation Systems Management and Operations R&T program, such that their personnel are the primary audience for the program's research outputs. As presented in the table above, program partner organizations, consisting of government and non-government entities as well as consultants and contractors that provide services and support, are involved in technology transfer with FHWA. As shown in the table, there are many benefits derived from these partnerships and partner contributions.

Since state and local highway agencies and MPOs are often the program's primary stakeholders, they are the target audience for most activities. The program office engages with them directly and through organizations such as the AASHTO, the Local Technical Assistance Program (LTAP), TRB, and the NOCoE. FHWA staff from headquarters, Turner Fairbank Highway Research Center, the Resource Center and the field offices work with partner organizations in a variety of ways, such as executing field tests and demonstration projects, conducting peer exchanges, holding roundtable discussions, developing written resources, conducting workshops and training courses, and providing technical assistance and support to assist with their deployments. In addition to the list of outputs below, the program office conducts multiple stakeholder meetings each year. These consist of "virtual" regional meetings that allow sharing of successes and lessons learned among partners in a region. The office also conducts in-person meetings that bring public and private

sector entities together to learn from each other. These meetings have proven to be invaluable for shortening implementation schedules and avoiding costly mistakes by the deploying agencies.

The program's outputs take the form of:

- Research and practitioner publications;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by relevant standard setting organizations;
- New and/or updated technical resources;
- Technical assistance;
- Training courses;
- Webinars;
- Workshops;
- Peer Exchanges.

The program office conducts a variety of performance assessments. One assessment tracks the number of deployments or planned deployments of operations capabilities by state, local and MPO partners. The program office also tracks whether its technology transfer efforts have led to changes in the business processes that state, local and MPO agencies adopt at the organizational level. The office encourages partner agencies to conduct and report annual self-assessments (e.g., Capability, Maturity Model assessments), where the practitioners evaluate their organization's capabilities and progression on a capability maturity scale. For organizations providing data, changes are monitored over multiple years. The office also conducts biennial evaluations to determine the extent to which state partners are implementing new solutions that are consistent with the office's priority technology transfer programs. Under the Every Day Counts program, the division offices work closely with their state partners to enter their implementation progress into a formal tracking system. This provides a way to assess the extent to which they adopt the specific solutions being promoted under that program.

Key 2019 FHWA Transportation Management and Operations R&T Program Outputs

Program Objective	**Key 2019 Outputs**
Understanding the impacts, benefits and costs of potential operational improvements to enable the development and deployment of Transportation Management and Operations strategies, and supporting agencies use of analysis, modeling and simulation tools to find the best solutions for their unique transportation problems and to improve decision-making.	• Develop first edition of a Transportation System Simulation Manual (TSSM) and support future updates. • Develop and disseminate tools to streamline the calibration of microsimulation models for operational analysis. • Provide valid analysis methodologies and tools for innovative operational strategies and performance-based practical design solutions, such as lane narrowing and part-time shoulder use. • Resources on network/system-level benefits of operational improvements.
Building the capability and capacity of operating agencies to optimize safety and system performance through targeted outreach and technology transfer, implementation of performance management systems, and the capability maturity frameworks for Transportation Management and Operations	• Deliver a series of webinars and peer exchanges on emerging TSMO topics with the National Operations Center of Excellence. • Delivery of training that addresses workforce capability and objectives- and performance-based approaches to managing traffic signal systems. • Providing training and technical assistance resources to prepare the transportation workforce to effectively manage and operate the transportation system and leverage emerging technologies and data. • Outreach and technical assistance to support state and local agency programs for localized congestion reduction, and managed lanes. • Resources and technical assistance to support state and local agency with Traffic Signal Management Plans.
Enhancing systems engineering, Regional ITS Architecture, and ITS Standards to improve planning and deployment of technologies and operational strategies.	Model Systems Engineering for Traffic Signals and other ITS modular devices in support of innovative and accelerated deployments among local agencies.
Support delivery of the Surface Transportation Systems Funding Alternatives Program (STFSA).	STSFA grants are awarded, provided risk-based oversight, effectively monitored and evaluated, and the results are shared.

Helping agencies to implement Data-Driven Decision Making.	Through new analysis tools and methods, enable State DOTs and local agencies to identify and select appropriate performance measures that reflect goals and objectives for regional transportation system performance.
Ensuring coordination and collaboration across multiple jurisdictions that play a part in intergrading corridors and enabling proactive, dynamic, performance-driven decision-making.	• Knowledge and technology transfer of ATDM, ICM, data and analysis tools, performance management tools. • Dissemination of ICM early deployer lessons learned reports and related outreach and technical support.
Understanding the opportunities that emerging technologies (e.g., ATDM, ICM, part-time shoulder use, managed lanes, etc) present to better manage and operate the transportation system.	• Guidance, data and enhanced analytical tools and simulation models to evaluate proactive, dynamic, integrated, performance-based transportation systems. • Data sharing strategies to develop and validate tools and to maintain situational awareness of the transportation system.
Ensuring that the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is maintained and is updated in a timely manner to reflect current and forthcoming needs of practitioners and road users, and that it accommodates automated driving systems.	• Revisions/updates and technical corrections provided to 2009 MUTCD. • MUTCD-related guidance on traffic control devices for emerging operational strategies, such as part-time shoulder use, Active Travel Demand Management (ATDM), all-electronic tolling, and managed lanes with complex eligibility criteria. • Request for Comments on future content and applicability of the MUTCD relative to such issues as highway classification, connected and automated vehicles, and other relevant factors

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

Evaluation / Performance Measurement:
This program directly supports both the Infrastructure and Innovation objectives of the 2019-2022 FHWA Strategic Plan. The outputs from the TSMO program enable state partners to maintain mobility within their transportation networks, which directly supports Infrastructure Strategic Objective 3 (System Operations and Performance) and the related performance goal to Alleviate Urban Congestion. This program enables the deployment of solutions to maintain a more reliable transportation system under challenging environments in both urban and rural areas. Likewise, the program promotes management of transportation systems in a proactive, integrated, and effective manner to more efficiently use existing transportation facilities. In addition, the program contributes to the performance goals for Innovation Strategic Objective 1 (Development of Innovation), which include: Increase Dissemination of DOT-Funded Research Reports, Increase Production of Tangible DOT-Funded Research Outputs, Increase DOT Technology Transfer Activity. The program produces a significant number of research reports, research outputs, and technology transfer activities.

Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the operations leadership, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. The program also tracks certain key output and outcome measures.

Program performance is assessed primarily based on project milestones. (successful delivery of all deliverables). The program also tracks certain key metrics. Including output measures such as workshop deliveries and completion of TSMO program plans, and outcome-based metrics such as the Transportation Performance Management System Performance Rule (PM3) metrics.

Many individual sub-elements of the program do analyze trends. For instance, the program tracks voluntary reporting of the number of state and local agencies that have developed TSMO business plans. The Urban Congestion Report tracks trends in congestion related delays in the largest metropolitan areas nation-wide and a Traffic Signal Benchmarking Report and State of the Practice tracks related measures. Both these reports are periodically updated using systematic data collection and analysis processes. The Transportation Performance Management rulemaking will require state reporting of implementation progress and results in future years. In addition, evaluation of benefits is conducted and reported for all major research conducted under this program.

The MUTCD sets parameters for and tracks the progress and effectiveness of official experimentation with novel traffic control devices and applications. Once these evaluations have been completed, the experimental devices or applications found to be effective are proposed for adoption in the MUTCD through rulemaking. This process aligns with the Department's strategic goals of advancing innovation, improving system performance through management of congestion, and reducing fatalities with new safety treatments involving traffic control devices. In addition, adoption into the MUTCD reduces regulatory and economic impacts to transportation agencies because it eliminates the need for those agencies to request approval to experiment, which involves data collection and semiannual reporting. To this end, advancing a new edition of the MUTCD, which was last updated in 2009, has the potential to advance all four of the Department's strategic goals.

Connected and Automated Vehicles
$5,800,000

Program Description/Activities:
Understanding and Preparing to Address the Challenges and Impacts to Roadway Infrastructure and Operations Needed to Facilitate the Integration of Automated Driving Systems (ADS). The FHWA Offices of Operations and of Operations Research and Development will jointly undertake initial research that will identify, define, and set in motion the development of information and capabilities needed for the DOT, FHWA, and stakeholders to jointly address the challenges of integrating ADS and to identify what needs to be done to make our roadways ADS-ready. The efforts will build from the initial FHWA National Dialogue on Highway Automation that aids the identification of challenges through interactive discussions with stakeholders. The National Dialogue will continue to support the creation of new relationships among infrastructure owners and operators and ADS and other automation technology developers.

Following the initial dialogue, efforts need to be taken to develop a far-reaching collaborative understanding of ADS and roadway integration. This understanding will allow all stakeholders to grasp how the challenges manifest themselves within the collective operation of ADS with the roadway and other road users. Putting the challenges into context to better understand how each can be addressed, we will use a First Stage Concept of Operations context. The First Stage is in relation to the unique mixed roadway environment, under which initial ADS deployment will occur. The development of the Concept-of-Operations will accelerate identifying and defining the collaborative research necessary to adapt roadways to support ADS.

Collaborative research will be necessary to understand the nexus between ADS and roadway capabilities. We anticipate that iterative interaction will be essential to best identify and refine roadway adaptations that fulfill the vision of safe and effective ADS operations. To support testing and evaluation, we will have to adapt roadway attributes to support all roadway users, including ADS. Research will be necessary to support the joint testing and evaluation activities identified by FHWA Request for Information (RFI) ADS commenters. We will need sound field tests and pilot studies. Given the new interactive nature of these tests and pilots, it is critical to investigate how to design and develop the test or pilots, and how to lay out the evaluation methods and procedures.

To smooth the iterative nature of the testing, we need to do research to identify how various roadway adaptations can be tested and reconfigured, without permanently changing testing facilities or actual roadways. The research results will support development of techniques, methods, and technology that can be used to mimic roadway adaptations to all road users so a multitude of different adaptation scenarios can be tested and evaluated. The research will build a more robust and efficient testing and evaluation capability that will support the testing and evaluation that needs to take place to adapt our roadways to support the evolutionary deployment of ADS.

Data and information will be a necessary link between the roadway and ADS operations. Basic information needs between the roadway and ADS need to be identified and ways to provide the information need to be investigated. Many RFI commenters identified and described the challenge associated with the multitude of different types of roadway information across the country as well as differing or inconsistent traffic control device practices. The challenges regarding roadway information include either developing ADS to account for the multitude of both static and dynamic

information, or the burden of providing the information to ADS and how it would be implemented across the nation. Initial collaborative research around a database of traffic regulation information will provide insight regarding how information about traffic regulations can be effectively passed between the roadway and ADS.

FHWA will also closely collaborate with the ITS JPO to conduct joint planning and roadmap development that is informed by stakeholder input. FHWA will participate in projects and other activities that advance FHWA mission and objectives and DOT strategic objectives. FHWA research allows early assessment of promising concepts; allows broad public dissemination of early research products, performance data, and results; and provides a foundation for subsequent research, development, and testing by private technology providers, commercial vendors, and highway infrastructure owner/operators enabled by ITS JPO funding.

National Dialogue Development of the First Stage Concept of Operations for Adaptation of Roadways to Support both human and Automated Driving Systems-operated vehicles. FHWA will work with the stakeholders that identified the issues and challenges that need to be addressed in relation to ADS integration into the nation's roadway system. This stage of the dialogue will focus on the development of a Concept of Operations for near-term (first stage) deployment of ADS into a mixed traffic environment that includes other road users. The development of the First Stage Concept of Operations will support the collaborative development of first stage scenarios that all users will need to understand and properly perceive to maintain a safe and efficient system; including adverse weather conditions, through work zones, and under other complex environments. The concept-of-operations will facilitate discussion regarding the roadway adaptation that may be required for a scenario to be correctly interpreted by both humans and automated systems. The concept-of-operations will document and support a common understanding that will facilitate collaborative work on innovative methods regarding the safe and efficient operation of our system with the implementation of ADS. The concept will assist in the development of identifying collaborated roadway and ADS research that needs to be completed to understand the exact nature of possible adaptations and what alternatives need to be evaluated to understand the roadway investments that should be made.

Research activities will meet the following high priority areas:

- Understand how roadway readiness for ADS can be addressed.
- Understand what critical ADS, roadway, and other user interactions need to be addressed.
- Establish a collaborative understanding among all stakeholders that will support collaborative development of ADS and roadway technology.
- Support the development and planning of joint roadway and ADS testing and pilot deployment activities.
- Engage the weather community and others to understand the operational challenges of ADS under adverse weather conditions, through work zones, and under other complex environments.

This research builds off the initial National Dialogue and the RFI comments that identified the need to address roadway (e.g. traffic control device) inconsistency, need for more information regarding roadway and ADS capabilities, and using joint testing and pilot deployments to establish a collaborative environment among infrastructure owners and operators and automation developers.

Testing and Pilot Design, Development, and Evaluation Framework. The National Dialogue Concept-of-Operations will identify various ADS and roadway scenarios that will be defined and identify the challenges that need to be addressed. Part of addressing and finding solutions to challenges between roadway adaptations and ADS will be to conduct sound field tests and pilot studies. Given the new interactive nature of these tests and pilots, there needs to be an investigation of how to design and develop the test or pilots, and how to design the evaluation methods and procedures. The effort will result in a ADS/roadway interactive testing and evaluation framework. The framework will establish an empirical foundation and a step wise process for the development of sound test and pilot activities. The framework will identify how to address changes to roadway adaptations and ADS adaptation in relation to conducting a successful test/evaluation. A successful test and evaluation of adaptations will yield the data necessary to make decisions regarding the adaptations that will enable the deployment of a safe and efficient roadway environment for all road users. The framework will enable stakeholders to collaborate on test or pilot study design, development, and evaluation design such that all stakeholders can obtain the needed results. The investigation will identify data collection musts, data collection parameters, and collection techniques that would support comprehensive evaluation. The framework will supply example prototype test scenarios that will provide a design, development checklist, a data collection and evaluation plan. The test scenarios will need to include ADS scenarios under adverse weather conditions, and to ensure the systems work in complex environments to better understand the operational challenges. Research to date has documented how some of the sensors operate under varying weather conditions. Further testing and analysis is critical to deepen this understanding given a combination of sensors, a broader range of environments, and possible enhanced roadway attributes.

Research activities will meet the following high priority areas:

- Provide a collective basis of understanding regarding how to design, develop, and structure the evaluation of ADS and roadway attribute testing and evaluation.
- Support the development and planning of joint testing and pilot deployment activities.
- Back identification of the proper balance of ADS and roadway capabilities to ensure a safe and efficient environment.
- Aid understanding of ADS capabilities under adverse weather and other complex environments and how roadway attributes can be adapted to assist ADS.

This research addresses the need to understand how iterative ADS and roadway attribute testing needs to be done with input from stakeholders. The testing will need to account for the technology and attribute that are brought for testing and by what stakeholders. The results from tests will need to satisfy multiple stakeholders from various perspectives for a cooperative development environment to exist. The framework will be positioned to assist in creating the cooperative environment to foster all stakeholders to implement consistent development changes that benefit the overall safe and efficient operations of ADS on our nation's roadway system. This effort addresses RFI comments that indicate a need to understand ADS and roadway capabilities and find a balance that supports a joint implementation.

Development of Innovative Techniques and Methods that Support a Modular and Changeable Roadway Environment That Can Support Joint ADS and Roadway Testing and Evaluation. This research will investigate and develop techniques, methods, and objects that can be used to mimic roadway operations, and/or traffic control for joint human, ADS, and other road user testing and evaluation. As more information becomes available and ADS can be demonstrated, there will

be a need to present different scenarios to ADS to evaluate how the ADS interpret the roadway environment. In addition, investigations will need to be done regarding how the roadway can be adapted to enhance the interpretation to ensure safe and efficient operations of ADS, human drivers, and other road users. This work will identify the joint needs of ADS and the roadway, develop alternative techniques and the innovative technology that could be used, and the prototyping and testing of modular and changeable roadway attributes. The basic premise is that the techniques and methods will support and depict realistic scenarios to all road users but that the scenario can be easily custom configured or changed to a different scenario without permanently changing basic test facilities of roadway configurations. The techniques and methods will need to mimic aspects of operations, and traffic control devices including changeable roadway makings. The results will support joint ADS and roadway testing and evaluation and enable the testing of multiple roadway configurations.

Research activities will meet the following high priority areas:

- Understand and evaluate how roadways can be adapted to enhance performance of ADS
- Extend testing and evaluation activities given the ability to support reconfiguration of roadway attributes.
- Facilitate collaboration among stakeholders to identify and modify configurations that meet the multiple needs of stakeholders.
- Support the development and planning of joint roadway and ADS testing and pilot deployment activities.
- Address testing and evaluation under adverse weather and other complex environments.

This research addresses the need to adapt roadway attributes to support all roadway users including ADS. The research will support the joint testing and evaluation activities identified by commenters to the FHWA RFI comments regarding Automated Driving Systems. The research will build a more robust and efficient testing and evaluation capability that will support the testing and evaluation that needs to take place to adapt our roadways to support the evolutionary deployment of ADS. It will provide the tools and information necessary for ADS developers as well as infrastructure owners and operators to make the most appropriate investment decisions.

ADS Operational Behavior and Traffic Regulation Information. ADS could benefit from a traffic regulations foundation to facilitate the development of ADS behavior. Many commenters to the FHWA RFI on ADS expressed that there is a need to develop a database of all traffic regulations across the country. A comprehensive database of traffic regulations would be used by developers to set basic programing standards regarding traffic regulations, and would decrease the burden of infrastructure owners and operators to support some other database of existing traffic regulations and the communication of these regulations to ADS. The development of this database will include investigating data formats, data elements, and structure for this information. Organizing and structuring the traffic regulation information will provide an essential foundation for the development of provisions that support processing of dynamic data such as changing speed limits. FHWA would facilitate the initial development and coordinate bringing in the new ADS stakeholders. A possible initial activity would be to assess the status of the Uniform Vehicle Code (UVC), and determine if the last update of the code could be resurrected and be transformed into requisites for ADS. The UVC was a privately prepared set of United States traffic laws prepared by the National Committee on Uniform Traffic Laws and Ordinances (NCUTLO), a private non-profit

organization that disbanded in 2008. Most of the members were state governments, in addition to some related organizations. The latest update to this code was done in 2000.

Research activities will meet the following high priority areas:

- Investigate basic traffic laws and the issue with inconsistencies across the nation.
- Support collaboration between State and local traffic code stakeholders, and ADS developers to identify the uses for a Traffic Regulation database to support ADS behavior development.
- Understand the basic information needs for ADS to comply with traffic regulations.
- Support the development and planning of joint roadway and ADS testing and pilot deployment activities.

This research addresses basic information needs between the roadway and ADS. Many RFI commenters identified and described the challenge associated with the multitude of different traffic regulations across the country and the challenges of either developing ADS to account for the multitude of both static and dynamic traffic regulations or the burden of providing the regulation information to ADS and how it would be implemented across the nation. This research investigates what type of digital infrastructure can be developed for traffic regulations and how that digital infrastructure can support the sharing and consumption of the information.

Transfiguration of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) for Connected and Automated Vehicles. The MUTCD is the national standard for traffic control devices on any street, highway, bikeway, or private road open to public travel, in accordance with 23 U.S.C. §§ 109(d) and 402(a). It is incorporated by reference in Title 23 of the *Code of Federal Regulations*, Part 655, Subpart F. The MUTCD is administered by FHWA, which issues revisions and updated editions through the Federal rulemaking process. The last edition was published in 2009, with two revisions in 2012.

Like the development of the database for Traffic Regulation Information, this research addresses basic information needs between the roadway and ADS. Many RFI commenters identified and described the challenges associated with the lack of uniformity, consistency, and maintenance of traffic control device infrastructure from one State to another and even within the same jurisdiction. Many States have also commented that it will be challenging to maintain traffic control devices to the extent that ADS will rely on them, either exclusively or principally, and that the extent of this reliance is not yet well-understood. This research investigates how the MUTCD and traffic control device maintenance practices might be adapted to accommodate ADS and how ADS can optimize its reliance on traffic control devices and redundant systems that account for a traffic control device that is missing due to knockdown or other event.

Integrating CVs into Systems Management and Operations. The FHWA Offices of Operations and of Operations Research and Development are leading research to integrate advanced technologies to actively manage traffic and improve systems management and operations. This research seeks to explore and validate the benefits of integrating advanced technologies and innovative uses of transportation systems management and operations strategies to optimize the performance of the surface transportation system. The research proposed for FY2019-2020 focuses on sharing and using electronic messages between travelers using connected devices, connected vehicles, and automated vehicles (CAVs) to enable public agencies to proactively manage and operate the next generation of traffic management systems (TMSs) and centers (TMCs).

Priorities for research include the sharing of data (e.g., through Intelligent Transportation Systems (ITS) infrastructure, connected and automated vehicles, and connected devices used by travelers) and the integration of this information into the proactive management and operation of traffic control plans, operational strategies, and the next generation of TMSs. Leveraging work being conducted by the DOT ITS Program (e.g., Data, Vehicle-to-Infrastructure (V2I), and Automated Vehicle), this proposed research will involve partnering with industry, institutions, and other federal agencies. This research will be conducted in a manner that optimizes the available technical expertise, capabilities, and facilities available at Turner Fairbank Highway Research Center (e.g., Saxton Lab), federal partners (e.g., Army Aberdeen Vehicle Test Center), and state or local agencies (e.g., Pooled Fund Studies (e.g., CV, Traffic Management Center, Managed Lane), Cooperative Automated Transportation Coalition).

The following two research initiatives will pursue the integration and use of advanced technologies to assess the feasibility (e.g., operational strategies and control plans, operational concepts, use cases, requirements, traffic analysis), development (e.g., design, proof-of-concept), testing (e.g., proto-type), validation (e.g., operational tests), technical guidance, information, and assistance to support the sharing and use of data between connected vehicles, travelers using connected devices, ITS devices, traffic management systems, and TMCs.

Integrating Connected Vehicles and Devices Used by Travelers into Traffic Management and Control. This research will facilitate public agencies enabling the sharing and use of data with connected and automated vehicles and devices used by travelers and integration into the active management and operation of traffic management systems, TMCs and sharing of this information with other systems. This research will explore the development and use of advanced technologies, scalable tools, methods, and practices to enable the sharing and use these new sources of electronic data to improve the performance of the trips of individual travelers and the facilities managed by these systems.

Transitioning from Legacy to Next Generation Traffic Management Systems (TMS) and Traffic Management Centers (TMCs). This research will develop and test the use of advanced technologies, scalable tools, methods, and practices to enable agencies to develop the capabilities to actively manage and operate the next generation of TMSs and TMCs. These next generation capabilities will enable these systems and TMCs to automate their operation, optimize their performance, and proactively collect, process, and share data with connected vehicles, devices, and other systems in response to predicted and changing conditions.

This proposed research will leverage work being conducted or planned by U.S. DOT ITS Program (e.g., Data, Vehicle-to-Infrastructure Data, and Automated Vehicle), other FHWA Office of Operations Program (e.g., Work Zones, Road Weather), state and local agencies (e.g., Pooled Fund Studies (connected vehicles, traffic management centers, Managed Lanes)), federal partners (e.g., Army Aberdeen Vehicle Test Center), Cooperative Automated Transportation Coalition, AASHTO, and TRB (e.g., NCHRP, TCRP).

Cooperative Automated Vehicles

Automated vehicles have the potential to make significant improvements in traffic safety, expand mobility services to underserved populations, and improve the convenience of travel. Combined with connected vehicle technologies into cooperative systems, cooperative automated vehicles have

the potential to reduce congestion and fuel consumption, allow better management of the road network, and stimulate the economy through improved freight movement. FHWA's research plan supports the integration of automated vehicles on our public roads in a manner that ensures safe, reliable, efficient, and sustainable mobility for people and goods. FHWA closely collaborates with the ITS JPO on cooperative automated vehicle research. This includes participation in ITS JPO multi-modal program teams where roadmaps are developed and progress is shared across the DOT. FHWA and ITS JPO, along with other DOT modes, coordinate funding investments at the project level, and staffing of specific research projects where cross-industry collaboration toward commercialization and deployment is a focus.

Cooperative Automated Driving Systems. Emerging technologies that are increasingly allowing the introduction of ADS enable drivers to disengage from most or all of the critical driving tasks. These systems, also known as highly automated vehicles (HAV), operate within SAE Levels of 3 through 5 and offer significant convenience benefits that will be attractive to consumers. All major automotive original equipment manufacturers (OEMs) and other technology organizations are conducting research and development of ADS. Some manufacturers have introduced commercial products, and others have been conducting testing of prototype vehicles on public roads with and without the supervision of test drivers. The ADS offer significant benefits to drivers by removing the need for constant driving tasks and likely will eventually significantly improve safety by avoiding driving errors by humans. But potential impacts and consequences for operations and safety are also not yet clear, particularly since early ADS appear to operate very conservatively in most driving environments, and absent communication with each other and with traffic management systems, cannot coordinate movements as humans can to optimize traffic performance. For example, the early introduction of ADS without such communication systems in high-volume traffic environments will likely reduce travel reliability and increase congestion. While ADS have safety and convenience benefits individually, they also introduce many unknown early deployment risks such as system-wide operational performance impacts at various levels of deployment, vehicle performance in urban environments, weather and other variable operating conditions, and infrastructure recognition, dependence, and impact. These represent a variety of research priorities that will impact operational, maintenance, and transportation management decisions, and will inform FHWA policy, deployment guidance and best practices for planning agencies, infrastructure owners and operators, and the private sector. The long-range potential of cooperative ADS, through the addition of communication systems, allows the potential to supplement the private benefits of increased convenience and safety with public benefits of improved mobility, traffic performance and reliability, and reduced fuel consumption. Since neither automotive OEMs nor emerging system developers will likely consider the benefits of incorporating vehicle-vehicle or vehicle-infrastructure communication systems in ADS absent leadership from the federal level, and FHWA needs to fill this gap to allow public benefits to also be achieved.

Cooperative Driving Automation Systems (DAS). Technology advancements in driver-assisted and vehicle self-driving capabilities have also enabled the introduction of systems that allow some driving functions to be conducted by the vehicle while others continue to be conducted by drivers. These partially automated systems operate within Society of Automotive Engineers (SAE) Levels of 1 and 2. Much like ADS, these driving automation systems also provide convenience and are attractive to consumers. FHWA has investigated the potential of cooperative DAS that retain driver engagement for management and safety while improving the performance of the traffic system through communication between vehicles and with traffic management systems. Industry's rapid development and early deployment of these systems has created an opportunity and critical need

for FHWA to assess the impacts of these systems on infrastructure, owners/operators, and transportation system performance and safety. More importantly, as in the case of ADS, FHWA must lead industry in the extension of commercial DAS to incorporate cooperation so that public benefits of increased mobility, traffic performance and reliability, and reduced fuel consumption can be achieved in addition to the private benefits of increased convenience that encourages industry to provide commercial products and consumers to purchase them.

Building upon foundational concept development and feasibility analysis, the Office of Operations and the Office of Operations R&D propose priority research to advance ADS and cooperative DAS implementation that will enhance transportation system performance and ensure near-term deployment readiness for transportation agencies.

Research activities will meet the following high priority areas:

- Integrate connected and automated vehicles into Systems Management and Operations
- Transition from legacy to next generation traffic management systems
- Conduct a National Dialog on adaptation to ADS
- Ensure FHWA research capacity to assess ADS and cooperative DAS performance
- Understand ADS and DAS Performance Characteristics
- Optimize system-wide performance enabled by ADS and DAS
- ADS and DAS Deployment Readiness and Uniform Vehicle Code Update

Builds upon foundational concept development research funded by both FHWA R&T and ITS JPO and in partnership with the CAMP OEM consortium in the following application and technology areas:

- Signalized Intersection Approach and Departure
- Speed Harmonization
- Light vehicle and truck platooning
- Lane change and merge applications
- Case studies development and modeling
- Human Factors research

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The MUTCD is the national standard for traffic control devices on any street, highway, bikeway, or private road open to public travel, in accordance with 23 U.S.C. §§ 109(d) and 402(a). It is incorporated by reference in Title 23 of the *Code of Federal Regulations*, Part 655, Subpart F. The MUTCD is administered by FHWA, which issues revisions and updated editions through the Federal rulemaking process.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Innovation	Improving mobility

FHWA's Connected and Automated Vehicles R&T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Using the National Dialogue to develop the First ADS/Roadway Stage Concept-of-Operations will identify what needs to be addressed to assure the safe integration of ADS into the roadway system; identify the critical roadway adaptation that will facilitate safe and efficient travel; and establish the necessary understanding and information to facilitate the development and deployment of the critical innovation. These innovative techniques to support innovative roadway testing and the testing framework will address improving infrastructure and facilitating deployment of both innovative infrastructure as well as ADS. Developing a digital infrastructure for traffic regulations will support future digital infrastructure development that address the information needs associated with facilitating the deployment of innovative technology, and the safe and efficient deployment of the technology. Updating and transfiguring the Manual on Uniform Traffic Control Devices will investigate how old information can be adapted to new information needs. Developing and modernizing the Manual on Uniform Traffic Devices, addresses Safety, Infrastructure, and Innovation. Specific contributions include:

Safety/Promoting Safety**:** ADSs will improve safety by automating driving tasks prone to human error, and the Connected and Automated Vehicles R&T Program will further improve safety by developing cooperative ADS and DAS that can improve response to hazardous conditions such as emergency stops caused by leading vehicle movements.

Infrastructure/Improving Infrastructure**:** The Connected and Automated Vehicles R&T Program recognizes that infrastructure changes might improve the operation of automated vehicles. This potential must be assessed and opportunities to incorporate infrastructure improvements identified so that stakeholders can make sound investment decisions.

Innovation**:** Automated vehicle technologies are disruptive and the Connected and Automated Vehicles R&T Program will identify opportunities where government can leverage advances by industry to enable automated vehicle commercialization and to support deployments that use and extend the emerging capabilities of automated vehicles to improve safety, mobility, and the infrastructure that benefits the public.

Improving Mobility/Preserving the Environment**:** The Connected and Automated Vehicles R&T Program includes critical research on cooperative ADS and DAS that will allow roadway operators to better manage traffic and so achieve greater mobility, improve the efficiency of operations, and reduce fuel use and emissions.

Automated Vehicles. This research will address the challenges of integrating ADS, will identify what needs to be done to make our roadways ADS ready, and will enable the introduction of cooperative ADS and DAS to allow public as well as individual benefits. The objectives are to:

- Extend the National Dialogue to facilitate continuing collaboration on how challenges can be addressed from both the roadway and automation sides and foster establishment of a longer-term mechanism to support this ongoing interaction.

- Understand how increasing deployment of automated vehicles, and their interaction with driven vehicles in mixed traffic, will affect the operation of traffic signals and other traffic management systems, and impact interactions with law enforcement and first responder traffic incident management activities.
- Develop, test, and demonstrate evolving automated driving technologies, particularly those that provide public as well as private real-world benefits in the near term. These will include technologies such as the platooning of both light vehicles and trucks. Truck platooning will offer significant opportunities to improve freight mobility and efficiency.
- Develop new traffic management technologies and applications to leverage cooperative automated driving systems.
- Develop and enhance vehicle, roadway, and operations data and models to help incorporate automated driving capabilities and so allow state and local governments to effectively use them.
- Encourage automated driving system providers to develop commercial products that work well with roadways and other infrastructure assets.
- Assist infrastructure owner-operators to recognize the potential opportunities, and risks, of automated driving systems and provide guidance so they can leverage them successfully.
- Understand the issues, challenges, and opportunities that need to be addressed to transition existing roadway capabilities to facilitate the safe and efficient operation of both human driven vehicles, other road users, and ADS on our nation's roads.
- Identify and plan for joint testing and evaluation that will enable joint understanding and a collaborative vision for the near-term to long-term evolution of automation development and deployment.

Integrating Connected Vehicles into Systems Management and Operations. This research program will transform how state and local agencies actively manage and operate the surface transportation system. The objectives are to:

- Improve the active management and control of traffic and operation of TMSs and TMCs by sharing, integrating, and using data with travelers using connected devices, connected and automated vehicles, and other sources.
  Enable agencies to develop and deploy the next generation of TMSs and TMCs by exploring, developing, testing, and providing tools and resources.

Key FY19 FHWA Connected and Automated Vehicles R&T Program Activities.

Activity	Period of Performance	Partners/Notes
National Dialogue Development of the First Stage Concept of Operations for Adaptation of Roadways to Support both human and Automated Driving Systems operated vehicles	2019-2020	National Dialogue partners that include Infrastructure owners and operators including traffic engineers, and ADS developers.

This stage of the dialogue will focus on the development of a Concept of Operations for near-term (first stage) deployment of ADS into a mixed traffic environment.		
Testing and Pilot Design, Development, and Evaluation Framework The framework will establish an empirical foundation and a step wise process for the development of sound test and pilot activities.	2019-2020	National Dialogue partners that include Infrastructure owners and operators, ADS developers, testing and research institutions.

Development of innovative techniques and methods that support a modular and changeable roadway environment that can support joint ADS/roadway testing and evaluation This research will investigate and develop techniques, methods, and objects that can be used to mimic roadway infrastructure, operations, and/or traffic control for joint human/ADS/other road user testing and evaluation.	2019-2021	National Dialogue partners that include Infrastructure owners and operators, ADS developers, testing facilitates and possible pilot locations.
ADS Operational Behavior and Traffic Regulations This research will include coordinating among State and local traffic code stakeholders and ADS developers the development of a possible database of traffic regulations that can serve the needs of ADS developers and a ADS ready roadway environment.		NHTSA, National Dialogue partners that include Infrastructure owners and operators, including State traffic engineers, ADS developers, and State and Local traffic code stakeholders, including State Departments of Motor Vehicles, Departments of Safety, American Association of Motor Vehicle Administrators (AAMVA).
Transfiguration of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) for CAV This task will focus specifically on adaptation and augmentation of existing provisions of the MUTCD to accommodate a ADS-ready environment that is coordinated among a traffic regulation database, the technological aspects of machine vision, and the constraints of maintaining traffic control device infrastructure, while retaining the provisions that address communication with human operators.	2019-2022	National Dialogue partners that include Infrastructure owners and operators, ADS developers, and State and Local traffic engineering stakeholders, AASHTO, National Committee on Uniform Traffic Control Devices (NCUTCD).

Integrate ADS into Emergency and Incident Management Strategies Develop new strategies to include tactical maneuver planning (i.e., lane change, merge), detection and response to emergency vehicles, emergency vehicle/incident scene advance working, and emergency vehicle variable speed limits. Develop Traffic Incident Management (TIM) strategies for first responders using ADS. This effort will begin in 2018 with Law Enforcement but in 2019 the next step would include Fire/Rescue, EMS, Transportation and Towing.	2019-2021	Law enforcement partners at federal, state, and local levels. It is envisioned that the strategies which are developed for law enforcement first will be used as the framework to help address the whole first responder community. Additionally, the TIM scenarios for ADS will include interaction between ADS and incident response/responders during Weather, Work Zones and Planned Special Event incidents.
Integrating Connected Vehicles and Devices Used by Travelers into Traffic Management and Control Conduct tests to evaluate the ability to share and use data between mobile devices, connected vehicles, ITS devices, and traffic management systems and develop the tools and resources to support public agencies pursuing similar projects.	2019-2021	DOT ITS JPO and FTA External: AASHTO, TRB Technical Committees, and other stakeholders will be offered the opportunity to review and provide feedback on key products to be developed.
Transitioning from Legacy to Next Generation Traffic Management Systems and Traffic Management Centers (TMC) Develop technical guidance and resources to support public agencies planning for and pursuing the development and integration of advanced technologies, (e.g., AI, Machine learning, decision support subsystems) in support of the deployment of the next generation of traffic management systems and TMCs to allow them to share and use connected vehicle and device data.	2019-2021	Internal: USDOT ITS JPO and FTA External: AASHTO, TRB Technical Committees, and other stakeholders will be offered the opportunity to review and provide feedback on key products to be developed.
Ensure FHWA research capacity to assess cooperative DAS performance HRDO Saxton Laboratory testbeds will support DAS vehicle, mobile device, infrastructure, modeling, hardware-in-the-loop, and data analysis research. HRDO has expanded the research and testing capabilities at TFHRC and established testbed partnerships. These testing centers combined with the FHWA Saxton Lab will provide a full range of advanced DAS	2011-2022	We previously established testbed partnerships with the U.S. Army Aberdeen Vehicle Test Center and the Department of Homeland Security Federal Law Enforcement Training Center (FLETC) to leverage expanded test facilities, their technical expertise, and their data analysis systems and

research capabilities to advance these transformative technologies to early deployment.		capabilities. Partnerships with University Test Centers (UTCs) and State/local agency Pooled Fund Studies (PFS) will also focus on automated vehicle and advanced traffic management system research.

Understand DAS Performance Characteristics HOP and HRDO continues to conduct research to support automated vehicle early deployment, collaborating across FHWA and with our modal partners through development of a 10-year cooperative automation Program Plan and Roadmap. Research priorities have been identified to advance near-term applications and capabilities from concept development to prototyping to field testing. Early deployment use cases and performance characteristics are being defined for applications that achieve Level 2 performance. These will build upon research FHWA has conducted for Level 1 Signalized Intersection Approach and Departure (SIAD), light vehicle and commercial truck platooning on managed lanes, slow speed automated shuttles, shared mobility, accessible mobility applications, and incident and emergency response. Integration of these automated vehicle use cases with transportation and emergency management strategies and systems is critical.	2012-2022	FHWA has established a productive partnership with CAMP, which allows FHWA to conduct pre-competitive research on topics of interest to FHWA and to the automotive OEM's and their suppliers. We anticipate that up to ten OEM's will participate in research projects. FHWA will explore the potential impacts, positive and negative, of key emerging automated driving technologies and the potential improvements possible through cooperation between vehicles and with the infrastructure. Federal partnerships with Department of Homeland Security and Army Aberdeen Test Center will continue to focus on emergency response strategies.
Optimized system-wide performance enabled by DAS Advanced Analysis, Modeling, and Simulation (AMS) framework and capabilities to assess DAS have been defined to include Hardware-in-the-loop analysis techniques to leverage small scale field tests with system-wide analysis. Human factors research and impact on both automated vehicle drivers themselves as well as the drivers of surrounding vehicles will need to be understood. Research results and lessons learned will feed planning, policy,	2012-2022	

and deployment guidance and Knowledge and Technology Transfer (KTT) activities to expedite national implementation.		
Automated Vehicle Deployment Readiness Infrastructure owners/operators, planners, the private sector, and the public need to be informed and prepared for ADS and DAS early deployment and implementation. FHWA will engage these stakeholders through KTT activities sharing research results, best practices, training, and deployment guidance as required. Automated vehicle technology showcases and driver clinics will be conducted to demonstrate automated vehicle benefits and capabilities as they are connected to and cooperating with the infrastructure and transportation system. Research results will inform federal policy, planning, and deployment guidance.	2017-2022	AASHTO, ITE, TRB, Standards Development Organizations (SDOs), and other groups will be actively engaged to define deployment needs and coordinate/leverage national readiness activities.

The research identified focuses on the integration of ADS into roadway operations that will connect and coordinate with research across the Department. The roadway operations research will complement and relate to automated vehicle research being conducted by FHWA pertaining to roadway safety, infrastructure, and planning, ITS JPO automated systems and data research, and NHTSA Automated Driving System research. The FHWA National Dialogue on Highway Automation will provide information and promote collaboration in support of FHWA core areas of safety, operations, infrastructure and planning, so the agency can address all aspects of roadway readiness for ADS deployment.

Research Collaboration Partners:

The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Benefits of Partnership and Partner Contributions to FHWA Connected and Automated Vehicles R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or	Funding
State Departments of Transportation	X		X	X	X	X	X		
AASHTO, including (IOO/OEM) Forum	X	X		X	X	X	X	X	
Cooperative Automated Transportation Coalition	X	X		X		X		X	
Society of Automotive Engineers		X	X			X	X	X	
ITS America	X	X							
U.S. Army Aberdeen Test Center				X			X	X	
Federal Law Enforcement Testing Center				X					
Universities, including UTCs						X	X		
Connected Vehicle PFS	X				X			X	X
Automotive OEMs, including CAMP	X	X	X	X	X	X	X		X
Automated System Developers	X	X	X	X	X	X	X	X	
Institute of Transportation Engineers	X			X	X	X		X	
Transportation Research Board	X						X	X	
Testing Facilities				X		X	X	X	

Acquisition/Assistance:
The Connected and Automated Vehicles R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. Other program needs are met primarily through competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. The amount of funding available from other programs (e.g., ITS, Every Day Counts, etc.) will significantly affect the request for Highway Research and Development funds. Research activities conducted through the CAMP cooperative agreement require a 20% participant match.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA Connected and Automated Vehicles R&T program, and is funded as such. Additionally, some program outputs are advanced through the Every Day Counts initiative.

The program supports technology transfer through partnerships within FHWA and also between FHWA and external organizations. Within FHWA, the Office of Operations R&D is primarily responsible for conducting research that will provide innovations and products that will benefit stakeholders. The Office of Operations conducts application research and is also primarily responsible for recognizing opportunities to transfer technology and for conducting outreach that will allow stakeholders to understand and use the technology.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Connected and Automated Vehicles Operations R&T program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services to those agencies are also engaged. Many of the partnerships identified in the preceding table represent opportunities for technology transfer, and FHWA engages these organizations and participates actively in outreach and communication activities that promote technology transfer of the innovations and research results of the program. Further leverage is provided through participation of FHWA Resource Center and, to a lesser extent, FHWA Division Office staff in the research and technology transfer activities. These offices assist the State and local agencies with carrying out the Federal Aid program and are often at the front line in making State partners aware of new innovations from FHWA research. The "Operations Discipline" is the FHWA's primary mechanism for keeping field staff up to date on trends and research outcomes. The Discipline hosts monthly internal webinars and newsletters, and promotes internal networking for information sharing and tech transfer. It holds an in person all hands conference every three years as intensive training for field staff and a boot camp for new employees. The FHWA Office of Operations and Resource Center share responsibility for managing the Operations Discipline. FHWA's National Dialogue on Highway Automation is a special opportunity that will allow FHWA to gather information from a broad group of stakeholders, to facilitate information sharing, inform the update of institutional structures for working with stakeholders, and raise awareness of FHWA activities in automation.

The program's outputs take the form of:

- Research and practitioner publications
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by relevant standard setting organizations
- New and/or updated technical guidance
- Technology demonstrations
- Provision of software and data from research activities
- Technical assistance
- Training courses
- Webinars
- Workshops

Key 2019 FHWA Connected and Automated Vehicles R&T Program Outputs.

Program Objective	**Key 2019 Outputs**
Extend the National Dialogue to facilitate continuing collaboration on how challenges can be addresses from both the roadway and automation sides and foster establishment of a longer-term mechanism to support this ongoing interaction.	• Development of the Draft First Stage Concept of Operations • Completion of the Testing and Evaluation Framework • Identify continuing National Dialogue organizational structure, members, and charter • Identification of prototype techniques and methods to mimic roadway and ADS joint capability testing
Understand how increasing deployment of automated vehicles, and their interaction with driven vehicles in mixed traffic, will affect the operation of traffic signals and other traffic management systems, and impact interactions with law enforcement and first responder traffic incident management activities. Develop and enhance vehicle, roadway, and operations data and models to help incorporate automated driving capabilities and so allow state and local governments to effectively use them.	DAS vehicle performance characteristics will be understood, and will enable a better understanding by state DOT's of system-wide impacts of these vehicle capabilities on overall transportation system performance and operations, with early results by 2018.
Develop, test, and demonstrate evolving automated driving technologies, particularly those that provide public as well as private real-world benefits in the near term. Develop new traffic management technologies and applications to leverage cooperative automated driving systems. Encourage automated driving system providers to develop commercial products that work well with roadways and other infrastructure assets.	Algorithms, software, test data, and test results for applications of Signalized Intersection Approach and Departure, Speed Harmonization, incident and emergency response, Light vehicle and truck platooning will be available to other researchers, automotive OEM's and other industry partners to guide continuing development and commercialization of these Level 1 DAS's by 2019.
Develop and enhance vehicle, roadway, and operations data and models to help incorporate automated driving capabilities and so allow state and local governments to effectively use them. Assist infrastructure owner-operators to recognize the potential opportunities, and risks, of automated driving systems and provide guidance so they can leverage them successfully.	Traffic models capable of incorporating DAS's, including Cooperative DAS's, will be validated and available for use by state DOT's and other agencies to enable data driven, performance based investments and decision-making by 2020.
Develop and enhance vehicle, roadway, and operations data and models to help incorporate	Case studies using improved traffic models that illustrate how Cooperative DAS's can

automated driving capabilities and so allow state and local governments to effectively use them. Develop and enhance vehicle, roadway, and operations data and models to help incorporate automated driving capabilities and so allow state and local governments to effectively use them.	be deployed to improve mobility and what public benefits can be expected will be available to state DOT's, automotive OEM's, and other possible users by 2020.
Understand the issues, challenges, and opportunities that need to be addressed to transition existing roadway capabilities to facilitate the safe and efficient operation of both human driven vehicles, other road users, and ADS on our nation's roads.	DAS's relationship to operations and infrastructure will be understood and will enable initial deployment readiness best practices and guidance, including possible changes to FHWA's Manual on Uniform Traffic Control Devices, by 2022.
Understand the issues, challenges, and opportunities that need to be addressed to transition existing roadway capabilities to facilitate the safe and efficient operation of both human driven vehicles, other road users, and ADS on our nation's roads.	• Development of the Draft First Stage Concept of Operations • Traffic regulation database including code data format and structure • Identify critical Interaction Scenarios • Understand testing and evaluations needs via the Testing and Evaluation framework

Identify and plan for joint testing and evaluation that will enable joint understanding and a collaborative vision for the near-term to long-term evolution of automation development and deployment.	• Development of the Draft First Stage Concept of Operations • Completion of the Testing and Evaluation Framework • Identification of prototype techniques and methods to mimic roadway and ADS joint capability testing
Improve the active management and control of traffic and operation of TMSs and TMCs by sharing, integrating, and using data with travelers using connected devices, CAVs, and other sources.	• Conduct prototype test to evaluate sharing connected device data with CVs, traffic management systems, and integration into traffic operational plans (D2X Hub Phase 2). • Support publishing and integration of FHWA's interests into the USDOT's Version 3.0 Connected Automation Guidance. • Initiation and support of the Cooperative Automated Transportation Coalition activities (Phase 2) completing the transition from the Vehicle to Infrastructure Coalition (Phase 1).
Enable agencies to develop and deploy the next generation of TMSs and TMCs by exploring, developing, testing, and providing tools and resources.	Develop technical guidance and outreach material for the next generation traffic management system & TMCs.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are essential for it to effectively reflect and represent the program's content and accomplishments.

Evaluation / Performance Measurement:
The Connected and Automated Vehicle program aligns most closely with Strategic Objective 1, Development of Innovation. Relevant Performance Goals include:

- Increase Dissemination of DOT-Funded Research Reports: Research reports are distributed after a publication and acceptance process described in FHWA's R&D Communications Reference Guide at https://www.fhwa.dot.gov/publications/research/general/15058/. Copies of publications are sent to the GPO, Library of Congress, NARA, the National Technical Information Service, and FHWA's Research Library. Printed copies of reports are also distributed on a case-by-case basis at relevant conferences that draw interested technical researchers and industry. FHWA also posts reports to the web and offers an RSS Feed as well at https://www.fhwa.dot.gov/research/whatsnew/tfhrcrss.xml#.

- Increase Production of Tangible DOT-Funded Research Outputs: The projects identified for this program include many research outputs that were listed in the Table above. When developing work plans for individual projects, staff routinely look for opportunities to receive interim deliverables before the project is completed.

- Increase Technology Transfer Activity: The program outputs identified in the above Table include many examples of technology transfer to researchers and practitioners. Some examples include the algorithms, software, test data, and test results for applications of light vehicle and truck platooning that will be available to other researchers, automotive OEM's, and other industry partners to guide continuing development and commercialization. Simulation models that are being refined and extended to address the performance of ADSs will also be validated and available for use by State DOT's and other agencies. Case studies of ADS strategies will also be shared with the Connected Vehicle Pooled Fund Study, among others, who have already been engaged in the selection of cases that will be most of interest to them.

Program performance is assessed primarily based on project milestones. These include the delivery of traffic models and algorithms, software, test data, and test results for proof-of-concept tests of automated vehicle applications. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the operations leadership, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances.

Outputs of this program will assist State and local highway agencies in understanding the impacts of automated vehicles and opportunities to leverage these technologies to improve transportation operations in the future.

Managing Disruptions to Operations
$2,730,000

Program Description/Activities:
Disruptions to transportation system operations, including those that occur at any given time on every given day (e.g., work zones, traffic incidents, planned events, adverse weather) as well as those that occur over longer time horizons (e.g., extreme weather events), have significant personal and economic consequences, and present huge demands on system owners and operators. They account for about half of all the delays, lead to an unreliable system, and contribute to many crashes. Public agencies are responsible for managing the system, especially under these disruptive conditions. They aren't able to wait for the impact to occur and then act, they must be proactive, and doing so requires the deployment of extensive technologies and operational strategies. In addition, these demands are on a path to increase as connected and automated vehicles are deployed, since it is under these disruptive conditions that they face the most difficult operational challenges.

Despite all the challenges that this dynamic environment creates, public agencies continue to make great advancements to minimize these impacts, especially in the form of proactive management strategies (e.g., decision support systems) and enhanced institutional capabilities. FHWA and its partners are uniquely positioned and play a pivotal role in the development, test, and evaluation of these systems and strategies, as well as through tireless knowledge and technology transfer efforts that enable these operating agencies to improve both their performance and the performance of the transportation system as a whole (i.e., in coordination with the private sector). While some of these products are mature, and require only minimal resources to maintain currency, others are still amid development and require significant levels of funding (e.g., the Integrated Model for Road Condition Prediction that integrates weather, work zone, traffic and incident models to predict road conditions hours into the future). New research and development needs will emerge as the vehicle fleet changes. And the need for extensive coordination across external partners (e.g., the various incident management disciplines), as well as the need for the aforementioned knowledge and technology transfer materials, are expected to continue for the foreseeable future in order to maintain current or improved level of system efficiency. Work is also needed to account for both long-term and catastrophic impacts, ensuring the system is resilient to impacts such as the increasingly common extreme weather events, cybersecurity threats, and natural disasters.

The scope of the program is broad, starting with applied research (from concept development to field testing and evaluation) and continuing through all the training, outreach and coordination necessary to ensure successful implementation by the operating agencies. The work is done through extensive coordination between the Office of Operations, the ITS Joint Program Office, the Office of Operations R&D, as well as with the Office of Safety, the Office of Infrastructure, and the Office of Safety R&D. Work on climate resilience is done in close coordination with the Office of Environment, Planning and Realty, and the Office of Policy.

Managing Disruptions to Operations focuses on those operating conditions that present distinct challenges to our public-sector partners (especially State DOTs). This work is closely coordinated with other research and technology priorities. Continuous and extensive collaboration across offices ensures that the efforts complement each other and there is no duplication. In particular, this work ties to the following cross-cutting priorities:

- Non-recurring events present the most challenging environments under which automated vehicles travel. Work under this program will both inform and learn from the research conducted in this cross-cutting area. In addition, this work will help to better understand any new requirements that automated vehicles may put upon the system and the system owners (e.g., special pavement markings through work zones). The challenges and opportunities for the incident responder community is unknown at this point but warrants responder-focused research.
- The data needs surrounding these non-recurring events go above and beyond the standard elements, and consequently require targeted resources to identify these unique data types, determine how to collect and process the data to make it useful, and how to use the data to better predict how these disruptions will affect highway operations (and, by extension, how transportation system operators can use them to better manage the system.) Data collection, crowd sourcing, and big data work already underway reflect the potential for significant opportunities for more efficient incident mitigation, weather events, and work zones through real time and predictive decision-making. There is also strong potential in using data to interact with vehicles during disruptions.
- The efforts to be conducted under this program area will achieve both safety and efficiency goals as the two are inextricably linked. In addition, the program will address longer-range resiliency issues as they pertain to operations and maintenance. To date, resource materials have been developed to introduce operating agencies to the concepts of climate resilience, and work will continue to inform them on actions they can take to better prepare for these types of disruptions.

<u>Safety, Durability and Resiliency of Transportation Systems</u>

There are some program dependencies and ongoing research:

- The amount of funding available from other programs (e.g., ITS, Every Day Counts, etc.) will significantly affect the request for Highway Research and Development funds.
- The extent to which connected and automated vehicles put new demands on the operating and responder agencies, particularly under disruptive conditions (i.e., through work zones, during incidents, under adverse weather) will drive the need for new approaches to effective management of non-recurring events.
- The availability of open data from connected and automated vehicles will significantly affect the success of advanced management tools.
- The willingness and ability of public agencies to share data (e.g., work zone activity data, road weather data, and crash data) will significantly affect the success of advanced management tools.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The following statutory requirements apply:

- The program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve **highway safety**, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, **reducing congestion**, and enhancing freight productivity, among others.

- This program supports implementation of other statutory mandates, specifically, Work Zone Safety and Mobility Rule (23 CFR 630 Subpart J), the Temporary Traffic Control Devices Rule (23 CFR 630 Subpart K), and the National Performance Management Measures (23 CFR 490).
- The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is the national standard for traffic control devices on any street, highway, bikeway, or private road open to public travel, in accordance with 23 U.S.C. §§ 109(d) and 402(a). It is incorporated by reference in 23 CFR Part 655, Subpart F. The MUTCD is administered by FHWA, which issues revisions and updated editions through the Federal rulemaking process. The last edition was published in 2009, with two revisions in 2012.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Managing Disruptions to Operations R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Managing Disruptions to Operations Program contributes to highway safety by providing tools, technologies/devices, resources, and training to minimize safety impacts (crashes, fatalities, injuries) of road construction, adverse weather, and traffic incidents on all road users including highway workers and emergency responders. The Manual on Uniform Traffic Control Devices improves safety by ensuring consistent use of traffic control devices in a way that accommodates road user expectancy.

Infrastructure/Improving Infrastructure: The Managing Disruptions to Operations Program supports this goal by ensuring impact of these disruptions are appropriately considered during life cycle cost analysis and other infrastructure investment analysis and decisions. Rebuilding our infrastructure, including traffic control devices, must be done in a manner that minimizes the impacts to those who rely on the system every day. This program area finds that balance between reconstruction, safety, and mobility.

Innovation: The Managing Disruptions on Operations Program supports this goal by undertaking research and development in the areas of automated and connected vehicles; data driven technologies and decision-making; experimentation of novel traffic control devices, and safety, durability, and resiliency of transportation systems. This effort is vital to improving the state-of-the-practice and mitigating impacts resulting from road construction, adverse weather, and traffic incidents.

Improving Mobility/Preserving the Environment: The Managing Disruptions on Operations Program contributes to improved mobility and ensuring the network is resilient by reducing duration and frequency of roadwork; effectively/consistently using traffic control devices;

restoring roadway capacity and thus minimizing traffic delays, fuel usage, and emissions; and reducing the use of treatment materials for snow and ice control.

Program Objectives:

- Understanding the operational impacts of these disruptions enables the development of predictive and real-time decision support systems that facilitate proactive operations and maintenance.
- Comprehending the opportunities that connected and automated vehicles present to better manage disruptive events (e.g., using connected vehicle data to track vehicles through work zones or using automated vehicle data to feed into block-level road weather forecasting), as well as to inform system owners of the actions they need to take to enable these vehicles to navigate through these difficult environments.
- Ensuring coordination across all the agencies that play a part in roadway safety and mobility (DOTs, law enforcement, fire, emergency medical services (EMS), etc.)
- Building the capability and capacity of operating agencies to optimize safety and system performance through the implementation of the capability maturity models for disruptive events.
- Be aware of the most effective messages to disseminate to the traveling public to educate and ultimately change driver behavior under these disruptive events.

Key FY19 program activities are identified below.

Activity	Period of Performance	Partners/Notes
Road Weather Management		
Develop tools and strategies to enable more effective system management under adverse weather, including analysis and use of road weather data, standards, and weather-responsive decision support tools that build upon vehicle-based technology advancements and effectively change driver/operator behavior	2019-2022	Intelligent Transportation Systems Joint Program Office (ITS JPO), American Association of State Highway and Transportation Officials (AASHTO)/State DOTs, private sector
Develop and measure performance standards for road weather management, including strategies that consider resilience and longer-range changes in weather patterns	2019-2022	AASHTO/State DOTs, private sector
Conduct targeted outreach and technology transfer of Road Weather Management products (e.g., performance management tool, vehicle data translator, integrated modeling for road condition prediction, etc.) through Every Day Counts 5, Capability Maturity Framework workshops, stakeholder meetings, etc.	Ongoing	ITS JPO

Traffic Incident and Event Management		
Use multi-discipline responder crash data, and integrate it with emerging connected and automated vehicle and other technologies (e.g., integrated Computer Aided Dispatch) to meet responders' needs and improve incident response	2019-2020	State DOT's, private sector, International Association of Chiefs of Police, Federal Law Enforcement Training Center (DHS), Public safety community
Promote continued deployment of state and local traffic incident management (TIM) programs including extensive coordination across the TIM community	Ongoing	State DOT's, Metropolitan, Planning Organizations, Towing and Recovering Association of America, Public safety community
Work Zone Management (WZM)		
Advance work zone management strategies and improve traffic models that incorporate vehicle-based technology advancements and data driven decision-making	2019-2022	AASHTO/State DOTs, private sector
Manage work zone grants to ensure products are effective and meet stakeholders' needs	2017-2021	American Road and Transportation Builders Association (ARTBA), American Traffic Safety Services Association (ATSSA), academic community
Advance WZM state-of-the-practice through a range of stakeholder engagement activities that focus on gaps in implementation (e.g., state-specific Capability Maturity Framework and targeted engagement workshops, process reviews, regional round tables, etc.)	Ongoing	AASHTO/State DOTs, private sector

Research Collaboration Partners:

The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance
- Delivers a clear public benefit and occurs where private sector investment is less than optimal
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently
- Meets and addresses current or emerging needs
- Addresses current gaps in research
- Presents the best means to align resources with multiyear plans and priorities
- Offers the best means to support Federal policy goals compared to other policy alternatives

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Benefits of Partnership and Partner Contributions to FHWA Managing Disruptions to Operations R&T Program.

Partner Organization	User Perspective on	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or	Donation of Material or	Funding
American Association of State Highway and Transportation Officials (AASHTO)	x		x		x				
American Road and Transportation Builders Association (ARTBA)		x			x				
American Traffic Safety Services Association (ATSSA)		x			x				
State DOTs	x			x	x				x
International Association of Chiefs of Police (IACP)	x	x		x	x		x		
Towing and Recovery Association of America (TRAA)	x	x			x		x		
National Ocean and Atmospheric Administration (NOAA)					x	x			
National Volunteer Fire Council (NVFC)	x	x			x				
Transportation Research Board (TRB)	x					x			
American Public Works Association (APWA)	x	x		x	x	x	x		
Institute of Transportation Engineers (ITE)	x	x	x		x	x	x		
American Trucking Associations (ATA)	x	x			x	x	x		
Owner Operator Independent Drivers Association (OOIDA)	x	x			x	x	x		
American Meteorological Society (AMS)	x	x					x		
National Weather Association (NWA)	x						x		
National Transportation Safety Board (NTSB)	x						x		
Occupational Safety and Health Administration (OSHA, within Department of Labor)	x						x		
Society of Automotive Engineers (SAE International)	x	x				x	x		

Acquisition/Assistance:
The Managing Disruptions to Operations R&T program primarily uses private sector (contractors, associations, etc.) to support research, development, and deployment activities and makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. Other program needs are met primarily through competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. Much of the applied research is complex and requires several years to complete, so multi-year acquisitions are utilized to maintain continuity. Other efforts are shorter in duration, so single year acquisitions are sufficient. This program leverages non-Federal funds by requiring 20% match funding for work zone safety related grants.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA Managing Disruptions to Operations R&T program, and is funded as such. Additionally, some program outputs are advanced through the Every Day Counts initiative.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Managing Disruptions to Operations R&T program, such that their personnel are the primary audience for the program's research outputs. We also engage consultants and contractors providing services to those agencies. The breadth of partners with whom we work is captured in the table above. However, since state and local highway agencies are often our primary stakeholders, they are the target audience for most of our activities. We engage with them directly or through organizations such as the American Association of State Highway and Transportation Officials (AASHTO) and the Local Technology Assistance Program (LTAP). FHWA staff from headquarters, the Resource Center and the Division Offices work with our partners in a variety of ways, such as executing field tests, conducting peer exchanges and demonstration site visits, and providing technical assistance to assist with their deployments. In addition to the list of outputs below, we conduct multiple stakeholder meetings each year. This consists of "virtual" regional meetings where we bring together state partners from a region and facilitate a discuss that encourages them to share their successes and lessons learned with their colleagues. We also conduct in-person meetings that bring both public and private sector entities together to learn from each other. These meetings have proven to be an invaluable way to shorten implementation schedules and avoid costly mistakes by the deploying agencies.

The program's outputs take the form of:

- Research and practitioner publications;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by relevant standard setting organizations;
- New and/or updated technical resource;
- Technical assistance;
- Training courses;
- Webinars;
- Workshops and peer exchanges.

We measure performance by conducting a variety of performance assessments. This consists of annual self-assessments, where the practitioners evaluate their level of implementation and we are then able to measure changes over the years. It also consists of evaluations that we conduct

biennially to determine the extent to which our state partners are implementing new solutions that come out of our programs. Under the Every Day Counts program, the Division Offices work closely with their state partners to enter their implementation progress into a formal tracking system. This provides an easy way to assess the extent to which they adopt the specific solutions being promoted under that program.

Key 2019 FHWA Managing Disruptions to Operations R&T Program Outputs.

Program Objective	**Key 2019 Outputs**
Understanding the operational impacts of these disruptions to enable the development of management strategies, and to enable the development of integrated predictive and real time models that feed into decision support systems	Open source software of decision support systems and other system components. • Vehicle Data Translator to optimize use of connected vehicle data • Integrated Model for Road Condition Prediction
Understanding the opportunities that connected and automated vehicles present to better manage disruptive events (e.g., using connected vehicle data to track vehicles through work zones or using automated vehicle data to feed into block-level road weather forecasting)	• Enhanced traffic models and simulation tools specific to disruptive conditions such as work zones, incidents, and weather • Performance management tools to help FHWA determine the effectiveness of their programs as well as for the operating agencies to determine the value of their deployments • Data sharing strategies and standards to maintain situational awareness under disruptive conditions
Ensuring coordination across all the agencies that play a part in roadway safety and mobility (DOTs, law enforcement, fire, EMS, etc.)	• Data standards (e.g., for work zones, traffic incidents) • National Work Zone Safety Awareness Week • National Traffic Incident Response Awareness Week
Building the capability and capacity of operating agencies to optimize safety and system performance through knowledge and technology transfer, implementation of performance management systems and the capability maturity models for disruptive events.	• Training platform for Traffic Incident Management • Knowledge and Technology Transfer materials across all types of system disruptions
Understanding the most effective messages to disseminate to the traveling public to educate and ultimately change driver behavior under these disruptive events.	Resources to public and private sector information providers on optimal messages for travelers

The program is represented in the DOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the DOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments.

Evaluation / Performance Measurement:
This program directly supports both the Infrastructure and Innovation goals of the 2019-2022 FHWA Strategic Plan. This outputs from this program of managing disruptions to operations enables our state partners to keep the system running, which directly supports Strategic Objective 3 regarding mobility and reliability. If the system shuts down because of an incident or adverse weather, then it's not reliable. This program enables the deployment of solutions that keep it reliable even under the most challenging environments. Likewise, it is disruptive events such as work zones that present the biggest challenges to innovative solutions such as automated vehicles. Therefore, the results of this program are essential to achieving Strategic Objective 4.

Program performance is assessed primarily based on project milestones and statistics (where available) such as crashes, improvement in mobility/level of service, partners' use of advanced management strategies (e.g., decision support systems). Biennial assessments are conducted on public partners' advancements. Project milestones are included and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the operations leadership, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Any performance statistics such as number of crashes due to disruptions in operations are considered in this evaluation. Outputs of this program will assist State and local highway agencies in more effectively managing their performance.

Freight Management and Operations RD&T
$3,400,000

Program Description/Activities:
Highway reliability affects our ability to visit family, get to work, deliver products to customers, live our lives, and grow the economy. FHWA's Office of Operations Freight Management and Operations Research, Development and Technology (RD&T) Program is developing innovative technology and processes that lead to system-wide improvements in how FHWA and its State and local partners and other stakeholders manage and increase the reliability of the National Highway System and the movement of people and goods throughout the transportation networks.

These innovations target the daily operations of transportation agencies and other stakeholders, and their planning for operations. Freight Management and Operations RD&T Research areas include performance management, efficient goods movement that enable freight to move where and when it needs to go, active transportation and demand management strategies, resources for transportation management for scheduled or unscheduled events, and improved traffic analysis techniques. Research into new technologies and noteworthy management practices provides State and local agencies and other operations and freight entities with additional tools to implement the institutional changes that will allow them to meet operational challenges.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topics to improve highway safety and infrastructure integrity, strengthen transportation planning and environmental decision-making, reduce congestion, and enhance freight productivity, among others.

In addition, the Fixing America's Surface Transportation (FAST) Act established a National Highway Freight Program (NHFP) (FAST Act § 8001: 23 U.S.C. 167) along with a National Highway Freight Network (NHFN).

The FAST Act includes several provisions to improve the condition and performance of the national freight network and to support investment in freight-related surface transportation projects, including:

- Establish a National Freight Strategic Plan [49 U.S.C. 70102] in consultation with State DOTs, MPOs, and other appropriate public and private transportation stakeholders.
- Establish a National Multimodal Freight Network [FAST Act § 8001: 49 U.S.C. 70103], to assess and support Federal investments to achieve the goals of the National Multimodal Freight Policy established in 49 U.S.C. 70101 and of the National Highway Freight Program described in 23 U.S.C. 167.
- Develop transportation investment data and planning tools [FAST Act § 8001: 49 U.S.C. 70203], which calls for stakeholder engaged efforts to: 1) develop new tools and improve existing tools to support evaluation of freight-related projects, 2) identify model freight data elements to support evaluation methods in making transportation investment decision, and 3) improve existing freight flow data collection efforts to reduce data gaps and improve forecasts of freight demand.

- Develop a freight conditions and performance report [FAST Act § 1116; 23 U.S.C. 167(h)], which continues the requirement for DOT to provide Congress with a biennial report on the condition and performance of the National Highway Freight Network.

The Freight Management and Operations RD&T Program supports FAST Act goals and requirements associated with the NHFP and national policy related to the condition, safety, security, efficiency, productivity, resiliency, and reliability of the National Multimodal Freight Network.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure
Innovation	Improving mobility

Infrastructure: The Freight Management and Operations RD&T Program seeks to improve the physical components of the highway system that support goods movement, including roads, bridges, pavement, parking facilities, and other components. These objectives seek to better understand how freight movement impacts—and is impacted by—this infrastructure.

The Freight Management and Operations RD&T Program also seeks to assess the condition and performance of key freight infrastructure, and to provide resources that permits States and other stakeholders to incorporate freight infrastructure improvement projects into transportation program delivery. Objectives include ensuring safe, durable, and high performing infrastructure, as well as identify solutions to mitigate or address the impacts of freight transportation.

Innovation: The Freight Management and Operations RD&T Program seeks to improve the reliability of travel and freight movement on the Nation's transportation systems by working with State DOTs and other stakeholders to identify data sources and models to assess overall system reliability.

The Freight Management and Operations RD&T Program seeks to improve the ability to measure current and future conditions and operation of the freight transportation network through the incorporation of more accurate, real-time, and localized freight data. These activities include improvements to:

- data collection methodologies (e.g., data sharing collaboration with industry and dynamic freight data collection and analysis)
- travel demand models (e.g., incorporating urban and rural freight movements and improvements to the accuracy and scale of the freight flows along the transportation network)
- strategies to facilitate public-private sector data coordination and sharing (e.g., facilitating peer exchanges and stakeholder outreach)

- freight-focused performance measures (e.g., incorporating reliability, economic impacts/costs, etc.)

The Freight Management and Operations RD&T Program will also enhance freight data resources, such as the Freight Analysis Framework (FAF), which provide national level freight flows and projections critical to understanding the impact of freight movement on the transportation network.

Program Objectives:
Moving goods safely and efficiently requires strategically located, adequate, and physically sound infrastructure. Within DOT, FHWA is aiming to promote a performance-based approach to transportation project delivery and management. The Freight Management and Operations RD&T Program addresses multiple needs both for DOT and for external stakeholders and leads to enhanced freight data and models that facilitate performance-based, data-driven analysis and decision-making, helping stakeholders more effectively incorporate freight infrastructure considerations into transportation planning and project development.

The objectives of the Freight Management and Operations RD&T Program include:
- Assessing the condition and performance of key freight infrastructure.
- Improving the understanding of the impact of freight movement on this infrastructure and vice versa.
- Developing and improving freight data analytical tools and data collection techniques and standards, and industry data analysis methods
- Convening stakeholder forums and outreach, peer exchanges, pilot implementations, and technology transfer to help ensure safe, durable, and high performing infrastructure.

These include initiatives focused on:
- Improving the representation of supply chain information into freight planning and modeling, by incorporating, industry dynamics, economic impacts, and commodities moved.
- Enhancing the integration, standards, and consistency among public and private multimodal freight data sources, including accessing more timely freight movement data to accurately represent dynamic freight movements on the transportation network.
- Improving the understanding of local, regional, and national freight flows, including enhancements to the Freight Analysis Framework, through a better understanding of freight data limitations and private industry constraints.
- Understanding how freight flows impact the condition and performance of the transportation system and help support transportation performance management requirements and system planning research.
- Identifying needs and demands for improved freight infrastructure, including truck parking, critical urban and rural intermodal connectors, alternative routes and redundant facilities.

Key FY19 FHWA Freight Management and Operations R&T Program Activities.

Activity	Period of Performance	Partners/Notes
Industry Supply Chain and Economics Impacts	2016-2019	TRB/SHRP2
Freight Movement Data Integration	2015-2023	BTS
Freight Flow Model Improvements	2015-2023	TRB/SHRP2
Freight System Conditions and Performance Management	2016-2021	Offices of Operations and Infrastructure (HOTM and HIF)
Freight Infrastructure Needs Identification and Analysis	2016-2021	Office of Planning (HEPP)

Research Collaboration Partners:
Operations and freight programs have developed internal and external stakeholder groups or leveraged stakeholder associations to engage the various transportation and program area communities and modal partners in gathering input through methods such as in-person meetings, peer exchanges, virtual meetings, or web-based events. Examples of these collaboration initiatives are: DOT policy and ongoing research to help inform the Freight Management and Operations RD&T Program. For example, the draft National Freight Strategic Plan (NFSP) documented the need for improved freight infrastructure to ensure efficient, safe, and reliable goods movement. The NFSP calls for research to review and evaluate the condition of National Highway System (NHS), Outside DOT, related research efforts include National Cooperative Freight/Highway Research Program (NCF/HRP).

- Ongoing USDOT research in this area includes continuation of Exploratory Advanced Research (EAR) Projects, as well as several efforts focused on freight performance measures and innovations in freight data collection, analysis, and dissemination.
- FHWA is also supporting follow-up activities to improve the utility of freight data and behavior based freight modeling innovations and effective practices as part of the Second Strategic Highway Research Program (SHRP2) C20 suite of products.
- The Freight Operations RD&T Program builds on current and future research to improve the Freight Analysis Framework (FAF) in coordination with US DOT Bureau of Transportation Statistics (BTS). It also incorporates new approaches to economic and supply chain effects as identified from the SHRP2 C20 product and the FHWA Freight Fluidity initiative.
- Other USDOT research includes work to develop new, nationally focused port performance data and metrics as part of the BTS Port Performance Freight Statistics Program (PPFSP). The PPFSP is a FAST Act requirement and involves producing an annual report.
- The Multimodal National Freight and Passenger Analysis and Modeling Program is a joint effort between the FHWA Offices of Operations, Planning, and Policy (HOFM, HEPP, and HPPI). This program has three key components: passenger data, freight data, and network data. The passenger data component is part of the Office of Policy's overall support data program. Freight data is carried out by the Office of Operations' Freight Management and

Operations Office. The multimodal routable network, which enables integrated analysis will be developed by the Office of Planning.

- The Performance Management Data Program (PMDP) is a joint effort with the Office of Infrastructure (HISM). It provides States and MPOs assistance (project planning and performance measurement requirements), completing the analytical elements of the State Freight Plans, and undertaking performance management and system planning. These include the Freight Analysis Framework (FAF), the Fluidity Analysis and Supply Chain and Cost Surveys, and data for Domestic Transport of International Trade.
- FHWA is conducting ongoing research to update a 2015 Jason's Law truck parking survey/analysis to better understand where truck parking shortages exist and tactics to address these shortages. Specifically, Jason's Law requires the US DOT to conduct a survey and comparative assessment in consultation with relevant State motor carrier representatives to 1) evaluate the capability of [each] State to provide adequate parking and rest facilities for commercial motor vehicles engaged in interstate transportation; 2) Assess the volume of commercial motor vehicle traffic in [each] State; and 3) Develop a system of metrics to measure the adequacy of commercial motor vehicle parking facilities in each State. An update of the Jason's Law Survey is expected in 2018.

Benefits of Partnership and Partner Contributions to FHWA Freight Management and Operations R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Deployment	Research Collaboration	Specialized Expertise or	Funding
American Association of State Highway and Transportation Officials (AASHTO)	X			X		X
State Departments of Transportation	X		X	X	X	X
Metropolitan Planning Organizations (MPOs)	X		X	X		
Research and Educational Institutions, such as Massachusetts Institute of Technology (MIT), Texas A&M Transportation Institute (TTI), Oak Ridge National Laboratories, etc.			X	X		
Transportation Research Board (TRB)			X	X		
Trade Corridors Coalitions, such as I-95 Corridor Coalition, North America's Corridor Coalition (NASCO)	X	X	X	X	X	X
American Trucking Associations (ATA), including American Transportation Research Institute (ATRI)	X	X	X	X	X	
Owner-Operator Independent Driver Association (OOIDA)	X	X		X	X	
National Association of Truck Stop Operators (NATSO)	X	X		X	X	
Commercial Vehicle Safety Alliance (CVSA)	X	X		X	X	

Other DOT partners, including Bureau of Transportation Statistics (BTS), Maritime Administration (MARAD), Federal Motor Carrier Administration (FMCSA), Federal Railroad Administration (FRA), etc.	X	X	X	X	X	X
Department of Commerce (including U.S. Census)	X			X	X	
Department of Agriculture	X			X	X	
Department of Energy	X			X	X	

Acquisition/Assistance:
The Freight Management and Operations R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. Other program needs are met through Blanket Purchase Agreements, competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate.

The Freight Management and Operations R&T Program acquisitions are most often multi-year acquisitions, funded over several fiscal years. Single year contracts, or multi-year contracts fully funded in the year of award, are occasionally used for projects and activities of limited scope.

"Sole source" acquisitions through the Freight Management and Operations R&T Program are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. For example, FHWA awarded Caliper Corporation a sole source contract to develop methods and tools to perform the Freight Analysis Framework Version 4 (FAF4) National Truck Assignment Process. Caliper possesses a unique expertise in network assignment research and development, devising new methods to perform network assignment, and software implementation needed for this project. Since 1997, FHWA FAF network assignment process is maintained in TransCAD software developed by Caliper and competing to other offerors to perform the assignment development activities required for FAF would result in substantial duplication that would not likely be recovered through competition.

Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies. For example, the Freight Management and Operations R&T Program participates in the Transportation Pooled Fund (TPF) Program. The TPF Program is intended to address a new area of research, planning, and technology innovation or to provide information that will compliment or advance previous efforts in these areas. An example of FHWA participation in a TPF study is the Institute for Trade and Transportation Studies (ITTS). Members of the TPF Program include Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Puerto Rico, Tennessee, Texas, Virginia, and West Virginia. The effort was funded through an FHWA Pooled Fund study using State Planning and Research (SPR) funds. The goals of ITTS are to help states develop their competitive advantages to capture trade opportunities and the associated economic benefits.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA Freight Management and Operations R&T program, and is funded as such.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Freight Management and Operations R&T program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The program's outputs may take the form of, but are not limited to:

- Research publications, including reports and technical notes
- New and/or updated technical resources
- Training courses and workshops
- Peer Exchanges
- Technical Assistance
- Webinars
- Workshops

Stakeholders are involved through the Freight Management and Operations R&T Program to maximize Technology Transfer and ensure success of transitioning research activities to program delivery. For example, State DOTs and MPOs are involved in working groups during the research phase, and are integral to ensuring research objectives are consistent with program delivery and outputs. For example, the Freight Fluidity initiative not only includes research institution partners, such as TTI, it also includes the IH95 Corridor Coalition, a coalition of State DOTs along the IH95 Corridor from Maine to Florida. These State DOTs will benefit from this research and put it to practical use. Activities in this Program also include extensive research on truck parking, including updating a national truck parking survey through Jason's Law, as well as research identified through the Truck Parking Coalition. Input from public and private sector stakeholders are critical throughout these activities. Not only are State DOTs and MPOs actively involved in this research, but also truck parking industry and advocacy groups, such as ATA, NATSO, CVSA, and OOIDA. Results from this research have been used as an input in state freight plans, resulting in additional planning, recommendations, and funding for truck parking initiatives. These activities, outcomes, and partnerships continue to build through this Program's activities.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	**Key 2019 Outputs**
Assess the condition and performance of key freight infrastructure.	Research national truck parking capacity, shortages, and needs through improved data collection methods, expanded stakeholder engagement, development of best practices, and publication of guidelines. Conduct ongoing research to update a 2015 Jason's Law truck parking survey/analysis to better understand where truck parking shortages exist and tactics to address these shortages. Develop freight specific report on the Status of the Nation's Highways, Bridges, and Transit: Conditions

	and Performance report to Congress (C&P report). (FY19). Continue Freight Performance Management (FPM) program, including implementation of MAP-21 freight performance -management and bottleneck identification and analysis requirements.
Improve the understanding of the impact of freight movement on the nation's highway infrastructure and vice versa.	Analyze the nation's urban and rural intermodal freight connectors through improved analytical tools, peer exchanges, and dissemination of best practices. Participate in development of the Infrastructure Resiliency Quantification Tool: Hampton Roads.
Develop and improve freight data analytical tools and data collection techniques and standards, and industry data analysis methods	Improved ability to conduct multi-modal measurement of freight flows. Continue maintenance of FAF Version 4 as well begin development of FAF Version 5 and associated enhancements, including the potential to include more granular detail and multi-modal networks. Improve understanding of how business transactional data could supplement or replace freight elements from probe data to measure performance and understand freight's relationship to the economy through innovations from the SHRP2 behavior based models and the FHWA Freight Fluidity initiative.
Incorporate stakeholder forums and outreach, peer exchanges, pilot implementations, and technology transfer to help ensure safe, durable, and high performing infrastructure.	Complete a synthesis of state freight plans to identify best practices, emerging issues, and freight corridors. Incorporate freight infrastructure planning, design, and project development into transportation program delivery, including identifying best practices.

Develop and improve freight data analytical tools and data collection techniques and standards, and industry data analysis methods	Improved ability to conduct multi-modal measurement of freight flows. Continue maintenance of FAF Version 4 as well begin development of FAF Version 5 and associated enhancements, including the potential to include more granular detail and multi-modal networks. Improve understanding of how business transactional data could supplement or replace freight elements from probe data to measure performance and understand freight's relationship to the economy through innovations from the SHRP2 behavior based models and the FHWA Freight Fluidity initiative.
Incorporate stakeholder forums and outreach, peer exchanges, pilot implementations, and technology transfer to help ensure safe, durable, and high performing infrastructure.	Complete a synthesis of state freight plans to identify best practices, emerging issues, and freight corridors. Incorporate freight infrastructure planning, design, and project development into transportation program delivery, including identifying best practices.

Evaluation / Performance Measurement:
Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Measures include quarterly program status meetings as well as regular tracking through the department Unit Plan. Program performance is assessed primarily based on project milestones. Outputs of this program will assist State and local highway agencies in more performance management.

The activities performed under the FHWA Freight Management and Operations R&T program support the Infrastructure goal identified in the US DOT Strategic Plan. For example, the performance goal for Strategic Objective 2: Life Cycle and Preventive Maintenance is "Improve conditions of America's Transportation-Related Infrastructure". This Program supports this strategic objective and performance objective through research focused on how freight flows impact the condition and performance of the transportation system and help support transportation performance management requirements and system planning. The activities under this program also identify the needs and demands for improved freight infrastructure, including truck parking, critical urban and rural intermodal connectors, alternative routes and redundant facilities.

In addition, this program supports Strategic Objective 3: System Operations and Performance and the performance goal: Alleviate urban congestion. Activities under this program that contribute to achieving this strategic objective include recognizing how freight flows impact the condition and performance of the transportation system and help support transportation performance management requirements and system planning research. This research also assists in improving the understanding of local, regional, and national freight flows, including enhancements to the

Freight Analysis Framework, through a better understanding of freight data limitations and private industry constraints, especially at the urban and metropolitan level.

Finally, this program supports Strategic Objective 4: Economic Competitiveness and Workforce and the performance goal: “Alleviate freight congestion”. Activities under this program improve the integration, standards, and consistency among public and private multimodal freight data sources, including accessing more timely freight movement data to accurately represent dynamic freight movements on the transportation network as well as continuing the Freight Performance Management (FPM) program, including implementation of MAP-21 freight performance - management and bottleneck identification and analysis requirements.

Truck Size and Weight RD&T Program
$1,100,000

Program Description/Activities:
The Truck Size and Weight (TSW) Research, Development and Technology (RD&T) Program will provide States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in harmonizing oversize and overweight (OS/OW) permitting requirements.

In addition, through the Truck Size and Weight RD&T Program, the FHWA Office of Operations (HOP) is assisting other FHWA Offices, including the Office of Highway Policy Studies (HPTS), Office of Infrastructure (HIAP and HIPT), who are conducting research to develop a pavement distress evaluation model and HPTS is currently developing tools for disaggregating vehicle miles travelled (VMT) based on vehicle classifications, vehicle weight groups, vehicle registered weight, and vehicle operation weights.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes, the program is statutorily mandated. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision making, reducing congestion, and enhancing freight productivity, among others.

Senate Report 115–138 (accompanying the FY 2018 Department of Transportation Appropriations Act) contained requirements for two new FHWA Reports to Congress about a Comprehensive Truck Size and Weight Research Plan. The Committee directs the Secretary to finalize the Research Plan within one calendar year of the enactment of this act, and to submit a report on the results of this effort to the House and Senate Committees on Appropriations within 30 days of completion. The Committee further directs the Secretary to submit a report on the status of this effort to the House and Senate Committees on Appropriations no later than 180 days after the enactment of this act.

In addition, Section 5502 of the Fixing America's Surface Transportation (FAST) Act requires the Department of Transportation to create an Emergency Route Working Group (ERWG). The research program area will carry out research related to the recommendations and advice the ERWG provides to the Secretary of Transportation on best practices for expeditious State approval of special permits for vehicles involved in emergency response and recovery.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

Infrastructure: The Truck Size and Weight RD&T Program addresses alternative truck configurations on the highway system and highway operations. Activities will include cost-benefit assessments of alternative truck configurations or OS/OW freight vehicles, and general analysis of alternative truck configuration impacts on freight infrastructure, safety, and operations.

The draft National Freight Strategic Plan (NFSP) provides important context for truck size and weight research. The NFSP acknowledges that lack of uniformity across State truck size and weight regulations may be a potential barrier to efficient freight movements. It also notes a need for truck size and weight research specifically to assess tradeoffs involved in raising weight limits or allowing longer combination trucks on national highways. Outside DOT, National Cooperative Highway Research Program (NCHRP) analyses have provided a foundation for this topic area. The Truck Size and Weight RD&T Program supports addressing these gaps in research and data.

Innovation: The Truck Size and Weight RD&T Program will provide States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in harmonizing OS/OW permitting requirements.

The Truck Size and Weight RD&T Program will support practitioners to plan for, prioritize, and implement projects that benefit goods movement. Truck Size and Weight RD&T Program activities include producing resource on what information is needed for analysis of freight vehicle size and weight, and examining methods for inventorying and applying these data.

Truck Size and Weight RD&T Program efforts aim to better understand the impacts of alternative truck configurations on freight infrastructure, safety, and operations, through data collection and development of data-driven tools and analytical techniques. Additionally, there is an effort to identify key TSW-related research needs relating to pavement, bridge, mode shift, safety, and enforcement. The combination of these activities will lead to improved technical and implementation resources for stakeholder decision-making and analysis.

Safety: Today, approximately 12 States require Pilot Car Certification. States use the guidelines developed through FHWA, to support their certification requirements; however, these requirements vary from state to state. As a result, pilot car operators in the U.S. have to navigate a complex web of requirements when making a multi-state move. FHWA research in this program area will support harmonization among states through collaboration with stakeholders on a framework for a national certification program for pilot car drivers escorting loads moving on oversize/overweight state and local permits. The outcome of this work will improve safety on the

national highways as well contribute to infrastructure preservation. Research actives will include research, review, and analysis of existing pilot/ escort vehicle operator (P/EVO) training materials, laws and rules relevant to P/EVOs, and case studies and other information focused on the movement of oversize loads.

Program Objectives:
The Truck Size and Weight RD&T Program will develop roadmaps and syntheses, improved analytical tools, resources, best practices, stakeholder forums and outreach, peer exchanges, and pilot implementations. The possibility of longer or heavier trucks on highways requires research on how these alternative truck configurations will affect freight operations, and vice versa. Research activities will also consider how to address increased freight demand.

Research is currently being led by the National Academy of Sciences (NAS) to develop a comprehensive truck size and weight limits (CTSWL) research plan as a follow-up action to the April 2016 "Truck Size and Weight Limits Study." The five topic areas (pavement, bridge, mode shift, safety; and enforcement) included in the 2016 Truck Size and Weight Limits Study will provide key focal areas for TSW research needs and activities, including the CTSWL research plan.

The Truck Size and Weight RD&T Program seeks to implement the highest priority elements of the CTSWL research plan. While these activities have not yet been determined, they would include research pertaining to the topic areas identified in the 2016 study. For example, activities could include: development of enhanced bridge deterioration models that can account for impacts of alternative truck configurations, development of more accurate models that States and others can use to identify impacts of heavy trucks on pavements, commodity analysis of truck types, and safety impact assessments.

The Truck Size and Weight RD&T Program seeks to analyze the impact of alternative truck configurations on the highway system and highway operations. Activities will include cost-benefit assessments of alternative truck configurations or OS/OW freight vehicles, and general analysis of alternative truck configuration impacts on freight infrastructure, safety, and operations.

The Truck Size and Weight RD&T Program seeks a better understanding of the operational, safety, and infrastructure impacts associated with allowing widespread use of twin-33 foot trailers configuration on the national network. This is spurred by recent (2015) legislation introduced in Congress to allow twin 33-foot trailers and 91,000 pound trucks on U.S. highways.

The Truck Size and Weight RD&T Program will seek to support practitioners to plan for, prioritize, and implement projects that benefit goods movement. Activities will include producing resources on what information is needed for analysis of freight vehicle size and weight, and examining methods for inventorying and applying these data.

Finally, the Truck Size and Weight RD&T Program will seek to provide States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in harmonizing OS/OW permitting requirements.

Key FY19 FHWA Vehicle Size and Weight R&T Program Activities.

Activity	Period of Performance	Partners/Notes
Implementation of Comprehensive Truck Size and Weight Limits (CTSWL) Research Roadmap	2016-2023	TRB
Analysis of Alternative Truck Configurations	2017-2023	While there are not specific partners envisioned for this research area; engaging stakeholders will be a key research element.
Analysis and Dissemination of Truck Size and Weight Data to Support Harmonization and Permitting Requirements and Pilot Car Escort Requirements	2018-2023	AASHTO, Industry Stakeholders, and State DOTs

Research Collaboration Partners:
The draft National Freight Strategic Plan (NFSP) provides important context for Truck Size and Weight RD&T Program. The NFSP acknowledges that lack of uniformity across State truck size and weight regulations may be a potential barrier to efficient freight movements. It also notes a need for TSW research specially to assess tradeoffs involved in raising weight limits or allowing longer combination trucks on national highways. Outside DOT, National Cooperative Highway Research Program (NCHRP) analyses have provided a foundation for this topic area.

A major Truck Size and Weight RD&T Program activity is the development of a CTSWL research roadmap, currently being developed by the National Academy of Science (NAS) to identify further data needs and a research roadmap spanning the five areas identified in the 2016 Study: pavement, bridge, mode shift, safety, and enforcement.

NAS is convening a series of expert panels to discuss the prioritized research needs and objectives. NAS will develop a synthesis document to summarize findings and the expert panels' discussions to articulate a set of problem statements, research activities and outcomes to address priorities among the five topic areas. This synthesis document would also include the list of prioritized research needs that incorporates experts' feedback.

Additionally, FHWA is conducting research on Twin 33-foot trailers, to better understand the operational, safety, and infrastructure impacts associated with allowing widespread use of this configuration on the national network.

Also, the FHWA Offices of HPTS, HIAP, and HIPT will be conducting research to develop a pavement distress evaluation model and HPTS is currently developing tools for disaggregating VMT based on vehicle classifications, vehicle weight groups, vehicle registered weight, and vehicle operation weights.

Truck platooning is being proposed by industry as a technology solution that could bring significant improvements to the cost and efficiency of highway freight movements. However, it has raised

concerns on the potential impact on pavements, bridges, and traffic operations. FHWA is collaborating with its DOT modal partners to develop a truck platooning research agenda that will be influenced by truck size and weight issues.

Benefits of Partnership and Partner Contributions to FHWA Vehicle Size and Weight R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Funding
American Association of State Highway and Transportation Officials (AASHTO)	X			X		X
State Departments of Transportation	X		X	X	X	X
Metropolitan Planning Organizations (MPOs)	X		X	X		
Research and Educational Institutions, such as Massachusetts Institute of Technology (MIT), Texas A&M Transportation Institute (TTI), Oak Ridge National Laboratories, etc.			X	X		
National Academy of Sciences (NAS)			X	X		
Trade Corridors Coalitions, such as I-95 Corridor Coalition, North America's Corridor Coalition (NASCO)	X	X	X	X	X	X
American Trucking Associations (ATA), including American Transportation Research Institute (ATRI)	X	X	X	X	X	
Owner-Operator Independent Driver Association (OOIDA)	X	X		X	X	
National Association of Truck Stop Operators (NATSO)	X	X		X	X	
Commercial Vehicle Safety Alliance (CVSA)	X	X		X	X	
Specialized Carriers and Rigger's Association	X	X		X	X	
Pilot Car Industry Stakeholders	X	X	X	X	X	
Other DOT partners, including Bureau of Transportation Statistics (BTS), Maritime Administration (MARAD), Federal Motor Carrier Administration (FMCSA), Federal Railroad Administration (FRA), etc.	X	X	X	X	X	X

Acquisition/Assistance:
The Freight Management and Operations R&T program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. Other program needs are met through Blanket Purchase Agreements, competitively procured IDIQ contracts, and small purchases. GSA schedule procurements are used where appropriate.

- "Sole source" acquisitions through the Freight Management and Operations R&T Program are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. For example, in 2017, FHWA awarded the NAS a sole source project to develop a CTSWL research plan. The NAS Transportation Research Board operates as an unbiased facilitator and investigator and forms and convenes independent expert committees focused on specific research topics. The products from the NAS must also undergo and independent peer review prior to delivery to FHWA.
- The Freight Management and Operations R&T Program acquisitions are most often multi-year acquisitions, funded over several fiscal years. Single year contracts, or multi-year contracts fully funded in the year of award are occasionally used for projects and activities of limited scope.
- Opportunities to leverage non-Federal funds are predominantly with State and Local highway agencies. For example, the Freight Management and Operations R&T Program participates in the Transportation Pooled Fund (TPF) Program. The TPF Program is intended to address a new area of research, planning, and technology innovation or to provide information that will compliment or advance previous efforts in these areas. An example of FHWA participation in a TPF study is the Institute for Trade and Transportation Studies (ITTS). Members of the TPF Program include Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Puerto Rico, Tennessee, Texas, Virginia, and West Virginia. The effort was funded through an FHWA Pooled Fund study using State Planning and Research (SPR) funds. The goals of ITTS is to help States develop their competitive advantages to capture trade opportunities and the associated economic benefits.

Technology Transfer (T2):
Technology transfer is an integral part of the FHWA Freight Management and Operations R&T program, and is funded as such.

State and local highway agencies are the primary stakeholders and beneficiaries of the FHWA Freight Management and Operations R&T program, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services (e.g., design, construction, inspection, etc.) to those agencies are also engaged.

The program's outputs take the form of:

- Research publications, including reports and technical notes
- New and/or updated technical resources
- Training courses
- Webinars
- Workshops

Stakeholders are involved through the Truck Size and Weight RD&T Program to maximize Technology Transfer and ensure success of transitioning research activities to program delivery. For example, State DOTs and MPOs are involved in working groups during the research phase, and are integral to ensuring research objectives are consistent with program delivery and outputs. For example, NCHRP analyses have provided a foundation for this activity, and this Program supports addressing these gaps in research and data through stakeholder input and outcome-based results. As part of the Implementation of CTWSL Research Roadmap, NAS is convening a series of expert panels from the public and private sector to discuss the prioritized research needs and objectives. NAS, with the assistance of this panel will develop a synthesis document to summarize findings and the expert panels' discussions to articulate a set of problem statements, research activities and outcomes to address priorities.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	**Key 2019 Outputs**
Implementation of Comprehensive Truck Size and Weight Limits (CTSWL) Research Roadmap	Implementation of the highest priority elements of the CTSWL Research Roadmap. These activities have not yet been determined.
Analysis of Alternative Truck Configurations	Better data collection techniques to assess large truck impacts and operations. Improved truck size and weight understanding through peer exchanges, development of best practices, publication of guidelines, and stakeholder outreach.
Analysis and Dissemination of Truck Size and Weight Data to Support Harmonization and Permitting Requirements	Improved understanding of enforcement and harmonization issues related to TSW through research studies, peer exchanges, and case studies. Research and development activities to standardize how information is requested prior to development of an electronic permitting systems, including establishing Multi-State Corridor Communication and communication between States and Industry and adaptation of electronic verification of permits. Multi-state demonstration project to advance the safety benefits of a pilot car escort certification program.

Evaluation / Performance Measurement:
Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Outputs of this program will

assist State and local highway agencies in more effectively management. Program performance is assessed primarily based on project milestones. Program performance baselines are not established in a formal manner.

The activities performed under the FHWA Freight Management and Operations R&T program support the Infrastructure goal identified in the US DOT Strategic Plan. For example, the performance goal for Strategic Objective 2: Life Cycle and Preventive Maintenance is "Improve conditions of America's Transportation-Related Infrastructure". The Truck Size and Weight RD&T Program addresses alternative truck configurations on the highway system and highway operations. Activities will include assessments of alternative truck configurations or OS/OW freight vehicles, and general analysis of alternative truck configuration impacts on freight infrastructure, safety, and operations.

In addition, this program supports the Innovation goal identified in the US DOT Strategic Plan. The performance goal of "Increase Dissemination of DOT-Funded Research Reports" under the Strategic Objective 2: Development of Innovation. Activities under this program that contribute to achieving this strategic objective aim to better understand the impacts of alternative truck configurations on freight infrastructure, safety, and operations, through data collection and development of data-driven tools and analytical techniques. Additionally, there is an effort to identify key TSW-related research needs relating to pavement, bridge, mode shift, safety, and enforcement. The combination of these activities will lead to improved technical and implementation resources for stakeholder decision-making and analysis.

Accelerating Project Delivery
$3,000,000

Program Description/Activities:
The Accelerating Project Delivery research program expedites project delivery by improving environmental review and permitting processes to reduce regulatory timeframes and costs. These efforts help FHWA deliver transportation projects more quickly and efficiently while safeguarding our communities and maintaining a healthy environment. This program supports improving the National Environmental Policy Act (NEPA) process and improves coordination and communication between Federal and State agencies, the public, and other stakeholders to create efficiencies in project review and development. This program supports work to accelerate project delivery through interagency collaboration, capacity building for environmental practitioners, integrating planning and environmental processes, and disseminating information about environmental program and process efficiencies.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. Sections 502 and 503 of title 23, United States Code (U.S.C.) authorize the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas including research on "Strengthening Transportation Planning and Environmental Decisionmaking (23 U.S.C. 503(b)(4)).

The program supports several mandates for FHWA to accelerate and improve environmental reviews in statute under 23 U.S.C. 139, "Efficient Environmental Reviews for Project Decision Making," 23 U.S.C. 168, "Integration of Planning and Environmental Review, 23 U.S.C. 326, "State Assumption of Responsibility for Categorical Exclusions," and 23 U.S.C. 327, "Surface Transportation Project Delivery Program." The program also supports coordination, partnerships, regulation, policy, and guidance efforts to deploy innovations to meet the agency's statutory mandates under the National Environmental Policy Act (NEPA) at 42 U.S.C. 4321, the National Historic Preservation Act at 54 U.S.C. 300101, the Endangered Species Act at 16 U.S.C. 1531 et seq., the Clean Water Act at 33 U.S.C. §1251 et seq., the Rivers and Harbors Appropriations Act of 1899 at 33 U.S.C. 401, the General Bridge Act of 1946 at 33 U.S.C. 525, and other environmental laws.
The Accelerating Project Delivery program is also responsible for the stewardship and oversight of the Federal-aid real estate acquisition program as well as the outdoor advertising and junkyard control programs on Federally controlled routes.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Accelerating Project Delivery supports the Department's Infrastructure, Innovation and Accountability Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Infrastructure/Improving Infrastructure: The Accelerating Project Delivery research program addresses the DOT goals of Infrastructure, Innovation, Improving Mobility, and Accountability through strategies that accelerate project delivery and support stewardship, improve coordination and partnerships, update regulations, control regulatory costs, track and improve program performance, develop information technology, and develop a workforce trained to accelerate project delivery and expedite environmental and permitting processes and decisionmaking.

Through intra-agency agreements with the Volpe Center and interagency agreements with resource and regulatory agencies, FHWA will continue to work with its Federal partners in FY19 to leverage the expertise, skills, and capacity they have to support several ongoing efforts and to respond to future needs to meet DOT's Strategic Goals in Infrastructure, Innovation, and Accountability. This program meets DOT's Strategic Objectives under each of these Goals by supporting project delivery, planning, environmental review process efficiencies, workforce development, updating regulations, reducing regulations, controlling regulatory costs, improving program performance, and advancing information technology to enhance mission performance and promote efficiency as they relate to environmental review and permitting processes. This program supports activities leading to technology development and transfer and introduces innovative ideas, practices, and approaches to inform training and technical support in environmental review and stewardship.

The Accelerating Project Delivery research program includes efforts that seek permitting efficiencies and reform through programmatic approaches under research-funded intra-agency agreements with the Volpe Center as well as interagency agreements with other agencies outside DOT. Beginning in FY18 and continuing in FY19, FHWA, with the assistance of the Volpe Center, will conduct a study to improve our understanding of how benefits may accrue due to accelerated project delivery times. The assessment will focus on determining the economic benefits of a shortened NEPA and permitting timeline for transportation agencies, businesses, and the general public.

FHWA maintains agreements with agencies that have permitting oversight or other jurisdiction under several environmental laws and regulations, and these agencies provide dedicated staffing positions that serve as national liaisons to develop policy, guidance, and programmatic approaches to expedite permitting and environmental review times. FHWA currently has agreements for national liaisons with the following agencies: the Advisory Council on Historic Preservation (ACHP), the National Marine Fisheries Service (NMFS), the US Army Corps of Engineers (USACE), the US Coast Guard (USCG), the US Environmental Protection Agency (USEPA), and the US Fish and Wildlife Service (USFWS). The National Transportation Liaisons program funds efforts that benefit FHWA projects by expediting the review of transportation projects. National Transportation Liaisons have developed guidance, best practices, programmatic approaches, permit synchronization, and other tools to accelerate the environmental review and permitting processes. Examples of tools that resource agencies (through their National Transportation Liaisons) have developed in coordination with FHWA are the bridge permitting 144(c) checklist for State Departments of Transportation (DOTs) to determine if a USCG permit is required pursuant to 23 U.S.C. 144, and the "Red Book: Synchronizing Environmental Reviews for Transportation and Other Infrastructure Projects". For FY19, FHWA anticipates initiating an agreement with USEPA to

continue funding their existing National Transportation Liaison position for work related to stormwater permitting efficiencies.

Another interagency agreement that the FHWA uses to accelerate project delivery by addressing permitting and interagency coordination issues is with the US Institute for Environmental Conflict Resolution (USIECR). The USIECR provides third-party neutral collaboration, coordination, facilitation, and conflict resolution services to assist FHWA and State DOTs as they work through permitting and consultation processes with resource agencies and tribes. The USIECR also offers training to FHWA and stakeholders to improve workforce skills in coordination among different agencies and across jurisdictions.

Other program areas that support the overall Accelerating Project Delivery program include Environmental Review Information Technology (IT) Development and Project Delivery Innovations. The program's IT solutions include the Project and Program Action Information System (PAPAI) tool to track projects and integrate with the Federal Infrastructure Permitting Dashboard and the eNEPA tool for online collaboration among FHWA and the resource agencies in the environmental decision making process.

The program also initiates research on various topics as part of Project Delivery Innovations that support the overall program by responding to new and emerging issues in the environmental review, project development and real estate acquisition. Examples of past innovations include studies on how to address topics such as tolling, automated connected vehicles, and alternative fuel corridors in the context of the environmental review process. The FHWA may address emerging issues through interagency agreements or through commercial contracts, as appropriate. Some research topics include:

- Efforts to improve the NEPA Assignment Program
- Efforts to examine processing times for all NEPA classes of action
- Tools to implement Executive Order 13807, "Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure."
- Respond to changes in environmental review law and policy
- Improved Implementation and Use of for Early Acquisition Flexibilities for Real Property

Innovation/Improving Mobility: Accelerating Project Delivery research will develop and analyze technology and innovation as they relate to accelerating environmental review and permitting processes. This research will leverage other Federal agency resources to provide tools, technologies, guidance and training to accelerate project deliver.

Accountability/Preserving the Environment: Within the context of accelerating project delivery, these activities will support efforts to reduce regulations and control regulatory costs with other Federal agencies and with Volpe support to draft policy, guidance, rulemaking as well as develop tools such as programmatic approaches to expedite regulatory requirements. All activities will improve performance by accelerating and improving processes and maximizing employee performance, development, and engagement to make efficient and effective use of resources.
Activities include:

- Workforce development: Environment Discipline Support System

- Information technology: IT services for interagency collaboration and project tracking

Program Objectives:
The main goal of the Accelerating Project Delivery program is to build tools and collaborate on studies to reduce regulatory burden and increase efficiencies in the environmental review process by innovating new ways to expedite project delivery. Examples of programs and tools that the Volpe Center supports to accelerate project delivery include activities related to regulatory reform, rulemaking, guidance, "planning and environmental linkages" (PEL), programmatic approaches, NEPA assignment program support and audit support, "Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects," resource agency liaison program support, and the Environment Discipline Support System. Examples of tools FHWA creates by coordination through interagency agreements include programmatic approaches to expedite permitting and regulatory review times and policy and guidance development for stakeholder flexibilities.

The National Transportation Liaison Program has helped develop techniques that has expedited federally funded projects and permits, such as programmatic agreements, memorandum of agreement, and other tools that result in increased efficiencies throughout the project development and the environment review processes. Additionally, the use of dedicated agency liaisons, such as the ones supported on this program, has been identified as a best practice in the "Recommended Best Practices for Environmental Reviews and Authorizations for Infrastructure Projects for Fiscal Year 2018" by the Federal Permitting Improvement Council, to meet the objectives for federal permitting process improvement. This arrangement provides the support of liaisons in the federal permitting agencies who ensure the efficient application of those agency's statutes and regulations. The research is conducted through continuous interaction between FHWA and the various liaisons. The work that FHWA does under intra-agency and interagency agreements is inherently governmental and specific to the authorities and jurisdiction of each agency, and therefore these services are not available in the commercial market.

This program will also increase the effectiveness and efficiency of acquisition and management of highway real property interests by developing methodologies, technology and systems to accelerate the Federal-aid real estate acquisition program with utilization of flexibilities. This research program will improve knowledge and provide tools necessary to ensure that effective stewardship and oversight is provided.

Key FY19 FHWA Accelerating Project Delivery R&T Program Activities

Activity	**Period of Performance**	**Partners/Notes**
Accelerating Project Delivery Services	FY19-FY24	Volpe Center, State DOTs, American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), ACHP, NMFS, USACE, USCG, USFWS, USEPA, US Geological Survey (USGS), USIECR
National Liaison Program	FY19-FY24	ACHP, NMFS, USACE, USCG, USFWS, USEPA
PAPAI	FY19-FY24	State DOTs
eNEPA	FY19-FY24	NMFS, USACE, USCG, USFWS, USEPA, State DOTs
Studies on Historic Properties and Tribal Consultation	FY19-FY24	ACHP, State DOTs, tribes, State Historic Preservation Officers
NEPA Assignment Program	FY19-FY24	State DOTs, Volpe Center

Permitting and Mitigation	FY19-FY24	ACHP, NMFS, USACE, USCG, USFWS, USEPA, USIECR, State DOTs
Planning and Environmental Linkages (PEL)	FY19-FY24	State DOTs, Volpe Center
NEPA document timelines	FY19-FY24	State DOTs
Stormwater studies	FY19-FY24	State DOTs, USGS, USEPA
Project Delivery Innovations	FY19-FY24	Varies by project
Tools to implement Executive Order 13807	FY19-FY24	ACHP, NMFS, USACE, USCG, USFWS, USEPA, State DOTs
Early Acquisition Flexibilities for Real Property	FY19-21	State DOTs, AASHTO
Study on the Economic Benefit of Accelerating Project Delivery	FY19	Volpe Center

Research Collaboration Partners:
Accelerating Project Delivery research would not be possible without collaboration with Federal and Non-Federal partners. As the Operating Administration, responsible for delivering the Federal aid program, FHWA and its Federal partners focus on program activities that are outside the purview of these non-Federal entities, such as research to implement and inform policy, guidance, and regulations. The FHWA works with Federal partners on program activities that seek permitting efficiencies and reform through programmatic approaches under an intra-agency agreement with the Volpe Center as well as interagency liaison agreements with resource agencies. The FHWA maintains agreements with agencies that have permitting oversight or other jurisdiction under several environmental laws and regulations, and these agencies provide dedicated staffing positions that serve as national liaisons to develop policy, guidance, and programmatic approaches to expedite permitting and environmental review times. FHWA currently has agreements for national liaisons with the following agencies: the Advisory Council on Historic Preservation (ACHP), the National Marine Fisheries Service (NMFS), the US Army Corps of Engineers (USACE), the US Coast Guard (USCG), the US Environmental Protection Agency (USEPA), and the US Fish and Wildlife Service (USFWS). The National Transportation Liaisons program funds efforts that benefit FHWA projects by expediting the review of transportation projects.

As a partner within USDOT, Volpe's support of the FHWA's efforts to accelerate project delivery is flexible enough to respond to emerging issues from the public and stakeholders. Volpe often assists with responding to public comments on policy, guidance, and rulemaking. Volpe also helps the FHWA engage stakeholders such as State DOTs and other transportation agencies through workshops and interviews on various topics. Volpe often synthesizes stakeholder input into case studies and other materials for FHWA to consider in developing policies to address issues the public and stakeholders raise. Public and stakeholder input also informs the products that FHWA develops with other Federal agencies under this program. State DOTs and other transportation agencies also collaborate on activities under this program. A summary of the benefits of various partners in implementing this program is outlined in the table below.

Non-governmental input on this program usually comes from public comments and stakeholder engagement related to projects and draft policies, guidance, and rulemaking. Additionally, transportation organizations such as the AASHTO, TRB, and University Transportation Centers (UTCs) contribute to this program by providing in-kind services or by funding research that compliments the Federal side of the program. AASHTO and TRB also support stakeholder engagement in the program to facilitate technology transfer between FHWA, its Federal partners, and the transportation industry.

Benefits of Partnership and Partner Contributions to FHWA Accelerating Project Delivery R&T Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Programmatic Approaches	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Provide Services	Technology Transfer
AASHTO	X	X	X			X	X	X	X
TRB	X	X	X			X	X	X	X
State DOTs	X	X	X	X	X	X	X	X	X
ACHP			X	X	X	X	X	X	X
NMFS			X	X	X	X	X	X	X
USACE			X	X	X	X	X	X	X
USCG			X	X	X	X	X	X	X
USEPA			X	X	X	X	X	X	X
USFWS			X	X	X	X	X	X	X
USGS			X	X	X	X	X	X	X
USIECR			X	X	X	X	X	X	X
UTCs		X		X	X	X	X	X	X
Volpe Center	X	X	X	X	X	X	X	X	X

Acquisition/Assistance:
For the Volpe intra-agency agreements and the interagency agreements with resource agencies, this program does not use a competitive procurement process. For other requirements, the FHWA may: compete the work among vendors who hold indefinite delivery, indefinite quantity (IDIQ) contracts with FHWA; compete the work among vendors who hold General Services Administration Federal Supply Schedule contracts; compete the work through small business set asides in accordance with Federal Acquisition Regulations (FAR) and the Small Business Administration's (SBA's) certification programs; award sole source contracts in accordance with the FAR and SBA's 8a program to 8a certified contractors; allocate funds to a State DOT to use their contract vehicles to administer projects, or award sole source purchase orders or competitive cooperative agreements to non-profit organizations, including academic institutions. FHWA uses a sole source procurement for agreements with other Federal agencies, because the nature of the work is inherently governmental and requires the expertise of the specific agencies who have responsibility to respond to the requirements of a given program area.

FHWA funds this program through multi-year research funds and a combination of multi-year agreements and multi-year contract awards. IDIQ task orders and other contracts and cooperative agreements are usually firm fixed price awards. This program often leverages non-Federal funds or in-kind services for work with State DOTs and non-profit organizations. For allocations to State DOTs, the State DOTs provide at least a 20% match.

Technology Transfer (T2):
The Accelerating Project Delivery program includes several mechanisms for technology transfer to stakeholders such as State DOTs, local transportation agencies, FHWA Division offices, other Federal agencies, and the public. Examples of products the program disseminates to stakeholders and the public include research publications, technical guidance, training courses, webinars, workshops, peer exchanges, guidance, and policy statements.

T2 Organization	Role	Activities	Results	Performance Measure
FHWA	Outreach, training, and technical assistance	Webinars, presentations, technical assistance, training, demonstration pilots	Target audience has full understanding of research products and how to use them effectively	Number of webinars, number of outreach participants, number of pilots funded
State DOTs	Implementer	Demonstration pilots, full implementation	Transportation plans and projects incorporate research products including environmental modeling tools, project tracking systems, and project development tools.	Number of State DOTs using research products, modeling tools, project tracking systems, and other project development tools.
AASHTO and Other Stakeholder Organizations	Peer support and exchange	Peer exchanges, webinars, and studies	Implementation results shared among stakeholder peers	Number of outreach participants and web hits on studies and other tools

Key 2019 FHWA Accelerating Project Delivery Program Outputs.

Program Objective	Key 2019 Outputs

Support regulatory reform and produce rulemaking and guidance	This program leverages Volpe and other Federal agency resources to help HEPE simplify regulations, policies, and guidance to support deployment of advances in technology and innovation as they relate to accelerating environmental review and permitting processes.
Build tools that reduce regulatory burden and increase efficiencies in the environmental review process	This program also supports efforts to reduce regulations and control regulatory costs with other Federal agencies and with Volpe support to draft policy, guidance, rulemaking as well as develop tools such as programmatic approaches to expedite regulatory requirements. This program also develops tools to expedite the environmental review process to increase procedural efficiencies. The Volpe Center and other Federal agencies support HEPE work in regulatory reform, permitting efficiencies, planning and environmental linkages, and other tools to help State DOTs expedite project delivery for the Federal-aid surface transportation program.
Collaborate on studies to reduce regulatory burden and increase efficiencies in the environmental review process	HEPE partners with other Federal agencies through the liaison program and partners with the private sector, research organizations, and State and local governments on several research topics such as storm water permitting and Endangered Species Act compliance, among other activities. State DOTs often provide expertise and resources for the program through advisory groups and by field testing research technologies.
Determine the economic benefit of accelerating project delivery, focused on NEPA and permitting for transportation agencies, businesses, and the general public.	The goal of the assessment is to improve our understanding of how benefits may accrue due to accelerated project delivery times. The assessment will focus on determining the economic benefits of a shortened NEPA and permitting timeline.

Evaluation / Performance Measurement:
FHWA tracks performance on the Accelerating Project Delivery program by tracking timeframes for the completion of environmental processes, especially the completion times for Environmental Impact Statements (EISs). FHWA tracks EIS timeframes on the quarterly Leadership Team Dashboard Report. Metrics for the timeframes of EISs include a goal to have a median EIS completion timeframe at or below 48 months across FHWA for post SAFETEA-LU projects. FHWA has tracked the baseline timeframes for EISs since 2005, when Congress initiated the 48-month goal in statute. FHWA also has a goal to use planning and environmental linkages (PEL) to expedite project delivery. FHWA tracks the use of PEL in the Leadership Team Dashboard Report. The measures and metrics for the Accelerating Project Delivery program are in the Strategic Implementation Plan under the Strategic Goals of National Leadership, System Performance – Infrastructure and Environment, and Program Delivery. Accelerating Project Delivery is also under the DOT Strategic Plan, Strategic Objective 1 (Project Delivery, Planning, Environment, Funding and Finance) under the Infrastructure Goal.

In addition to tracking EIS timeframes and PEL use, Volpe's work helps FHWA assess the effectiveness of several of its programs. For example, Volpe assists FHWA with the Indiana and northern long-eared bat programmatic approaches that help expedite the Endangered Species Act Section 7 consultation process in as many as 37 States. Through Volpe's data collection support, FHWA knows that over 1,000 Federal-aid projects used the bat programmatic agreement for informal consultation in the first year after

executing the agreement with the U.S. Fish and Wildlife Service. After the formal programmatic biological opinions for the two species of bats, Volpe data show that State DOTs are using the programmatic approaches for informal and formal consultations to expedite approximately 2,000 Federal-aid highway projects per year.

Performance Based Planning
$2,000,000

Program Description/Activities:
The Performance Based Planning research program supports the connection between performance measures and performance target levels that lead to data-driven, effective transportation solutions. These measures and targets are connected through transportation plans and programs developed at the statewide and metropolitan levels. In accordance with Federal law, the United States Department of Transportation (USDOT) is responsible for assisting States and metropolitan planning organizations (MPOs) identify performance measures and associated targets related to national highway and transit performance goals. Performance based planning and programming (PBPP) provides a strategic, data-driven approach to decision-making that enables transportation agencies to efficiently allocate resources, maximize the return on investments, and achieve desired performance goals while increasing accountability and transparency to the public.

To advance performance-based planning and analysis, FHWA will conduct research focused on providing quality data; analysis; and information to States, MPOs, transportation partners, and decision-makers. FHWA will also work with other Federal, State, and local agencies to develop methods and tools to analyze transportation system performance to develop effective transportation solutions. The intent of this program is to develop and implement strategies and activities that advance and support comprehensive international, interstate, state, metropolitan, rural, regional, multi-modal, and tribal planning processes. Other planning research initiatives that support the performance based planning process and links planning data to the National Environmental Policy Act (NEPA) process include: environmental justice and public engagement, transportation safety planning, forecasting project benefits and impacts, smart growth, exploratory modeling, scenario planning, and transportation land use.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topics to improve highway safety and infrastructure resiliency, strengthen transportation planning and environmental decision making, reduce congestion, and enhance freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Performance based planning supports each of the Department's goals and contributes to all USDOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Safety/Promoting Safety: States are required to use a performance based process through the development of data-driven, Strategic Highway Safety Plans (SHSPs), which involve tracking safety indicators, analyzing data, and identifying emphasis areas and strategies. Each State's Highway Safety Improvement Program (HSIP) should be consistent with the SHSP, and includes collecting and maintaining data, conducting studies, establishing priorities, and implementing and evaluating the effectiveness of safety improvements. This research will provide tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to achieve desired performance outcomes for the multimodal transportation system.

Infrastructure/Improving Infrastructure: Research will highlight the emphasis on performance management within the Federal-aid highway program, and requires use of performance-based approaches in statewide, metropolitan, and nonmetropolitan transportation planning. This research will provide examples of effective practices to help practitioners advance these approaches in their own planning and programming activities; promote and maintain the highway infrastructure asset system in a state of good repair; identify tools, technologies, and guidance for States and MPOs; offer capacity building opportunities that plan and prioritize investments, accelerates project delivery; and effectively improve connectivity, accessibility, safety, and convenience for all users, including those in rural areas.

Innovation/Improving Mobility: Within the context of performance based planning, the scenario planning approach visualizes and demonstrate, in both qualitative and quantitative terms, how the combination of various strategies would help meet performance targets. Research will allow for the consideration of how various factors, such as revenue constraints, demographic trends, economic shifts, or technological innovation can affect a state or region and its transportation system performance. Potential regional investment strategies for the planning horizon include packages of investments in transit, highway capacity, Intelligent Transportation Systems (ITS), and travel demand management strategies, or system preservation. Research will also assess new modes and technologies, notably automated vehicles and automated driving systems linked to data-driven decision-making.

Accountability/Preserving the Environment: The expenditure of these resources ensures that the goals are achieved in accord with the performance based planning process, societal needs, e.g. safety, accountability, asset preservation, and the environment can be addressed in accordance with the priority placed on each by the public. Performance based planning allows planners to evaluate and recommend strategies, projects, and programs to policy-makers based on anticipated system-wide impacts and support for goals. This research will provide tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to improve mobility while preserving the natural and human environments.

Program Objectives:

Performance based planning refers to the application of performance management within the planning and programming processes of transportation agencies to achieve desired performance outcomes for the multimodal transportation system. It ensures that transportation investment decisions are made – both in long-term planning and short-term programming of projects – based

on their ability to meet established targets. The program will develop a clearer understanding of the complex relationship between surface transportation and the environment, and will promote more informed transportation decision making that improves transportation planning, programming, operations, and coordination.

The over-arching objectives are to:

- Advance the continuing, comprehensive, and collaborative statewide transportation planning processes that facilitates the efficient movement of people and goods in all areas of the state, including metropolitan, rural, and tribal areas;
- Partner with agencies on the implementation of transportation planning and programming process needs and priority areas;
- Offer products, services, and provide information, training, and technical assistance to transportation professionals responsible for planning for capital, operating, and maintenance needs of our nation's surface transportation system;
- Build transportation planning institutional capacity to effectively apply analytical tools in the transportation planning decision-making process and better incorporate planning research into practice and promote best practices in travel data analyses and quantitative methods application;
- Support transportation data and analysis, including geographic information systems (GIS) and transport simulations and models, and provide technical support through training, peer reviews, peer exchanges, clearinghouses, and other discussion forums;
- Facilitate the safe, secure, efficient, and environmentally responsible movement of people and goods across the Canada-U.S. and Mexico-U.S. borders;
- Bring multiple transportation and border agencies together to coordinate transportation planning, policy implementation, data-sharing, and the deployment of technology to enhance border infrastructure and operations;
- Use performance based planning decisions to provide accountability, guide exploratory modeling and simulation tools, and support transportation decisions using advanced application methods;
- Provides program policy, guidance, training, and technical assistance to FHWA Division Offices, States, MPOs, Regional Transportation Planning Organizations (RTPOs), tribal governments, local and international governments (Mexico and Canada);
- Develop methods and tools to analyze transportation system performance to develop effective transportation solutions that improve the availability, quality, and utility of information used by agencies, elected officials, and the public to make transportation-related policy and investment decisions; and
- Lead national research on wide breadth of transportation topics ranging from stewardship and oversight of statewide and metropolitan planning, planning capacity building (including regional transport modeling, GIS and visualization, and border/international planning), systems planning and analysis, and the overall planning discipline (with support from other participating program offices).

Key FY19 program activities are identified below.

Activity	Period of Performance	Potential Partners
Identify and disseminate best practices in integrating PBPP into required statewide and metropolitan planning documents and processes through peer exchanges and case study research	2018 - 2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO NARC, NADO, APTA NACO, APA
Examine the impacts of emerging technologies on PBPP requirements and the existing and future transportation system through exploratory modeling, GIS, and other innovations	2018-2023	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, NARC, NADO, APTA, NACO, APA
Explore new data sources and analysis techniques to provide necessary information on how emerging technologies might impact metropolitan and statewide travel trends that feed into the PBPP.	2018-2023	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, NARC, NADO, APTA, NACO, APA
Research and innovation deployment to analyze the economic benefits of infrastructure investments. Supports agencies by completing research on innovations in economic analysis and related best practices.	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, NARC, NADO, APTA, NACO, APA
Examine how PBPP can support a data-driven, performance-based approach to decision-making for safety, asset management, economic resiliency, freight movement, congestion management, system reliability, and air quality through scenario planning and exploratory modeling research.	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, NARC, NADO, APTA, NACO, APA
Examine how PBPP can enhance the safety, durability, and resiliency of the transportation system.	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, NARC, NADO, APTA, NACO, APA
Development of a framework for the integration of PBPP into National Economic Networks to increase collaboration and coordination beyond traditional jurisdictional boundaries.	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, APA
Explore how PBPP can accelerate project delivery through planning and environmental linkages, effective public	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO,

involvement, and community connections considerations.		NARC, NADO, APTA, NACO, APA
Explore PBPP's impact on data-sharing and analysis to enhance the efficient movement of people and freight across international borders (Mexico and Canada)	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, APA
Examine how PBPP can enhance a state or local communities' ability to withstand economic shocks to maintain and grow a strong economy	2018-2021	FHWA Division Offices, State DOTs, MPOs, RTPOs, AASHTO, TRB, AMPO, NARC, NADO, APTA, NACO, APA

Research Collaboration Partners:
Collaboration on performance based planning regularly involves engagement with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State DOTs, MPOs, RTPOs, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), universities engaged in related work, and professional organizations such as the American Planning Association. Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Non-government groups partner and contribute to performance based planning related research.

Benefits of Partnership and Partner Contributions to FHWA Performance Based Planning R&T Program.

Partner Organization	Implementer Perspectives	Stakeholder Perspective
AASHTO and Associated Standing Committees		**X**
TRB		**X**
State DOTs	**X**	
FHWA Division Offices	**X**	
MPOs	**X**	
Regional Transportation Planning Agencies (Rural)	**X**	
Association of Metropolitan Planning Organizations (AMPO)		**X**
National Association of Regional Councils (NARC)		**X**
National Association of Development Organizations (NADO)		**X**
American Public Transportation Association (APTA)		**X**
National Association of Counties (NACO)		**X**

American Planning Association (APA)		**X**
General Public		**X**

Acquisition/Assistance:
For performance based planning research, FHWA makes use of a variety of competitive acquisition methods, with the specific mechanism depending on the program need to be met. For example, competitive, multi-award task order contracts are being used to procure much of the performance based planning currently conducted. Other program needs are met through interagency agreements (such as with the Volpe National Transportation Systems Center), cooperative agreements (such as with Department of Energy), and purchase orders for small purchases.

This program utilizes both single year and multi-year acquisitions. Competitive, multi-award task order contracts are most often multi-year acquisitions, funded over several fiscal years through individual task orders. Multi-year acquisitions are also utilized for interagency agreements and cooperative agreements. Single year contracts or purchase orders are used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. Most acquisitions under this program are competitively procured.

Opportunities to leverage non-Federal funds are predominantly with State and regional transportation planning agencies with a cost share of 20% of the total project cost. In addition, pooled fund studies are utilized to leverage funding, such as the current "Moving Forward with the Next Generation Travel Behavior Data Collection and Processing" Transportation project.

Technology Transfer (T2):
Technology transfer is an integral part of the implementing performance based planning research, and is funded as such.

T2 Organization	Role	Activities	Results	Performance Measure
FHWA	Outreach, training, and technical assistance	Webinars, presentations, technical assistance, training, demonstration pilots	Primary audience has full understanding of research products and how to use them effectively	Number of webinars or workshops, number of outreach participants, number of pilots funded
State DOTs	Implementer	Demonstration pilots, full implementation and deployment	Transportation plans and projects incorporate research products	Number of State DOTs using research
Regional Transportation Planning Agencies	Implementer	Demonstration pilots, full implementation	Transportation plans, projects, and processes incorporate	Number of Agencies deploying the research

			research products	
AASHTO and Other Stakeholder Organizations	Peer support and exchange	Peer exchanges, workshops	Implementation results shared among stakeholder peers	Number of webinars/workshops held or outreach participants

FHWA Divisions, State DOTs, MPOS, and RTPOs, are the primary stakeholders and beneficiaries of performance based planning research and are the primary audience for the program's research outputs. The program's outputs take the form of:

- Guidebooks, handbooks, and research publications, including reports and technical notes
- New and/or updated technical guidance
- Live and online training courses
- Bootcamps, webinars, and videos
- Workshops and peer exchanges
- Notable practices and case studies

The predominant measures for the program's T2 activities are output measures, for example, number of web visits to a research publication, or number of presentations delivered. Audience assessments of effectiveness are obtained and analyzed for some webinars and formal classroom training.

The benefits to be accrued by planning stakeholders include efficiency and effectiveness improvements in the planning, development, and design of safe and connected multimodal projects that benefit all users.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	Key 2019 Outputs
Offer products, services, and provide information, training, and technical assistance to transportation professionals responsible for planning for capital, operating, and maintenance needs of our nation's surface transportation system	Conducting program development, technical assistance, and marketing activities, including: ▪ Transportation Management Area (TMA) Certification and state of the practice reviews ▪ Handbooks, white papers, case studies, and analytical tools ▪ Peer exchanges, workshops, webinars, technical assistance, videos, and training ▪ Marketing and outreach materials ▪ Statewide Transportation Improvement Program (STIP) and long-range transportation plan (LRTP) approval guidance
Build transportation planning institutional capacity	▪ Identifying notable plans and examples of planning frameworks and governance structures in transportation agencies ▪ Connect transportation planners through virtual and in-person peer exchanges to share best practices and innovations. ▪ Initiate pooled fund studies to support and share information
Bring multiple transportation and border agencies together to coordinate transportation planning	Advancing and implementing border master plans at the US-Canada and US-Mexico borders
Develop methods and tools to analyze transportation system performance	▪ Examine and disseminate new transportation data and analysis techniques ▪ Develop the next generation of transportation models and scenario planning tools. ▪ Research on the impacts of emerging technologies, including autonomous and connected vehicles, impact on system performance ▪ Examining how innovative/alternative finance strategies are considered in scenario planning, the development of LRTPs and STIPs, and used to leverage non-federal funds

Evaluation / Performance Measurement:
Project milestones are included and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated periodically by the Leadership Team (which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances). Program performance is assessed primarily based on project milestones and deliverables. Performance baselines are not established in any formal way; however, outputs of this program will assist States, MPOs, and RTPOs to plan for and develop performance based planning approaches in their planning and programming processes. This will ensure that selected projects using Federal funds can effectively promote safety; improve infrastructure, support economic growth, improve mobility, and preserve the environment for all users.

DOT Strategic Plan – Strategic Objectives	Performance Goals
Safety – Strategic Objective 1: Systemic Safety Approach	The Performance Based Planning research will address this objective in providing tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to achieve desired performance outcomes for the multimodal transportation system.
Infrastructure – Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance	The Performance Based Planning research will address this objective in providing examples of effective practices to help practitioners advance these approaches in their own planning and programming activities; promote and maintain the highway infrastructure asset system in a state of good repair; identify tools, technologies, and guidance for States and MPOs; offer capacity building opportunities that plan and prioritize investments, accelerates project delivery; and effectively improve connectivity, accessibility, safety, and convenience for all users, including those in rural areas.
Infrastructure – Strategic Objective 4: Economic Competitiveness and Workforces	The Performance Based Planning research will address this objective in encouraging investments that promote economic revitalization, job growth, and affordable transportation options by promoting collaborative strategies that encourage successful economic development, especially in underserved and rural communities
Innovation – Strategic Objective 2: Deployment of Innovation	The Performance Based Planning research will address this objective in considering how revenue constraints, demographic trends, economic shifts, or technological innovation can affect a state or region and its transportation system performance. Research will also assess new modes and technologies, notably automated vehicles and automated driving systems linked to data-driven decision-making.
Accountability – Management Objective 2: Mission Efficiency and Support	The Performance Based Planning research will address this objective in providing tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to improve mobility while preserving the natural and human environments

Modeling
$2,000,000

Program Description/Activities:
The Modeling research program supports the administration of FHWA's air quality and highway noise programs, compliance with current statutory and regulatory requirements and the development of future legislature, regulatory and policy development for these program areas: air quality and transportation conformity requirements in the Clean Air Act requirements; highway traffic noise standards development; Congestion Mitigation and Air Quality Improvement (CMAQ) Program; air quality analysis and assessment; and environmental mitigation strategies. Research activities include: advancing the practice of near-road air quality modeling applications and analysis, enhancements to the CMAQ public access system functions, and updating and supporting the Traffic Noise Model applications and guidance while exploring the potential of roadside structures and vegetation to reduce traffic related air quality and noise impacts.

Modeling research also supports forecasting transportation demand derived from changes in population, regional economies, and transportation systems. Research in this area includes new exploratory modeling and analysis methods for dealing with uncertainty, for example the impacts of automated vehicles on travel demand. New technologies that are moving ahead include agent based models that implement streamlined conceptual models better suited for simulating transport systems. Agent-based model technologies make new modeling concepts available, such as behavioral user equilibrium, and take advantage of emerging machine learning capabilities for training simulation agents. The Travel Model Improvement Program (TMIP) works to deliver these research products into practice and improve the analysis, modeling, and simulation capabilities of our program partners at State DOTs and MPOs.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. The modeling research is needed to ensure compliance with several statutory mandates: the Transportation Conformity provisions of the Clean Air Act and its implementation regulations (see Section 176(c) of the Clean Air Act (42 U.S,C. 7506(c)); 40 CFR Parts 51.390 and 93); the promulgation of highway noise levels and standards (23 U.S.C. 109(i); 23 CFR 772); the implementation of the Congestion Mitigation and Air Quality Improvement (CMAQ) program (23 U.S.C. 149) and the CMAQ program performance measures (23 U.S.C. 150(c); 23 CFR 490); the statewide and metropolitan planning process (23 U.S.C 134 and 135; 23 CFR 450) and the integration of planning and environmental review (23 U.S.C. 168).

This research is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topics to improve highway safety and infrastructure integrity, strengthen transportation planning and environmental decision making, reduce congestion, and enhance freight productivity, among others.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
	Promoting safety

Infrastructure	Improving Infrastructure
Innovation	Improving mobility
Accountability	Preserving the environment

Modeling supports the Department's Infrastructure, Innovation, and Accountability Goals and all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Infrastructure/Improving Infrastructure: Air quality, highway traffic noise and land use and travel forecasting modeling research will focus on technologies, tools, analysis methods, and performance management approaches to accelerate the environment review process, and to effectively and efficiently analyze the impacts of projects to meet the statutory and regulatory requirements cited above. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies so that transportation projects, will be delivered more quickly and efficiently while maintaining a healthy environment, safeguarding our communities and stimulating economic growth. The research will also provide tools and other resources to assist State and local transportation partners to measure the performance of the transportation system.

Innovation/Improving Mobility: Modeling research will advance the state-of-the practice by developing and deploying analytic methods and tools for air quality, highway traffic noise, and considering the impact of uncertainty, such as vehicle automation, on travel forecasts for plans and projects. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies in the areas of air quality, highway traffic noise, transportation planning, land use and travel forecasting.

Accountability/Preserving the Environment: Modeling research will develop tools, methods and guidance to support a clearer understanding of the complex relationship between transportation and the environment, especially in the areas of air quality, highway traffic noise, transportation planning, land use and travel forecasting process. It will promote more informed transportation decision making that improves transportation planning, programming, operations, and coordination. This research will provide tools and methods to identify approaches in reducing regulatory burden of air quality and highway noise analyses and accelerating the project development processes.

Program Objectives:

The objectives of modeling research are:

- Streamlining highway traffic noise and air quality analyses and to develop and provide state-of-the-art models, tools and methods to enhance air quality and noise analyses
- Enhancing data collection and analytical tools development to support and improve project level air quality and noise analyses, and to improve the understanding of potential environmental impacts in the near road environment with the goal of expedited project delivery
- Developing strategies and build capacity to improve future project selection and program performance

- Developing an effective framework and process to ensure information and results from FHWA's air quality and noise research results are shared in a timely manner

The modeling research will address two major research needs:

- Develop and provide data and analysis tools as well as the technical assistance and support to understand the data and analysis to States, MPOs and other stakeholders as they make investment decisions and report on system performance.
- Support the acceleration of the highway project environmental review process through best practices and expediting infrastructure projects without undermining environmental laws or limiting opportunities for public engagement.

Key FY19 FHWA Structures R&T Program Activities

Activity	Period of Performance	Partners/Notes
Develop and provide data and analysis tools	FY18-FY19	AASHTO; AMPO; EPA
Support the acceleration of the highway project environmental review process	FY18-FY19	AASHTO; AMPO; EPA; State DOT (AZ, CA, CO, OH, TX, VA, WA) Pooled Fund; TRB; Trinity Consultants;

Research Collaboration Partners:

Collaboration on modeling research regularly involves engagement with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include representatives of individual State departments of transportation, regional planning agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), universities engage in related work, and professional organizations such as the Institute of Transportation Engineers, and the American Planning Association. Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Other Federal agencies, especially EPA and other non-government groups partners and contribute to modeling research.

Benefits of Partnership and Partner Contributions to FHWA Modeling R&T Program.

Partner Organization	User Perspective on Needs	Demonstration/ Field Testing	Deployment	Research Collaboration/ Coordination	Stakeholder Perspective	Subject Matter Expertise	Jointly Funded Research

AASHTO Environment & Sustainability					X		
AASHTO Air Quality, Climate Change, and Energy					X		
AASHTO Highway Traffic Noise Working Group					X		
TRB Committee on Transportation and Air Quality					X		
TRB Committee on Transportation Related Noise and Vibration					X		
State DOTs	X	X	X				X
Metropolitan Planning Organizations	X	X	X				
Associations of Metropolitan Planning Organizations					X		
US EPA				X		X	
Health Effects Institute				X		X	
USDOT Volpe Center				X		X	

Acquisition/Assistance:
For modeling research, FHWA makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, competitive, multi-award task order contracts are being used to procure much of modeling research currently conducted. Other program needs are met through interagency agreements (such as with the Volpe National Transportation Systems Center), cooperative agreement (such as with AMPO), and purchase orders for small purchases.

This program utilizes both single year and multiyear acquisitions. Competitive, multi-award task order contracts are most often multi-year acquisitions, funded over several fiscal years through individual task orders. Multiyear acquisitions are also utilized for interagency agreements and cooperative agreements. Single year contracts or purchase orders are used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. Most acquisitions under this program are competitively procured.

Opportunities to leverage non-Federal funds are predominantly with State and regional transportation planning agencies with a cost share of 20% or the total project cost. In addition, pooled fund studies are utilized to leverage funding, such as the current Near Road Air Quality Pooled Fund Study. A specific example of non-governmental partnership and opportunity to leverage non-Federal funds includes work with Health Effects Institute to support research that assess potential impacts in the near road environment.

Technology Transfer (T2):
Technology transfer is an integral part of the implementing modeling research, and is funded as such.

State departments of transportation and MPOs are the primary stakeholders and beneficiaries of modeling research, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services to those agencies are also engaged.

T2 Organization	Role	Activities	Results	Performance Measure

FHWA	Outreach, training, and technical assistance	Webinars, presentations, technical guidance and assistance, Outreach materials, Dedicated websites, Training,	Primary audience has full understanding of research products and how to use them effectively	Number of webinars, number of outreach participants, number of website hits
State DOTs	Implementer	Demonstration pilots, Full implementation	Transportation plans and projects incorporate research products	Number of State DOTs using research
Metropolitan Planning Organizations and other Regional Transportation Planning Agencies	Implementer	Demonstration pilots, Full implementation	Transportation plans and projects incorporate research products	Number of Agencies using research
AASHTO and Other Stakeholder Organizations	Peer support and exchange	Peer exchanges, Workshops	Implementation results shared among stakeholder peers	Number of webinars, workshops, or outreach participants

The program's outputs take the form of:

- Research publications, including reports and technical notes
- New and/or updated technical guidance
- Training courses, both web-based and instructor led
- Webinars
- Workshops and Peer Exchanges
- Case Studies
- YouTube videos
- Dedicated websites

The predominant measures for the program's T2 activities are output measures, for example, number of web visit to a research publication, or number of presentations delivered. Audience assessments of effectiveness are obtained for some webinars and formal classroom training.

The benefits to be accrued by multimodal connectivity stakeholders include efficiency and effectiveness improvements in the planning, and development, of transportation projects that benefit all users.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	Key 2019 Outputs
Provide state-of-the-art models, tools and methods to enhance air quality and noise analyses and to support the acceleration of the highway project environmental review process	▪ Update CALINE air quality dispersion model to provide States and MPOs with alternative modeling techniques that are more readily applicable to highway projects than other models ▪ Develop and deploy additional modules of the CMAQ emission calculator toolkit that will enable States and MPOs to more quickly and easily demonstrate progress on performance targets ▪ Develop tools for near road emissions estimations to address air quality concerns in project development ▪ Research of road dust to assist State DOTs in conducting emissions modeling and to identify possible solution to address re-entrained road dust issues to demonstrate compliance with Clean Air Act requirements ▪ Complete development and the release of final traffic noise model (TNM 3.0) and supporting tools, creating a model that is quicker and more user-friendly through the addition of graphic user interfaces and visualization techniques ▪ Research to support noise regulation update that will reduce and simplify noise requirements
Enhancing data collection and analytical tools development to support and improve project level air quality and noise analyses	▪ Develop applications tools using national traffic database to improve accuracy of air quality and noise analysis ▪ Develop process to collect and analyze meteorological data to help streamline project level air quality analysis ▪ Complete synthesis of heavy duty truck age distribution, emissions patterns, and policy implications ▪ Complete synthesis of factors affecting health effects of near road related air and noise emissions. The synthesis will support future policy development
Provide tools, technical assistance, and support to States, MPOs and other stakeholders as they make investment decisions and report on system performance to ultimately improve future project selection and program performance	▪ Complete update for the CMAQ Cost-Effectiveness Tables ▪ Develop “data dictionary” to enhance emissions inputs to CMAQ Public Access System ▪ Complete CMAQ Program review of project types, emissions estimates and dispersion of projects nationally

	▪ Provide tools and information using scenarios to support State and MPO investment and policy decisions involving disruptive and uncertain factors affecting transportation-related outcomes. ▪ Develop and document land use and travel forecasts to advance highway project delivery in NEPA, including completing methodological reference syntheses for principal forecasting techniques; developing case study resources relevant for PEL applications; and producing and piloting training materials.
Ensure information and results from FHWA's air quality and noise research results are shared in a timely manner	Conduct outreach to raise public awareness and disseminate critical information, research results and other outreach materials in support of air quality and noise programs

Evaluation / Performance Measurement:
Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated periodically by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Program performance is assessed primarily on the basis of project milestones. Performance baselines are not established in any formal way. Although they are not tied directly to any specific measures or targets in DOT strategic or performance plans, this program contributes to a number of DOT goals and strategic objectives. Outputs of this program will assist State departments of transportation and regional planning agencies to plan and develop multimodal transportation infrastructure projects that will more effectively; ensure mobility, and accessibility for all users; support economic growth, and reduce regulatory and analytical burden.

Infrastructure – Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance	Modeling research will develop tools, methods and guidance to support a clearer understanding of the complex relationship between transportation and the environment, especially in the areas of air quality, highway traffic noise, and travel demand forecasting process. It will promote more informed transportation decision making that improves transportation planning, programming, operations, and coordination.
Infrastructure – Strategic Objective 3: System Operations and Performance	Air quality, highway traffic noise and travel demand modeling research will focus on technologies, tools, analysis methods, and performance management approaches to accelerate the environment review process, and to effectively and efficiently analyze the impacts of projects on the environment and communities so that transportation projects, will be delivered more quickly and efficiently

	while maintaining a healthy environment, safeguarding our communities and stimulating economic growth.
Innovation – Strategic Objective 2: Deployment of Innovation	Modeling research will advance the state-of-the practice by developing and deploying analytic methods and tools for air quality, highway traffic noise and travel demand forecasting analyses.
Accountability – Management Objective 1: Regulatory Reform	Modeling research will provide tools and methods to identify approaches in reducing regulatory burden of air quality and highway noise analyses and accelerating the project development processes

Resiliency
$1,800,000

Program Description/Activities:
The Resiliency research program focuses on development and deployment of tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs. Addressing the risk of damage and service interruption and increases in lifecycle cost of infrastructure caused by extreme weather events and natural hazards is essential in ensuring the continued integrity, safety and function of the highway system. To better address these risks and vulnerabilities, FHWA will conduct research and development activities to integrate resiliency and sustainability into transportation planning, project development and design. FHWA will also work with other Federal agencies to better predict and estimate the future levels of exposure of infrastructure to extreme weather events including changes in precipitation patterns, temperature, and cyclonic storm surge and waves. This program will also explore flexibilities in right-of-way use when quantifying existing operational and safety concerns and assist states in identifying what right-of-way could be utilized for alternative uses.

Statutory Requirements:
Is this program statutorily mandated (Y/N)? Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas. More specifically, 23 U.S.C. § 503(b)(3)(B)(viii) states that "the Secretary shall carry out research and development activities…to study vulnerabilities of the transportation system to … extreme events and methods to reduce those vulnerabilities". In addition, 23 U.S.C. § 503(b)(3)(C)(x) and (xvii) specifies that research activities may include "sustainable infrastructure design and construction" and "studies of infrastructure resilience and other adaptation measures" respectively.

Other sections of 23 U.S.C. addresses the resiliency of the highway system in the conduct of FHWA programs and activities, including:

- 23 U.S.C. § 109 (preserve and extend the service life of highways)
- 23 U.S.C. § 116 (preventive maintenance)
- 23 U.S.C. § 119(d)(2)(B) and (C) and 23 U.S.C. § 133(b)(2) (funding eligibility for "protection against extreme events")
- 23 U.S.C. § 134 (a)(1) (management, operation, and development of surface transportation systems)
- 23 U.S.C. § 150(b) (state of good repair)

The Omnibus Appropriations Bill of 2018 conference report instructs FHWA to:

- Submit a report to the House and Senate Committees on Appropriations that includes recommendations for States, MPOs, and cities to plan for and develop resilient Federal-aid highways.
- Expand its technical assistance and training workshops to help coastal States, MPOs, and cities to revise their practices …with the goal of improving the resiliency of our coastal highways and reducing the life-cycle costs.

The FAST Act Section 1413 requires the Secretary to solicit nominations and designation national alternative fuel corridors.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

Resiliency supports the Department's Infrastructure and Innovation Goals and all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

> Infrastructure/Improving Infrastructure: In the Infrastructure Goal, under Strategic Objective 2: Life Cycle and Preventive Maintenance, the Plan states that "DOT will increase its effectiveness in ensuring that infrastructure is resilient enough to withstand extreme weather…which could otherwise disrupt the transportation network and require major reconstruction." Our past work is highlighted as an example in support of this objective under the "Sustainable Highways Initiative." Under RD&T Critical Topics Section 4.3, Improving Infrastructure, the RD&T Plan states that "development of advanced materials can enable new infrastructure designs, improve structural resilience to natural disasters." Our past work, which we propose to continue in FY19, is highlighted as examples of work to support this research area. Conducting research on resiliency and sustainability of highways supports all areas, including rural communities.
>
> Innovation/Improving Mobility: In the Innovation Goal, under Strategic Initiative 1: Development of Innovation, the Plan identifies development of new tools to improve transportation infrastructure durability and resilience as a priority innovation area. Our proposed research for FY19 directly supports these objectives by developing and deploying tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs.

Program Objectives:

The goal of this program is to integrate consideration of resiliency and sustainability into the transportation planning, project development and design processes. The program objectives are:

- Develop and deploy of tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs
- Provide guidance to State departments of transportation (State DOTs) and other partners on resiliency and durability
- Support expansion of alternative fuel corridors through technical assistance and training
- Disseminate research through use of workshops, training and peer-to-peer communication
- Identify, share, and promote best practices for assessing and addressing system vulnerabilities
- Partner with State DOTs and others to improve tools and methods through demonstration projects and applied research (jointly with HIF)
- Update training on engineering highways in coastal and riverine environments (jointly with HIF)

- Conduct studies with other Federal agencies to improve predictions and estimates of future levels of extreme weather exposure for use in planning and design of highways and bridges (jointly with HIF)
- Explore flexibilities in right-of-way use when quantifying existing operational and safety concerns. Address technical analysis and data needs to inform decision making
- Assist states in identifying what right-of-way could be utilized for alternative uses.

Key FY19 FHWA Resiliency R&T Program Activities.

Activity	Period of Performance	Partners/Notes
Support expansion of alternative fuel corridors through technical assistance and training	FY19 – FY20	USDOE, Volpe center, AASHTO
Partner with State DOTs and others to improve tools and methods through demonstration projects and applied research	FY19 – FY20	State DOTs, MPOs, AASHTO
Expand training and technical assistance on planning and engineering highways in coastal and riverine environments	FY19 – FY21	HIF, TFHRC
Explore flexibilities in right-of-way use when quantifying existing operational and safety concerns.	FY19 – FY20	State DOTs, AASHTO

Research Collaboration Partners:
Collaboration on resiliency and sustainability involves engagement with key stakeholders in both formal and informal settings to gather input concerning research challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Primary stakeholders include representatives of individual State DOTs and metropolitan planning organizations, Federal land management agencies (FLMAs), and pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB). Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured.

In addition, resiliency and sustainability research is conducted in coordination and partnership with several other FHWA program offices. HEP regularly collaborates with the Office of Infrastructure (HIF), Operations (HOP), and Federal Lands Highway (HFL).

Benefits of Partnership and Partner Contributions to FHWA Resiliency R&T Program.

Partner Organization	User Perspective on Needs	Demonstration/ Field Testing	Deployment	Research Collaboration/ Coordination	Stakeholder Perspective	Subject Matter Expertise	Jointly Funded Research
AASHTO Environment & Sustainability				X	X		
AASHTO Committee on Transportation System Security & Resilience				X	X		
TRB Executive Task Force on Resiliency				X	X		
TRB Special Task Force on Climate Change and Energy				X	X		
TRB Committee on Hydrology and Hydraulics				X	X		
TRB Transportation System Resilience				X	X		
State DOTs	X	X	X				
Metropolitan Planning Organizations	X	X	X				
FLMAs	X	X	X				
Other FHWA Offices (Infrastructure, Operations, Federal Lands)					X	X	X

Acquisition/Assistance:
For research conducted in this program area, FHWA makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, competitive, multi-award task order contracts are used to procure most the research conducted. Other program needs are met through interagency agreements (such as with the Volpe National Transportation Systems Center), and purchase orders for small purchases. We also use the Federal Aid process when partnering directly with a State or MPO on a demonstration project.

This program utilizes both single year and multiyear acquisitions. Competitive, multi-award task order contracts are most often multi-year acquisitions, funded over several fiscal years through individual task orders. Multiyear acquisitions are also utilized for interagency agreements and cooperative agreements. Single year contracts or purchase orders are used rarely since it would be for activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. Most acquisitions under this program are competitively procured.

Opportunities to leverage non-Federal funds are predominantly with State DOTs and MPOs for demonstration or technology deployment projects, with a cost share of 20% to 50% of the total project cost. In addition, pooled fund studies are utilized to leverage State and local research

funding, such as the current study on alternative fueled vehicles. We have also added funding to specific research studies conducted by TRB's National Cooperative Highway Research Program. Internal to FHWA, we often co-sponsor research with other FHWA program offices.

Technology Transfer (T2):
Technology transfer is an integral part of the deployment of resiliency and sustainability research. Funding for outreach and T2 activities is routinely included into research projects along with significant amounts of staff time.

State DOTs, MPOs and FLMAs are the primary stakeholders and beneficiaries of resiliency and sustainability research. The tools, techniques, strategies and methodologies created in this research program are for use by these stakeholders to better integrate resiliency and sustainability into their programs.

T2 Organization	Role	Activities	Results	Performance Measure
FHWA	Outreach, training, and technical assistance	Webinars, presentations, technical guidance and assistance, Outreach materials, Dedicated websites, Training,	Primary audience has full understanding of research products and how to use them effectively	Number of courses, workshops, webinars, presentations, number of outreach participants, number of website hits
State DOTs	User/Implementer	Demonstration pilots, Full implementation	Transportation plans and projects incorporate or use research products	Number of pilots, number of State DOTs using research
Metropolitan Planning Organizations and other Regional Transportation Planning Agencies	User/Implementer	Demonstration pilots, Full implementation	Transportation plans and projects incorporate research products	Number of pilots, number of Agencies using research
AASHTO and Other Stakeholder Organizations	Peer support and exchange	Peer exchanges, Workshops	Implementation results shared among stakeholder peers	Number of webinars, workshops, or outreach participants

The program's outputs take the form of:

- Research publications, including reports and technical appendices

- New and/or updated technical guidance
- Training courses
- Webinars
- Workshops and Peer Exchanges
- Case Studies

The predominant measures for the program's T2 activities are output measures, for example, number of web visits to a research publication, or number of presentations delivered. We also track the number of recipients on our GovDelivery list which we use to inform our stakeholders of research products and T2 opportunities.

The benefits to be accrued include longer service lives and decreased life-cycle costs of highways, fewer interruptions of service due to extreme weather events, and improved methods of responding to natural disasters.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	**Key 2019 Outputs**
Develop and deploy of tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs	Complete resiliency demonstration projects and document results for dissemination to partners
Provide guidance to State departments of transportation (State DOTs) and other partners on resiliency and durability	Document and disseminate results of method and tool research Updated best analysis practices by State DOTs and others Educate and inform partners of research results through training and technical assistance
Conduct studies with other Federal agencies to improve predictions and estimates of future levels of extreme weather exposure	Complete statistical and analysis research on extreme event analysis conducted with USGS and NOAA

Evaluation / Performance Measurement:
Tracking and evaluation of projects is typically done in context of assuring milestones and deliverables are of quality, on time and within budget. Many of our initiatives are complex, multi-year efforts, so tracking individual project performance in the most used performance evaluation mechanism. Programmatic evaluation is conducted periodically in assessing past accomplishments, assessing gaps, and planning new activities and is qualitative in nature. This program area is not addressed in any measures or metrics included in Departmental plans.

Infrastructure - Strategic Objective 1: Project Delivery, Planning, Environment, Funding, and Finance	Resiliency and sustainability research creates tools, methods and procedures that are applied to plans, projects and programs. The application of the research helps agencies better protect the natural and human

	environment, enhance the environmental performance and improve community engagement, and leads to expedited project delivery.
Infrastructure – Strategic Objective 2: Life Cycle and Preventive Maintenance	Resiliency research creates tools, methods and procedures that, when applied to plans and projects, help increase effectiveness by ensuring that infrastructure is resilient enough to withstand extreme weather. Projects life cycle costs are reduced and results in cost savings since projects will not require premature, major reconstruction.
Innovation – Strategic Initiative 1: Development of Innovation	Resiliency research supports development of new, innovative tools to improve transportation infrastructure durability and resilience.

Multimodal Connectivity
$1,000,000

Program Description/Activities:
The Multimodal Connectivity research program studies and fosters the application of multimodal planning and design resources to improve safety and accelerate multimodal project development, with an emphasis on pedestrians and bicyclists. There is a need to provide transportation for people to access economic centers by identifying gaps in connectivity and how to fill the gaps with transit and access to transit.

This research, coordinated with the Federal Railroad Administration (FRA), Federal Transit Administration (FTA), and the National Highway Traffic Safety Administration (NHTSA), will produce techniques, strategies, and tools for improving pedestrian and bicyclist safety and facilities. It will provide technical support to safety professionals at State departments of transportation (DOTs), metropolitan planning organizations (MPOs), local governments, and Federal land management agencies. Research gaps are discussed and evaluated through the OST Bike and Pedestrian Workgroup, and the new Mobility Innovation Working Group.

To meet multimodal connectivity goals, this research will provide accurate and timely information about the National Highway System (NHS) and its component parts, which is critical to efficient multimodal transportation planning. In addition, research will provide technical information and methods for State DOTs, MPOs, local governments, and others to support economic development goals.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

The goal of this research is to support States and MPOs in planning for new bicycle and pedestrian facilities on highways and bridges per the metropolitan and statewide planning statutes (23 U.S.C. 134(c)(2) and 23 U.S.C. 135(a)(2)). These provisions require States and MPOs to provide for the planning, development, and integrated management and operation of transportation systems and facilities (including safe and accessible pedestrian walkways, bicycle transportation facilities, and intermodal facilities).

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure

Multimodal connectivity supports the Department's Safety and Infrastructure Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Safety/Promoting Safety: This research will provide tools, technologies, guidance, and training to support State DOTs, MPOs, and other transportation agencies in ensuring that multimodal transportation facilities are planned and designed to safely accommodate all users, including pedestrians and bicyclists. We need to reduce pedestrian and bicyclist fatalities and serious injuries while improving access to jobs and other important destinations. Through this investment, we will develop and implement products to support data-driven, systemic safety improvements. This includes cooperation with NHTSA to promote safety research and communication.

Infrastructure/Improving Infrastructure: Multimodal connectivity research will provide tools, technologies, guidance, and training to support State DOTs, MPOs, and other transportation agencies to plan and prioritize multimodal investments, accelerate the delivery of multimodal infrastructure more efficiently and effectively, and improve connectivity, accessibility, safety, and convenience for all users, including those in rural areas.

For example, people in low income and underserved transportation areas of Baltimore cannot access jobs along the I-270 Tech Corridor 20 miles away. As transit options improve, communities need to plan for walking and biking networks around fixed route stops, shared use mobility hubs, and passenger intermodal facilities.

FHWA and FTA coordinated to produce the *City of Richmond: Bicycle and Pedestrian Network Improvement Study*, which provides a detailed set of infrastructure improvement recommendations to enhance bicycle and pedestrian access to and from seven future bus rapid transit stations along a 7.6-mile corridor in Richmond, Virginia.

FHWA assisted FTA in developing the *Manual on Pedestrian and Bicycle Connections to Transit*, a compendium of best practices to help transit and other transportation professionals improve pedestrian and bicycle safety and access to transit, including information on evaluating, planning for, and implementing improvements to pedestrian and bicycle access to transit.

The National Park Service, Department of Housing and Urban Development, Centers for Disease Control and Prevention, and the Environmental Protection Agency have used FHWA's multimodal research products to advance access to recreation, improve health and environmental outcomes, and improve connectivity for housing and jobs,

Accurate and up-to-date information about the NHS is critical for State and local transportation planners to effectively plan for an efficient multimodal transportation system. The NHS provides the critical links and intermodal connectors that connect all transportation modes.

Improving Mobility/Preserving the Environment: Multimodal connectivity research will study technologies, tools, analysis methods, and performance management approaches to promote to improve multimodal mobility for all users, while safeguarding communities, maintaining a healthy environment, and stimulating economic growth. This research will also address mobility innovations that involve emerging technology, such as shared mobility, mobility as a service, and the interaction of automation with pedestrians and bicyclists. In addition, the research will analyze

the accessibility of the transportation system for underserved populations, public involvement, and economic development.

Program Objectives:
Multimodal connectivity research seeks to promote transportation policy that supports multimodal transportation by assisting transportation agencies to build capacity to support an integrated, safe, and convenient transportation system for all users, in urban, suburban, and rural areas. The objectives are:

- Identify, share, and promote effective and successful tools and information necessary to assess and bridge the gaps in multimodal transportation connectivity.
- Research, develop, and promote strategies that improve multimodal transportation connectivity, including access to transit and safe access across highway, transit, and railroad barriers.
- Research and technology deployment to support an integrated surface transportation system for all users that is efficient, equitable, safe, environmentally sustainable, and supports economic revitalization.
- Improve the way transportation contributes to economic development and communities' quality of life. Research, develop, and promote strategies that encourage multiagency collaboration that supports successful economic development outcomes.
- Identify and promote strategies that strengthen national security and economic development through transportation planning, programming, operations, and management.
- Identify and promote strategies that support equity, access, and public engagement to strengthen the ability of States and communities to respond to citizens' needs.

Key FY19 program activities are identified below.

Activity	Period of Performance	Partners/Notes
Pedestrian and bicycle safety and mobility research and innovation deployment	Ongoing; throughout FY 2019	FRA, FTA, NHTSA State DOTs MPOs Local Governments Federal Land Management Agencies Supports agencies by completing research on innovations in planning and design and providing training materials and technology transfer reflecting those innovations.
Highway Infrastructure and Regional Economic Trends	Ongoing; throughout FY 2019	FRA, FTA, NHTSA State DOTs MPOs Rural planning agencies Local agencies Federal Land Management Agencies Supports agencies by completing research on innovations in economic analysis and related best practices.

Administration of the National Highway System Official Record and GIS Database	Ongoing; throughout FY 2021	State DOTs MPOs Rural planning agencies Federal Land Management Agencies Department of Defense Supports agencies by establishing eligibility for Federal-aid funding; necessary for agencies to meet performance management requirements.

Research Collaboration Partners:
Collaboration on multimodal connectivity regularly involves engagement with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. Stakeholders include FRA, FTA, NHTSA, representatives of Federal Land Management agencies, State DOTs, MPOs and other regional planning agencies, pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), universities engage in related work, and professional organizations such as the Institute of Transportation Engineers, the Association of Pedestrian and Bicycle Professionals, the National Association of City Transportation Officials, and the American Planning Association. Interactions with AASHTO, TRB, and professional organizations generally occur at regular intervals (at least annually, and as often as quarterly), but are not formally tracked or measured. Nongovernment groups partner and contribute to multimodal connectivity research.

Benefits of Partnership and Partner Contributions to FHWA Multimodal Connectivity R&T Program

Partner Organization	**User Perspective on Needs**	**Demonstration/ Field Testing**	**Deployment**	**Research Collaboration/ Coordination**	**Stakeholder Perspective**	**Subject Matter Expertise**	**Jointly Funded Research**
AASHTO Active Transportation Council					X		
AASHTO Center for Environmental Excellence				X	X	X	
TRB Standing Committee on Pedestrians					X		
TRB Standing Committee on Bicycle Transportation					X		
TRB Standing Committee Environmental Justice in Transportation					X		
TRB Standing Committee on Transportation and Economic Development				X	X	X	
TRB Standing Committee on Public Involvement					X		
State DOTs	X	X	X				X

Regional Transportation Planning Agencies	X	X	X				
National Association of City Transportation Officials					X		
Association of Metropolitan Planning Organizations				X	X	X	
Association of Pedestrian and Bicycle Professionals					X		
University of North Carolina Highway Safety Research Center				X		X	
Portland State University's Transportation Research and Education Center				X		X	
National Association of Development Organizations					X		

Acquisition/Assistance:
For multimodal connectivity research, FHWA makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. For example, competitive, multi-award task order contracts are being used to procure much of the multimodal connectivity currently conducted. Other program needs are met through interagency agreements (such as with the Volpe National Transportation Systems Center), cooperative agreement (such as with University of North Carolina Highway Safety Research Center, in coordination with NHTSA), and purchase orders for small purchases.

This program utilizes both single year and multiyear acquisitions. Competitive, multi-award task order contracts are most often multiyear acquisitions, funded over several fiscal years through individual task orders. Multiyear acquisitions are also utilized for interagency agreements and cooperative agreements. Single year contracts or purchase orders are used for projects and activities of limited scope.

"Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. Most acquisitions under this program are competitively procured.

Opportunities to leverage non-Federal funds are predominantly with State and regional transportation planning agencies with a cost share of 20% or the total project cost. In addition, pooled fund studies are utilized to leverage funding, such as the current Fostering Innovation in Pedestrian and Bicycle Transportation Pooled Fund Study. A specific example of nongovernmental partnership includes work with University of North Carolina Highway Safety Research Center to support research that increases the safety of walking and bicycling.

Technology Transfer (T2):
Technology transfer is an integral part of the implementing multimodal connectivity research, and is funded as such.

State DOTs, MPOs, and other regional planning agencies are the primary stakeholders and beneficiaries of multimodal connectivity research, such that their personnel are the primary audience for the program's research outputs. Consultants and contractors providing services to those agencies are also engaged.

T2 Organization	Role	Activities	Results	Performance Measure

FHWA and other DOT modes	Outreach, training, and technical assistance	Webinars, presentations, technical assistance, training, demonstration pilots	Primary audience has full understanding of research products and how to use them effectively	Number of webinars, number of outreach participants, number of pilots funded
State DOTs	Implementer	Demonstration pilots, full implementation	Transportation plans and projects incorporate research products	Number of State DOTs using research
Regional Transportation Planning Agencies	Implementer	Demonstration pilots, full implementation	Transportation plans and projects incorporate research products	Number of Agencies using research
AASHTO and Other Stakeholder Organizations	Peer support and exchange	Peer exchanges,	Implementation results shared among stakeholder peers	Number of webinars or outreach participants

The program's outputs take the form of:

- Research publications, including reports and technical notes
- Technical assistance to a wide range of audiences
- FHWA websites, newsletters, publications, research reports, and social media
- Pedestrian and Bicycle Information Center website, image library, and reports
- Webinars, conducted jointly with FRA, FTA, and NHTSA, as appropriate
- Presentations at professional conferences
- Meetings with State DOTs and other partners

The predominant measures for the program's T2 activities are output measures, for example, number of web visit to a research publication, or number of presentations delivered. Audience assessments of effectiveness are obtained for some webinars and formal classroom training.

The benefits to be accrued by multimodal connectivity stakeholders include efficiency and effectiveness improvements in the planning, development, and design of safe and connected multimodal projects that benefit all users.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	**Key 2019 Outputs**
Pedestrian and bicycle safety and mobility research and innovation deployment.	• Supporting the systemic application of cost-effective countermeasures with known safety benefits that can help reduce pedestrian fatalities at both uncontrolled and signalized crossing locations, in rural and urban areas. • Measuring bicycle safety and network quality. • Understanding common pedestrian/bicycle crash types.

	• Implementing improved bicycle design guidance and safety information in conjunction with the next edition of the AASHTO Guide for the Development of Bicycle Facilities. • Improving designs and engineering to help older adults walk and bike more safely. • Understanding the impacts of automation on bicycling and walking safety. • Planning, designing, and setting policies around emerging vehicle types and monitoring safety issues. • Increasing the adoption of child/teen pedestrian and bicyclist safety activities and projects, coordinated with NHTSA. • Improving the integration of existing bicycle and pedestrian data collection and project prioritization methodologies. • Improving the reconstruction, signing, and markings of intersections. • Providing an overall program of multistate pooled fund research related to fostering innovation in pedestrian and bicycle transportation, which focuses on planning, safety, design, equity, data, and other issues. • Updating aging design flexibility and performance based practical design resources to reflect modern research and safety and infrastructure standards, such as the updated AASHTO Green Book. • Providing information on rail-with-trails research, together with FRA, FTA, and NHTSA. • Analyzing, coordinating, and deploying mobility-related research and key strategic policy ideas being conducted across FHWA and externally. The analysis will reflect the U.S. DOT and FHWA Strategic Plans, and may include recommendations for internal consideration. • Examining how transportation economic development is addressed in project delivery. Additional research and analysis is needed to facilitate Federal interagency efforts to advance economic revitalization and job growth, including in rural areas. • Analyzing public involvement approaches, methodologies, and data in the planning and NEPA processes, with an emphasis on increasing transportation choices; expanding access to essential services; and improving connectivity for citizens to jobs, health care, and other critical destinations. • Analyzing the accessibility of multimodal transportation network performance for all users and modes, especially for people with disabilities. The analysis will focus on complete trips, underserved populations, and changing demographics.

Research, develop, and promote strategies that encourage multiagency collaboration that supports successful economic development outcomes.	• Case studies of the use of economic development analysis in project development. • Peer exchanges on integrating economic development in transportation planning.

Evaluation / Performance Measurement:
Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated periodically by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Program performance is based on an assessment of project milestones. Performance baselines are not established in any formal way.

DOT Strategic Plan – Strategic Objectives	Performance Goals
Safety – Strategic Objective 1: Systemic Safety Approach	Multimodal connectivity research will support the reduction of surface transportation-related fatalities by systemic multimodal network planning and design that improves the safety of bicyclists and pedestrians.
Infrastructure – Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance	Multimodal connectivity research will enhance the environmental review process by improving context sensitive design, public engagement, and related analysis to accelerate project decision-making.
Infrastructure – Strategic Objective 4: Economic Competitiveness and Workforces	Multimodal connectivity research will encourage investments that promote economic revitalization, job growth, and affordable transportation options by promoting collaborative strategies that encourage successful economic development, especially in underserved and rural communities

Although they are not tied directly to any specific measures or targets in DOT strategic or performance plans, outputs of this program will assist State DOTs, MPOs, and other regional planning agencies to plan and develop multimodal transportation infrastructure projects that will more effectively reduce safety risks; ensure safety, mobility, and accessibility for all users; and support economic growth.

Policy Analysis and Global Outreach
$4,660,000

Program Description/Activities:
The domestic component of the Policy Analysis and Global Outreach program seeks to enhance FHWA's understanding how national transportation strategies and policies can improve the overall value of transportation investments to the American people through 1) integrating economic, public policy, geography, and statistics disciplines to improve FHWA forecasting and policy analysis capabilities; 2) providing 'what if' empirical analyses of future transportation needs and policy options; and 3) facilitating transportation policy and strategy dialogue. Economic and socio-demographic research conducted as part of this program complements program office expertise while providing an agency-wide perspective on policy context and options. This research program supports the development and maintenance of a carefully-selected suite of tools and models to assess and forecast the factors shaping travel behavior and user needs, system performance, highway construction costs, and user contributions to highway costs; identify cost-effective future highway investment levels and associated job/gross domestic product growth; and assess a range of revenue options. Although national in focus, this research includes the identification of those geographic and demographic differences in transportation availability, performance, and costs which are key to understanding the scalability and impact of program and policy options. The domestic component of this research program encompasses two broad lines of research which include eight main emphasis areas:

- *Transportation Investment*
    - Impacts of Investment on Conditions and Performance
    - Macroeconomic Impacts
    - Benefit-Cost Analysis
    - Highway Costs and Funding Options.
- *Transportation Demand and Travel Behavior: Policies and Strategies for Future Transportation Markets*
    - Emerging Trends and Future Performance
    - Geo-Economics of Transportation
    - Strategic and Performance Management
    - Future Policy Symposia

The international component of the Policy Analysis and Global Outreach program seeks to gather, promote and disseminate global policy, best practices, and technical innovations to ensure a safe and efficient United States (U.S.) highway transportation infrastructure. Three main international program elements, Global Benchmarking, Multilateral, and Bilateral, facilitate the exchange of innovative ideas, best practices and technologies that can have a direct and practical impact on improving the high system. Through collaboration with international and domestic partners, this program works to address the Secretary's and FHWA's priorities. The three program elements also work together and cross-pollinate, with developments in one area sometimes leading to opportunities in others. For example, a one-time visit to a country for Global Benchmarking may lead to a long-term exchange as part of a bilateral relationship. A successful bilateral exchange may lead to a multilateral research project. Information or developments gleaned during a multilateral meeting may attract the interest of FHWA subject matter experts and lead to a Global Benchmarking study. In this way, the programs work in complementary ways to address different aspects of FHWA's international efforts, all while focusing on U.S. priorities and the objectives of the agency.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes (partially) . The program is authorized in 23 USC §502 and 23 USC §503, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others. Research conducted under this program cuts across these areas, supporting the development of transportation policies and assessing the impacts of proposed and implemented policies. Policy research provides the foundation for the development of new policies and legislative actions, assists decision makers in the evaluation and selection of policy options, and facilitates subsequent policy implementation. The international component of this program has a strong emphasis on technology and innovation development and deployment.

Within the domestic component of this research program area, one major focus is addressing the requirement under 23 U.S.C. §503(b)(8) for the submission of a biennial report to Congress that describes estimates of the future highway and bridge needs of the U.S and the backlog of current highway and bridge needs. Meeting the expectations of the Congress requires an ongoing research investment to support model development, data analysis, and communication of results.

This research program supports the development of economic impact analysis of the regulations issued by the Federal agencies required under Section 6(a)(3)(c) of Executive Order (E.O.) 12866, "Regulatory Planning and Review," the Regulatory Right-to-Know Act, a variety of related authorities and the January 30, 2017, Presidential E.O. 13771, "Reducing Regulation and Controlling Regulatory Costs."

This program directs resources towards FHWA strategic and performance planning efforts, in accordance with the Government Performance and Results Act Modernization Act of 2010 (P.L. 111–352), the Program Management Improvement Accountability Act (P.L. 114–264).

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The Policy Analysis and Global Outreach program supports all four Department Goals and contributes to all four DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: This research program contributes to a systemic safety approach by developing data-driven baseline forecasts of crash and fatality rates reflecting changing economic and socio-demographic factors and travel behavior (including modal choices). This research provides a context for assessing the impacts of a range of broad policy options as well as specific safety options identified through participation in the USDOT Safety Data Initiative, which is supported by this research program. Predictive methods and analysis as well as socio-economic factors affecting rural travel safety are being explored.

International safety-related activities include examples such as leading the development and dissemination of the Road Safety Manual for the World Road Association, collaboration with Japan and the Netherlands on bridge and tunnel safety, and road safety, respectively.

Infrastructure/Improving Infrastructure/Improving Mobility/Preserving the Environment: This research program supports the development of tools and techniques for evaluating tradeoffs across competing types of transportation investments, including specialized and priced lanes, and multimodal applications. This research includes tracking of highway construction costs, baseline forecasts of established system performance metrics, and estimates of cost-effective investment levels that can be used in setting performance targets intelligently. Risk assessment is also addressed in this research area to support investment decisions and planning during an environment of uncertainty as is with rapid technology change. Transportation system investment, performance, and associated travel mobility are assessed for rural areas as well as for the Nation.

International infrastructure-related activities include supporting the development and dissemination of the Road Network Operations/Intelligent Transportation Systems (ITS) Manuals for the World Road Association, studies of infrastructure resiliency practices in Netherlands, Denmark, and Norway, exchanges with Korea on bridges and pavements, and collaboration with Japan on Intelligent Transportation Systems and environmental issues.

Innovation: This research program focuses heavily on the identification of emerging policy issues and support for the agency's development of strategies for addressing them. This includes extensive coordination among stakeholders, exploration of emerging data analytic and methodological approaches for assessing the impacts of policies and strategies, including FHWA's first use of Artificial Intelligence data fusion techniques to understand

emerging travel behavior. This program takes innovative approaches to assessing the various ways in which transportation investments and economic development affect each other, including GPD, employment, and land use. This research program is also exploring multi-modal geo-economic variations in transportation infrastructure costs, travel demand, and transportation services to better understand how technology and socio-economic changes may be reshaping future transportation system performance and policy opportunities. This geo-economic approach includes specific consideration of the differing travel needs of rural communities.

The Global Benchmarking Program (GBP) obtains and adapts foreign innovations that directly support DOT strategic goals and critical Research Development and Technology (RD&T) areas. Instead of re-creating advances already developed by other countries, the GBP facilitates the acquisition and adoption of technologies and best practices already available and used abroad. FHWA is supporting dissemination and implementation efforts of web-based versions of the Road Safety Manual and Road Network Operations/ITS Manuals. FHWA led the development of these products for the World Road Association. Bilateral program activities directly address agency priorities. The FHWA's Office of International Programs works closely with FHWA Leadership, Program Offices, and the Office of the Secretary of Transportation to ensure that international topics and activities are geared to Strategic Goals and topics. The specific areas addressed by each bilateral relationship depend on the expertise of the country involved and the interests of our partners, both internal and international. Two examples are Japan, with whom we have a long-standing collaboration on bridge and seismic issues that has been very beneficial, and the Netherlands, with whom we have collaborated on road safety, performance measurement, project acceleration, infrastructure resilience, emergency/crisis management, truck platooning and Smart Mobility.

Accountability: This program supports economic regulatory impact analyses conducted on behalf of the Office of Chief Counsel for all regulatory and deregulatory actions under consideration within FHWA. It enables more consistent and methodologically-sound application of lifecycle-cost, and related economic-impact strategic, programmatic, and project decision-making. This program's baseline forecasting also serves as an anchor for accountable strategic planning and development of measurable performance targets.

International activities in this area include collaboration with the Netherlands on emergency/crisis management.

The domestic portion of this program includes targeted research on rural communities, in particular measuring rural transportation access and identification of potential strategies for improvements. Past efforts include the development of access measures for all rural counties in U.S, documenting distance to transportation facilities, work/shop centers, and broadband access. A visioning session was held and report prepared on rural trends in the context of transportation policy and policy needs. Current efforts include the development of rural technology research briefs on topics including the impacts of automated vehicle technology on rural communities, broadband internet access on rural transportation, and impacts of agricultural automation on rural areas. A separate set of rural economic research briefs and white papers covers topics on boom and bust cycles of rural infrastructure investment, level of investment in rural highways, and trends in

rural transportation finance. Another white paper discusses the migration patterns in and out of rural areas and factors influencing population growth and decline in these areas.

The international component of this program has supported investment in the development and implementation of the World Road Association products (noted above) that adapt well to the U.S. rural transportation arena. U.S. representatives from state DOTs are leading the effort of promoting and disseminating these products beyond the Federal sphere including to counties and local rural communities. While the Bilateral program does not specifically target rural areas, the benefits from the exchanges are applicable to rural, suburban and urban areas.

Program Objectives:
The domestic component of this research program informs decisions concerning highway infrastructure investments, policies, and strategies at all levels of government by providing assessments of their impacts on the future condition and performance of our highways and transportation systems, as well as the impacts of these investments on our broader national economy.

Domestic program objectives include:

- Solicit knowledge from outside experts to inform future policy directions through means such as organized symposia.
- Identify cost-effective strategies and investment levels for the nation's highways overall, for regulatory or programmatic actions, and to support grant programs.
- Provide empirical estimates and base forecasts of the factors shaping highway investment cost-effectiveness, including construction costs and user cost impacts.
- Provide the insights necessary to align transportation policies and strategies to emerging transportation trends in technology, costs, travel behavior, and economic vitality at the national, regional, and local levels.
- Provide the insights necessary to understand how geography and markets shape mobility, travel patterns and modal choices and how policy and strategy impacts may vary regionally and locally.

The international activities conducted as part of this program fall within FHWA's role as a national leader and facilitator of innovation in the highway transportation industry, which is a governmental rather than a private sector role. Bringing these innovations and best practices to the U.S. for industry while potentially opening access for U.S. companies abroad provides benefits for the entire industry and the traveling public.

International program objectives include:

- Identifying, evaluating, and adapting innovative foreign technologies and practices that have the potential to significantly improve highway transportation in the U.S.
- Enable U.S. stakeholders to access and accelerate deployment of technology, best practices and information relevant to domestic transportation priorities
- Promote global awareness of U.S. technologies and best practices, which improves market access for U.S. transportation firms, whose services are based on U.S. standards.

Much of the policy research and analysis conducted as part of this program is intended to inform inherently governmental policy, regulatory, and strategy decisions, for which the private sector is not positioned to provide unbiased analytics or alternatives. Policy options can significantly shape

the efficiency of transportation networks and the availability of transportation service to people and businesses. While FHWA taps the results of privately-funded research, effective stewardship of highway resources requires the availability of core data and analysis reflecting the full, broader public interest, as well as the quality control and transparency needed to be able to provide consistent and well-documented assumptions and methods behind the information used in making public decisions. The private sector would not have a direct interest in supporting much of this research on its own.

The international activities conducted as part of this program fall within FHWA's role as a national leader and facilitator of innovation in the highway transportation industry, which is governmental rather than a private sector role. Bringing these innovations and best practices to the U.S. for industry while potentially opening access for U.S. companies abroad provides benefits for the entire sector.

Key FY19 program activities are identified in the table below.

Activity	Period of Performance	Partners/Notes
Impact of Investment on Conditions and Performance		FTA, FHWA program offices
• Develop NBIAS version 5.3	2018-2019	
• Develop HERS version 5.5	2018-2029	
• Convert HERS from FORTRAN to modern program language	2019-2020	
• Develop 25th C&P Report	2019-2020	
Macroeconomic Impacts		
• Develop USAGE version 1.1	2018-2019	
Benefit-Cost Analysis		
• New vehicle operating cost model – develop and inform potential users.	2015–2019	TRB, State DOTs, etc. to inform potential users.
• Research value of travel time savings and reliability	2015-2019	DOT OST, PIARC
• Enhance methodologies for ex post evaluation of highway projects including priced managed lanes.	2017-2020	PIARC, TRB, Millennium Challenge Corporation
• Benefit-cost evaluation of options of fuel economy standards vs. fuel taxes.	2019-2020	EIA, NHTSA, EPA
• Regulatory analyses		
• Economic support to facilitate BCA reviews for discretionary grants	2015-2020 Ongoing	FHWA Program Offices OST
Highway Costs and Funding Options		FHWA Office of Infrastructure, and Office of Infrastructure R&D
• Pavement Distress Analysis and Prediction Modeling	2017-2019	
• Produce National Highway Construction Cost Index and improve understanding of its drivers;	2018-2019	

• Estimate external costs generated by highway users; • Estimate marginal costs of highway infrastructure; • Assess whether public investment promotes or depresses private investment	2017-2019 2018-2019	
Emerging Trends and Future Performance • Develop and enhance methods for analyzing system and multimodal impacts of emerging trends and policy option. • Analyze and forecast travel demand in the context of emerging economic, demographic, and technological trends. • Develop methods to maximize application of Big data and data fusion and integration needs for enhance understanding of the level and distribution of future demand. • Identify and develop solutions to address key uncertainties, risks and opportunities with Automated Vehicles • Analyze policy alternatives and system impacts for emerging technologies including shared modes, on demand transportation, automated and/or connected vehicles, alternative fuel vehicles, and multimodal corridor investments.	2018-2022	Symposia, NHTSA, FHWA program offices, TRB, Census, BLS, and University research centers, private industry, DOE, nonprofit and special interest groups.
Geo-Economics of Transportation: • Geospatial transportation economics, modal options, and user behavior • Geospatial modeling of user/freight throughput given alternative multi-modal ROW configurations • Develop framework for linking system modal mix, management solutions, and system performance to geographic factors to support regional knowledge sharing, planning and policy formulation. Modeling Strategies for Reflecting Demand Response to Tolled and Priced Lanes Framing Paper • Analysis of rural mobility, employment, and safety. • Initiate new collaborative research efforts based on FHWA leadership input	2018-2019 2018-2019 2018-2019 2019-2020 2019-2023	FHWA program offices, US DOT, University research centers, US national laboratories, DOE
Strategic and Performance Management: • Develop Performance Measures through statistical analysis to improve safety and mobility.	2018-2022	Symposia, US DOT, FHWA program offices, OMB

Future Policy Symposia: • Host transportation symposia to provide a formalized information resource for FHWA to gain insight and perspectives on key transportation policy questions in the context of emerging trends.	2016 - 2020	Academia; federal, State and local agencies; policy and research organizations; other private sector
Global Benchmarking Program • Initiate two new benchmarking studies. • Continue development of two studies initiated in 2018.	2018 - 2023	Other FHWA HQ and field Offices; AASHTO, NCHRP, TRB, State DOTs, U.S. academic institutions, occasional private sector partners, Department of State, foreign national ministries of transport, foreign research institutes
Multilateral • Engage with the World Road Association, the Forum of European National Highway Research Laboratories (FEHRL), and the Conference of European Directors of Road (CEDR), as well as strategically targeted trilateral collaborations, such as cooperation on ITS with Japan and the European Commission (EC).	2016-2022	World Road Association, TRB, FEHRL, EU/EC, CEDR, State DOTs
Bilateral • Continue FHWA's prioritized bilateral engagements which cover topics such as innovative financing, freight, infrastructure resilience, safety, bridges, binational planning and coordination, and pavement, among others. Bilateral partnerships currently include: Japan, Korea, the Netherlands, Australia, Sweden, Mexico, South Africa, Brazil, and Israel.	2018-2021	State Department, Dept. of Commerce, U.S. Trade Development Agency, Academic Institutions, World Bank, Interamerican Development Bank, Foreign Ministries and Embassies, State DOTs

Research Collaboration Partners:
FHWA policy staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally. A key tool for gathering stakeholder input are future policy symposia, a quarterly dialogue series which facilitates discussion with external experts and practitioners to frame future policy considerations and options. The information gathered via the symposia help to broaden the relevance of future policy research and helps avoid duplication with research being conducted by other entities. Input received via this mechanism are documented in summary reports.

Another mechanism used to gather stakeholder input are rollout events for individual policy research projects. For example, following the release of the biennial Conditions and Performance report, FHWA staff typically brief Congressional staff and transportation industry groups on key findings. The questions posed during such briefings (particularly those for which current modeling is insufficient to answer such questions) help guide plans for future model enhancement and development. Input gathered from informal settings is not routinely tracked in a systematic way.

The input obtained through these interactions is considered by program staff as they identify and formulate a program of research and technology initiatives that, in accordance with 23 USC 502(a)(3),

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Primary partners for the domestic portion of this program area include:

- FHWA Headquarters Program Offices (FHWA HQ)
- Federal Transit Administration (FTA)
- National Highway Traffic Safety Administration (NHTSA)
- Federal Aviation Administration (FAA)
- Office of the Secretary of Transportation, Bureau of Transportation Statistics (BTS)
- Department of Labor, Bureau of Labor Statistics (BLS)
- Department of Commerce, Bureau of the Census (Census)
- Transportation Research Board (TRB)
- Professional Societies
- Academic Institutions (Academia)
- State and local agencies

Primary partners for the international portion of this program area include:

- FHWA (Administrator's Office, all the HQ program offices, TFHRC, HCC, Acquisitions, various Division offices, Resource Centers)
- Office of the Secretary of Transportation, multiple offices (OST)
- U.S. Department of State, headquarters and embassies (State Dept.)
- U.S. Department of Commerce (Commerce Dept.)

- U.S. Trade and Development Agency (USTDA)
- American Association of State Highway & Transportation Officials (AASHTO)
- State Departments of Transportation (State DOTs)
- Academic institutions
- The Transportation Research Board
- Private sector partners (limited due to authorization restrictions and the need to avoid the appearance of favoritism)
- Foreign national ministries of transport, foreign provincial/state ministries of transport, foreign ministries of foreign affairs/embassies (Foreign agencies)
- International Organizations - The World Bank, the World Road Association, the Forum of European National Highway Research Laboratories (FEHRL), the Interamerican Development Bank

Benefits of Partnership and Partner Contributions to FHWA Policy Analysis and Global Outreach Program

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services (Including Data)	Funding
FHWA HQ						X	X		X
FHWA Field		X		X	X		X	X	
FTA						X			
NHTSA				X		X			
FAA	X	X	X			X	X	X	
BTS						X	X	X	
Other OST			X						X
BLS	X		X	X		X		X	
Census	X		X	X		X		X	
Commerce	X	X	X		X		X	X	X
State Dept.							X	X	X
USTDA		X	X		X		X		X
NCHRP		X	X			X	X	X	X
TRB	X	X	X			X	X	X	
AASHTO	X	X	X		X	X	X	X	X
Academia	X		X	X	X	X	X	X	
State & Local agencies	X	X	X	X	X	X	X	X	X
Policy and Research Organizations		X				X	X		
Other Private Sector	X	X		X	X	X	X	X	X
World Road Association	X		X		X	X	X	X	X

FEHRL	X	X	X	X	X	X	X	X	X
EU/EC	X	X	X	X	X	X	X	X	X
CEDR	X	X	X	X	X	X	X	X	X
Interamerican Development Bank							X	X	X
Foreign Ministries and Embassies				X		X	X	X	X

Acquisition/Assistance:
The Policy Analysis and Global Outreach research program makes use of a variety of acquisition methods, with the specific mechanism depending on the program need to be met. This program generally utilizes competitive procurement processes, including competitively procured multi-year IDIQ contracts, GSA schedule, cooperative agreements, and small simplified acquisitions. The range of acquisition methods utilized is being expanded to include mechanisms such as agreements with competitively procured federally funded research and development centers (FFRDCs).

- Sole source acquisitions are used occasionally for this program, typically for interagency agreements. This program utilizes economists from the Volpe National Transportation Systems Center (VNTSC) for some types of modeling and analysis work. The VNTSC is typically used where they have a comparative advantage over outside vendors in terms of experience and expertise in a particular technical area or for selected inherently governmental activities for private sector vendors might have inherent conflicts of interest. Because Volpe is part of the U.S. DOT, it can act as a Federal partner in many of its projects. As such, Volpe understands the government perspective and provides objective expertise (because it is not a for-profit contractor). Other examples of sole-source acquisitions include membership to the World Road Association. Other program activities have used the 8(a) contracting mechanisms, due to the relatively small dollar amounts involved and the simplified acquisition process. This permits a sole source contract, though multiple vendors are always evaluated prior to selecting a firm for the award.

- The program uses a mix of single year and multi-year acquisitions, as research projects in this area will often take longer than 1 year to complete. Multi-year acquisitions are often set up with option years or optional tasks, so that the government's financial commitment is minimized and new contracts can be solicited if a vendor's performance is not meeting expectations. Multi-year acquisitions are often used for international activities, given the unique characteristics of international coordination and the impact of foreign funding and planning processes, which can result in unforeseen delays.
- Traditionally the domestic portion of this research program has not entered into cost sharing agreements with outside entities, but this is an avenue that is currently being explored, via a cooperative agreement with a required 20% match that is currently being solicited. Some aspects of this research program that primarily generate pre-decisional material do not lend themselves to external partnerships, but this would be a viable option for research projects with external deliverables. The international portion of this research program has traditionally entered into more cost sharing agreements. For example, the GBP leverages funding from AASHTO/NCHRP which is used to support state DOT participation on GBP studies. Other agencies, other DOT modes and offices and foreign counterparts contribute significantly to bilateral agreements, with both funds and in-kind contributions.

Technology Transfer (T2):
The FHWA's involvement in multi-lateral relations spans a wide range of program and research activities that cover Department and Agency priorities. These relationships include global and regional organizations, such as the World Road Association (WRA), the Forum of European National Highway Research Laboratories (FEHRL), the European Union/European Commission (EU/EC), and the Conference of the European Directors of Roads (CEDR). Participation in the WRA provides a means through which FHWA can exchange information on innovative road practices with 120 member governments.

There has been and continues to be technology transfer through the multilateral program. For example, the U.S. has gained significant technical knowledge in the winter maintenance field through the World Road Association (WRA) participation. Deicing and anti-icing practices used in many U.S. cities are a direct result of involvement with the WRA. The USDOT-European Commission Twinning Initiative has also led to beneficial technology transfer. Twinning research projects address U.S. transportation challenges by improving the transportation system and reducing taxpayer costs.

The Office of International Programs' (OIP) Global Benchmarking Program (GBP) supports FHWA's leadership role and strategic priorities by seeking out and adapting foreign innovations that could significantly improve highways and highway transportation services in the US. The program focuses on acquiring and adapting technologies and best practices already available and used abroad. This not only helps avoid duplicative research, but it also reduces overall costs and accelerates the deployment of innovative technologies and practices.

Within the international component of this research area, current performance metrics for the GBP focus on process-based outputs. The program operates on the premise that the OIP creates the opportunity to obtain the information overseas through the GBP, but relies on the organizations responsible for the individual study areas (i.e., FHWA program offices, AASHTO committees, TRB) to lead the implementation process. This division of responsibility was established in recognition of the different offices' expertise and resources. Based on this, OIP maintains measures for those parts over which it has responsibility and control. Where possible, benefits and impacts are quantified in dollar savings, time savings, improvements or other measurable indices. This excludes the technical aspects of implementation, which rely on expertise, funds, and access beyond that available to OIP. Performance measures include the extent to which innovative technologies, practices, and ideas identified on studies are: (1) being integrated into U.S. policies and practices and (2) resulting in changes to programs, procedures, and projects.

The OIP' Global Technology Exchange Program (GTEP*)* consists of FHWA's prioritized bilateral engagements that support Departmental and Agency strategic goals, and U.S. foreign and trade policy. Topics include innovative financing, freight, infrastructure resilience, safety, bridges, binational planning and coordination, and pavement, among others. Examples of bilateral partnerships include: Japan, Korea, the Netherlands, Australia, Sweden, Mexico, South Africa, Brazil, and Israel.

The focus of the bilateral program is to exchange innovations and best practices that will have a practical benefit and to facilitate the implementation of that knowledge. Therefore, all the stakeholders and participants mentioned previously are involved in T2 to an extent (though to different degrees in different partnerships), and all benefit, as well as the traveling public and industry. The exchange of ideas, technologies, lessons learned and best practices provides national and State/provincial entities additional tools and information to inform policy decisions, to disseminate among practitioners and to use in

developing better programs for their institutions and industry. The traveling public benefits from the use of new and/or proven ideas and technologies that improve the mobility and safety of U.S. transportation. Industry benefits from the dissemination of better practices and access to new technologies, as well as sometimes by better market access. The audience for the program's outputs is primarily U.S. and foreign national and State agencies, though sometimes industry and academia do participate and are part of the audience. Dissemination takes place through webinars, reports, conference and meeting presentations, and through existing FHWA programs, such as Every Day Counts.

Primary customers for the domestic component of this program research output include FHWA and DOT leadership; some research feeds pre-decisional material that will not ultimately be distributed to the general public. Other research from this program supports the Congress, State and local government decision makers, and transportation policy practitioners. Outputs from the Policy Analysis and Global Outreach (Domestic) program area take the form of:

- Advancing methods for consistently and broadly assessing the effectiveness of transportation investments, policies, and strategies to meet transportation goals.
- Developing ongoing and special-topic studies of emerging transportation trends and strategies for meeting a range of transportation performance goals.
- Facilitating the dialogue needed to inform policy-makers of emerging research on transportation trends and policy effectiveness, and informing the policy research community of emerging transportation policy issues.
- Documenting methods, outcomes, and next steps to facilitate knowledge sharing.

Specific program outputs anticipated in 2019 are identified in the table below.

Program Objective	**Key 2019 Outputs**
Impact of Investment on Conditions and Performance To provide policymakers with information on the impact of alternative investment strategies on system conditions and performance.	• 24th C&P report, providing a 20-year outlook through 2036 on cost-effective highway infrastructure investment add associated impacts on congestion and pavement and bridge conditions. • NBIAS v 5.3 with bridge capacity expansion options, separate VMT growth rates for passenger vehicles and trucks, new replacement rule for bridges rated as poor, and ability to identify and analyze bridges on the National Highway Freight Network (NFHN). • Completion of HERS v. 5.5 for use in 25th C&P report. Update Technical Report and System Maintenance Manual
Macroeconomic Impacts To provide policymakers with information on the impact of alternative funding strategies on macroeconomic measures such as Gross Domestic Product and employment.	• Upgraded USAGE-HWY model based on inputs and feedback from stakeholders and technical experts. Potential updates include differentiating households by travel modes and other travel behavior matrices to assess the distribution of the impacts of transportation policy, and the interactions between transportation policy and socioeconomic conditions. • Technical reports, white papers and policy briefs based on various USAGE-HWY scenarios will be developed to facilitate policy dialogue. The

	documentation will review the approach and assumptions used within the analysis, and comparisons with related findings from external research where relevant.
Benefit-Cost Analysis (BCA) To improve the state of the art in BCA methodology while addressing the agency's needs for regulatory impact analysis, and the Department's need for support in evaluating project BCA's for discretionary grant programs.	• Completion of report on new vehicle operating cost equations. • Presentation/paper on value of travel time savings and reliability • Contributions to portions of PIARC reports on ex post valuation and on travel time reliability. • Briefing on BCA of CAFE and fuel tax options. • Completion of regulatory impact analyses as directed by FHWA Office of Chief Counsel, in cooperation with program offices. • Economic support facilitating staff evaluations of BCA's submitted with discretionary grant applications.
Highway Costs and Funding Options To provide policymakers with information on highway costs, including construction costs and externalities associated with highway use, and to provide analysis and forecasts for funding and financing options.	National Highway Construction Cost Index (NHCCI) • Quarterly index updates. • A technical report on understanding and monitoring the major drivers of the NHCCI. Highway Revenue Forecasting Model • Completion of HRFM 2.0. • Revenue forecasts by vehicle class and weight distribution. • Disaggregated VMT, vehicle stock and sales data. • Updated Operating weight and registered weight group. • Analytical tools for (1) developing vehicle operating weight distribution using Weight-in-Motion data, and (2) disaggregating VMT by vehicle class and weight distribution. Pavement Distress Analysis and Prediction Modeling • A report on current and emerging models and analytical techniques for pavement performance analysis at the national level. External Costs of Highway Users • Analytical tool for estimating external costs of highway users, including congestion, safety, air pollution, and noise pollution. • Annual external cost estimates for ten years in current and constant dollars. Marginal Costs of Highway Infrastructure • Methodology and estimates of marginal costs of highway infrastructure by vehicle class for each state, documentation of methodology and spreadsheets.

Emerging Trends and Future Performance To provide policymakers with information on technological, economic, and socio-demographic forces shaping observed safety, congestion, and reliability, and project future trends.	• Annual analysis and reporting of emerging trends to support forecast of future travel demand and assessment of policy alternatives. • Analysis of policy alternatives and system impacts for emerging technologies including shared modes, on demand transportation, automated and/or connected vehicles, alternative fuel vehicles, and multimodal corridor investments. • Development of framework for refining big data methods and tools. • Topic policy briefs to summarize research outcomes, emerging issues, and policy alternatives.
Geo-Economics of Transportation To enhance understanding of the economics of transportation systems and user choices from a geographic perspective, considering how population density and regional demand shape travel behavior and the effectiveness of different types of investments.	• Development of geotypologies to support the analysis of national policy impacts on local and regional transportation service. • Establish framework and quantitative tools for assessing market viability and economic impacts of emerging transportation services, including shared mobility, at varying population densities, levels of access, and socio-economic characteristics. • A technical report on current and emerging models and analytical techniques for estimating the impacts of toll and priced lanes on travel demand. • Evaluation results of the FHWA's Interstate Tolling Analysis Tool.
Strategic & Performance Management To support leadership discussions in defining strategic risks, objectives, and performance targets.	• Identification and development of solutions to address key uncertainties, risks and opportunities with AVs
Future Policy Symposia To enable exploratory dialogue with external experts and practitioners to frame future policy considerations and options.	• Host transportation symposia to provide a formalized information resource for FHWA to gain insight and perspectives on key transportation policy questions. Potential topics may include Transportation Energy, Multi-modal Transportation, and other emerging trends. Each symposium gathers national experts and delivers summary white papers and key takeaways
Global Benchmarking Program To obtain and adapt foreign innovations that directly support DOT strategic goals and critical RD&T areas.	• Two new studies per year will be undertaken on priority topics that will be identified by FHWA's leadership. • Implementation activities from GBP studies on Highway Tunnel Fire Fighting Systems and Shared Mobility will be completed.

Multilateral **World Road Association** To impart our knowledge and experience, and promote U.S. ways of doing business on a global scale, and provides the U.S. with access to relevant transportation information and technology exchange.	The development of web-based versions of the Road Safety Manual and Road Network Operations/ITS Manuals. State DOTs are leading the effort of promoting and disseminating these products beyond the federal sphere including counties and local rural communities.
Global Technology Exchange Program To create partnerships with other countries whose advances in highway research and practice are beneficial to FHWA's priority goals and objectives.	The Global Technology Exchange Program will continue to promote technology exchange activities among FHWA and its domestic and international partners. It is anticipated that the annual US-Japan Bridge Workshop will take place in 2019, as well as the annual US-Korea Roads workshop. The US-Netherlands project on infrastructure resilience (one pilot project in each country) should be completed in 2019. Information from all three activities will be disseminated to relevant programs and audiences.

While the domestic component of this program area does not currently have formal measures for T2 activities, a greater emphasis is being placed on developing products for broader consumption beyond internal agency and Departmental leadership. The effectiveness of the international component of the program is measured through the number of best practices, lessons learned and technologies exchanged, and the number of activities through which those exchanges take place.

The program is represented in the USDOT Research Hub and NTL Digital Library (ROSA P). However, improvements in the organization and presentation of the USDOT Research Hub information are needed for it to effectively reflect and represent the program's content and accomplishments. This program has not traditionally generated outputs that take a form that would be reportable as T2 Annual Performance (Intellectual Property) activity. We do not anticipate any reportable outputs in 2019.

Evaluation / Performance Measurement:
For the domestic portion of this research area, project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the Program Area Leadership Team, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Program performance is assessed primarily on the basis of project milestones; in particular, the advancement of new or revised tools to an operational state. There is no formal structure in place to quantitatively evaluate the benefits created through the research. This program area does supports the analysis of benefits and costs of regulatory and deregulatory actions across FHWA, so it provides data needed to measure the FHWA's implementation of the "Regulation: Reduce Regulations and Control Regulatory Costs" strategy supporting the Regulatory Reform Strategic Objective within the Accountability goal area.

Informal measures of program performance include the volume of requests for technical assistance based on work previously developed. Knowledge transfer is considered a key outcome of this

program, and "echos" (in the form of further dissemination of knowledge or follow up inquiries) is considered a measure of success. Engagement with users, and web hits on posted products both serve as a measure of the degree to which knowledge transfer has been successful.

As this program area includes research that cuts across goal areas, it is not closely linked with specific measures associated with particular goals in the DOT Strategic Plan or Annual Performance Plan. This research program also supports the development of documents such as the FHWA Strategic Plan itself. The analytical tools developed as part of this research are used to develop baseline estimates of anticipated future pavement and bridge conditions for use by other programs in evaluating their performance.

Similarly, the international component of this research area also includes research that cuts across goal areas. It is not closely linked with specific measures associated with particular goals in the DOT Strategic Plan or Annual Performance Plan, but instead provides tools that assist other programs in evaluating and improving their performance.
For example, the Global Benchmarking Program (GBP)has yielded significant benefits and improvements in the U.S. highway system. Two examples, are: 1) the expanded use of warm-mix asphalt to lessen energy consumption and costs of paving, resulting in savings of over $600 million in fuel used during production (as of 2013); and 2) accelerated bridge construction and self-propelled modular transporters, resulting in major cost savings, time savings, safety advantages, and convenience for travelers, such as the $55.16 million saved on six Utah DOT projects.

For Multilateral programs, the Office of International Programs released a report of the benefits of the U.S. participation in the World Road Association (WRA) over the 2008-2011 and 2012-2015. The report identifies the outcomes and technology transfer activities that have been achieved through U.S. participation in the WRA and singled out opportunities for FHWA, AASHTO, and TRB to increase awareness of U.S. participation in the WRA. Some of the activities suggested have been implemented during this cycle. Similar efforts will be conducted after the conclusion of the 2016-2019 cycle.

For Bilateral programs, performance is measured through identification of best practices, lessons learned and technologies exchanged, and the number of activities through which those exchanges take place. Progress is evaluated by the number of exchanges for each partnership, the depth and detail of those exchanges, the usefulness of the information exchanged and the degree to which that information addresses agency priorities. Implementation is done primarily through other FHWA offices, who are intricately involved in the partnerships themselves. The program is performing well, as evidenced by the variety of benefits derived over many years. Examples include the proof of standards and other critical information learned through exchanges with Japan regarding bridges; ThinkBike workshops with Dutch experts held in Washington, Milwaukee and Detroit that have helped make cycling paths and areas safer and more effective, plus the incorporation of Dutch standards into U.S. guidance and publications on bike safety; extreme weather resilience adaptation tools being developed and used on pilot projects in the Netherlands and the US; learning of innovative pavement technologies with the Koreans; learning about and adopting the use of a Heavy Vehicle Simulator developed in South Africa for accelerated pavement testing and G1 pavement design and used by the U.S. Army Corps of Engineers and the California and Florida Departments of Transportation; and learning of livability performance measures from Sweden, among other benefits.

It should also be noted that bilateral relationships sometimes lead to developments in the Global Benchmarking program as well, as learning about a technology or best practice may cause a program office to submit a proposal. The reverse is also true in that GBP studies may lead to a more in-depth exploration of a topic through the bilateral relationship.

Highway & Transportation Data
$6,440,000

Program Description/Activities:
Highway & Transportation Data (H&TD) is a comprehensive program of research, development, maintenance, and technology activities focused on supporting and advancing the current and future state of data collection, processing, analysis, modelling, dissemination, and visualization. The H&TD activities directly and indirectly support policy and program activities, and decisions across FHWA and the U.S. DOT, as well as data driven activities and research throughout state DOTs, MPOs, academic, the private sector, and the entire transportation community. The H&TD work also provides support to data providers at State DOTs and MPOs through policy and technical guidance development, training, and technical support.
The H&TD program encompasses 6 key data areas covering 1) public roadway inventory, 2) travel condition including traffic volume, class, weight, speed and pavement, 3) travel behavior including why, how and when people travel, 4) fuel consumption including both gasoline and special fuels, 5) licensed drivers and registered vehicles, 6) highway financing data including local, state and Federal spending, revenue, tolls, and bonds.
The 6 data areas are supported by 3 key H&TD research programs through 11 emphasis topics as summarized below.

- Inventory and Baseline Data and Information Collection, Processing and Publishing
  - A – National Performance Management Research Dataset (NPMRDS)
  - B – Highway Performance and Monitoring System (HPMS)
  - C– Traffic Monitoring and Traffic Data
  - D– Infrastructure Inventory
  - E– Other Section 6028 and Section 150USC23 Data
- National Household Travel Survey Data
  - F– National Household Travel Survey (NHTS)
  - G– Travel Behavior Data – a critical subset of the NHTS Data
  - H– Specialized Performance Management Data (vehicle occupancy)
- Developing and Implementing Data Collection Guidance, Tools, and Processing Methods
  - I- Integrated Transportation Analysis Platform (ITIP)
  - J- Specialized Performance Management Data Tool (Data Portal)
  - K- Data Quality and Technical Guidance

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes.

The highway and transportation data program are authorized by various statutes. The current FAST Act Section 6028 provides the most recent authorization to all six areas.

In addition, The H&TD programs are directly and indirectly statutorily mandated by the following:

- 23 USC § 143 – Directly authorizes the Highway Use Tax Evasion Program, which is one of the H&TD programs.
- 23 USC § 315 - Authorizes the Secretary to prescribe and promulgate all needful rules and regulations for the carrying out of the provisions of title 23, which broadly covers the rules and regulations of the various data programs.
- 23 USC § 104 – Authorizes the apportionment factors. Several of the data programs, by their data being cited specifically as Apportionment factors, are authorized directly by this section.
- 23 USC § 503 – Directs FHWA to conduct the biennial Condition & Performance (C&P) Report to Congress. The Highway Performance Monitoring System (*HPMS*) is specifically cited in this section, and the remaining data programs are indirectly mandated since they provide needed data for the C&P Report.
- 23 USC § 103 – The HPMS and ITIP are indirectly mandated, since they serve as systems of record for many of the national performance measures.
- 23 USC § 150 – The HPMS is indirectly mandated since it will soon serve as the system of record for the National Highway System.
- 23 USC § 167 – The HPMS is indirectly mandated since it will soon serve as the system of record for the National Highway Freight Network.
- 23 CFR § 420.105 (b) – Requires State DOTs to provide data that support FHWA's responsibilities to Congress and to the public.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

FHWA's H&TD program serves a foundational role in achieving all the DOT's Strategic Goals and contributes to all the DOT RD&T Critical Topic Areas. Specific contributions are as follows:

DOT Strategic Goals

Safety: The H&TD program contributes directly to highway safety and the Department's Systematic Safety Approach by providing mission critical exposure data on: personal and commercial travel; highway system performance and use; traveler demographics and use; weigh-in-motion and vehicle classification; vehicle registrations; and licensed drivers. The H&TD program continues to enhance and employee innovative tools and techniques for analyzing, visualizing, and disseminating transportation data to support Department-wide Safety programs.

Infrastructure: The H&TD program provides mission critical data on the nation's infrastructure to support the delivery of the Federal-Aid program, Performance

Management, and a number Agency-wide programmatic needs. These data include: highway system condition, performance, and use; personal and commercial travel; traveler demographics and use; weigh-in-motion and vehicle classification; and highway finances. The program continues to enhance training and support for data providers, while also expanding the tools and techniques used to quality check, analyze, visualize, and disseminate past, present and future data. Several of the data programs are undergoing reassessments to ensure their ability to meet current and future Department-wide needs.

Innovation: The H&TD program continues to be a hotbed for testing and deploying new technologies and techniques for data analysis and visualization. The program developed and deployed the first Agency-wide data warehouse, which is currently being moved to the cloud. The program also developed a generic data portal using commercial off the shelf software (COTS) for any program or office to use for collecting form based data, thus eliminating the need to build new systems every time an office or program wants to collect new data. The program manages the Data Visualization Center (DVC), which is an Agency-wide service providing: customized data visuals; assistance with existing data visualizations; and consulting services. Since its inception, the DVC has received over 135 requests for services from 29 Offices throughout FHWA and the U.S. DOT. In addition, on the data application front, significant effort has been devoted to cooperate and partner with private businesses on adopting and using private data.

Accountability: The H&TD program serves a critical role in implementing the Transportation Performance Management (TPM) requirements of MAP-21 and the FAST-Act which were codified in 23 USC § 103. The HPMS serves as the system of record for the travel, pavement, National Highway System (NHS), adjusted urbanized boundaries, and speed data. The Integrated Transportation Information Platform (ITIP), which is the name of the data warehouse, will serve as the central repository for all TPM data. The program also provides information on how much States and Locals spend annually on transportation, by various categories of improvements including but not limited to: capital improvements; restoration and rehabilitation; maintenance; and safety.

DOT RD&T Critical Transportation Topics

Promoting Safety: The H&TD program contributes significantly to Department-wide safety initiatives by providing information on who, when, why, where, and how people travel. These data are used throughout the DOT by various Offices for calculating safety exposure by type of road, type of vehicle, and age of driver.

Improving Infrastructure: The H&TD program serves a critical role in providing information on inventory, condition, performance, and use of the nation's highway infrastructure. These data are used throughout the Department for: Apportionment of federal funds; performance measures; legislative, policy and program development and evaluation; planning and environmental conformity analyses; and investment requirements.

Improving Mobility: The H&TD program, specifically the HPMS, Travel Monitoring and Analysis System (TMAS), National Household Travel Survey (NHTS), and recently acquired National Performance Management Research Data System (NPMRDS) provide much of the underlying information on nation-wide personal and commercial travel. These data have been used for developing bottleneck studies and modeling freight and passenger travel.

Through the analysis and visualization of these data, we have a much more complete picture of who, when, and where people and freight use our nation's highways, and the impact that national transportation legislation and decisions have on these users.

Preserving the Environment: The H&TD program supports Agency efforts to preserve the environment by providing information on infrastructure use, performance, and condition trends. These data are used for: air quality conformity analysis; studying the long-term durability and resiliency of the highway infrastructure; and measuring the effectiveness of national and state construction, reconstruction, repair, and maintenance strategies.

Program Objectives:

The goal of FHWA's Highway and Transportation Data (H&TD) program is to serve as the national source of surface transportation data. Providing the U.S. DOT, Congress, and transportation community with accurate information products in a timely manner to inform the development and implementation of decisions, policies, legislation, programs, and performance goals, while constantly striving to improve the efficiency and effectiveness of data collection and analysis on travelers and the physical, operational and financial condition of our transportation system.
The H&TD program provides national leadership on transportation data through the development of national standards and guidance, and providing ongoing support and training for State data providers as well as internal and external customers. The specific objectives of FHWA's H&DT program are to:

- Enhance data and information collection, processing, analysis, and dissemination;
- Serve as the national source for data and information on highway to deliver the Federal-aid highway program effectively
    - Extent, condition, use and performance;
    - Personal and commercial travel;
    - Fuel consumption;
    - Licensed drivers and registered motor vehicles;
    - Toll facilities and certified public road mileage;
    - Surface transportation demographic and behavior data; and
- Develop and implement data collection guidance, training, tools, and processing methods to improve efficiency accountability and reduce burden to all involved.

The Inventory and Baseline Data and Information Collection, Processing and Publishing roadmap area enables quality and timely data collection and processing to support the delivery of the Federal-aid highway program including the annual Federal-aid apportionment, safety exposure and trending analysis, and performance management.

The National Household Travel Survey Data roadmap area supports all levels of government in transportation planning, safety programming, and fundamental R&D research to analyze the effectiveness of past, present and new initiatives. The information on why people and how people travel dissected by gender, age, ethnicity, income, education, and employment status offer insight and the analytical foundation for both project and program planning, implementation, and research.

The Developing and Implementing Data Collection Guidance, Tools, and Processing Methods roadmap area explores new and innovative approaches for data acquisition and processing to ensure a) data collected throughout the nation can be compared, b) efficient technology is used, c)

private sector data is considered and taken advantage of, and d) effective visualization approach is utilized.

The program's research addresses weaknesses or gaps in relevant technologies, knowledge, and analyses due to lack of capabilities and/or interests from private entities. Key FY19 program activities are identified in the table below.

Activity	Period of Performance	Partners/Notes
National Performance Management Research Dataset (NPMRDS) - • To collect, process, analyze and release the 2019 NPMRDS data covering all NHS roadways in partnership with State DOTs and MPOs through improved and enhanced methods.	2017 – 2023 (continuous on a calendar year data cycle)	All State DOTs except California, Louisiana, North Carolina, Oklahoma, Oregon, Utah, and Maricopa County Department of Transportation (MPO), Southeastern Wisconsin Regional Planning Commission (MPO) which may opt to use local travel time and information.
Highway Performance Monitoring System (HPMS) • To implement priority highway performance data through enhanced IT system to control data quality. • To collect, analyze and release highway inventory, annualized traffic data and pavement data through enhanced methods. • Deliver full set of data for Apportionment, C&P Report, Freight, Congestion, and TPM usages.	2016-2020 (continuous on a calendar year data cycle)	All State DOTs, DC and PR
Traffic Monitoring and Traffic Data • To update and debug the current IT data processing codes. • To improve current codes in processing vehicle weight data. • To collect and process monthly traffic volume data. • To generate the monthly Traffic Volume Trend reports.	2016-2023 (continuous on a monthly data cycle)	All State DOTs and DC
All Road Network of Linear Referenced Data – Infrastructure Inventory • To integrate highway, bridge, bicycle facilities and other infrastructure data geospatially.	2016-2023	
Other Section 6028 and Section 150 of USC 23 data	2016-2023	All State DOTs and DC

• Continue to pilot the new finance data collection system and start to deploy the full system. • Continue fuel data, licensed driver data, and registered vehicle data collection.		
National Household Travel Survey (NHTS) • Perform the probability based sample data collection method development and testing. • Testing out the passive data integration method with the aim to significantly reduce cost. • Execute appropriate agreements with State DOTs and MPOs for data gathering and cost sharing. • Carry out actual 2019 data collection and compilation.	2016-2023	The following DOTs: AZ, CA, GA, IN, MD, NC, NY, SC, TX, WI and Des Moines Area MPO, Indian Nation COG, Iowa Northlands Regional COG, North Central TX COG.
Travel Behavior Data - a critical subset of the NHTS data • Carry out the actual origin destination data collection.	2018-2023	All State DOTs and DC
Specialized Performance Management Data • Collect, process and deliver vehicle occupancy data for all states and urban areas.	2018-2023	All State DOTs and DC
Integrated Transportation Analysis Platform (ITIP) • Update the ITIP and deploy it with 1/3 of Division Offices.	2016-2023	
Data Quality and Technical Guidance • To develop, innovate and improve methods, approaches and guidance for data collection, processing and application with the goal of reducing cost, minimize burden and increase quality.	2018-2023	NHTSA, BTS, FMCSA, FTA, AASHTO, TRB, State DOTs and

Research Collaboration Partners:

The H&TD program staff regularly engage with key stakeholders in both formal and informal settings to gather input concerning challenges and opportunities that might be addressed through the program, as well as information on work undertaken by other organizations both nationally, and internationally.

Stakeholders include representatives of individual highway agencies (State DOTs), metropolitan planning organizations (MPOs), pertinent committees of the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB), industry

organizations such the American Trucking Association, American Bus Association, and others. The H&TD staff also partner with researchers from universities and other public and private entities.

Formal interactions with AASHTO, TRB, and industry organizations generally occur at regular intervals (at least annually, and as often as quarterly). Interactions with States and MPOs tend to be on a more frequent, but ad hoc basis.
Inputs obtained through these interactions are considered by program staff as they identify and formulate the research program and technology initiatives that, in accordance with 23 USC 502(a)(3):

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the following table.

Benefits of Partnership and Partner Contributions to FHWA Highway and Transportation Data R&T Program

Partner Organization	User Perspective on Needs	Data Provider Perspective	Industry Perspective	Standard Setting	Testing	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Data or Services	Funding
Internal DOT Partners: NHTSA, FMCSA, FTA, BTS, Volpe, and OST	**X**			**X**	**X**	**X**	**X**	**X**	**X**	**X**
Other Federal Partners: FMLA's, DOE, DOD, Census, and USGS	**X**			**X**		**X**	**X**	**X**	**X**	**X**
Data related AASHTO Committees		**X**		**X**	**X**	**X**	**X**			
State Departments of Transportation		**X**		**X**	**X**	**X**	**X**	**X**		**X**
Metropolitan Planning Organizations		**X**		**X**		**X**	**X**			
National Laboratories			**X**	**X**				**X**		
Universities	**X**							**X**	**X**	
American Trucking Association			**X**			**X**				

American Bus Association			**X**			**X**				
American Association of Retired Persons			**X**							
Association of Motor Vehicle Administrators			**X**							
Vendor Community			**X**					**X**	**X**	

Acquisition/Assistance:
The type of acquisition method can vary depending on the program need and services required. The H&TD program typically utilizes one of the following methods for procuring services:

- New task order or modification to one of the FHWA competitively procured indefinite quantity contracts (IDIQ);
- GSA Competitive Order through the FedBizOpps.gov website; and
- Open competitive Broad Agency Announcement (BAA).

The majority of contracts are single year. The very few multi-year acquisitions are always constructed on an annual basis where the FHWA has the option to terminate the contract upon the end of each performance year without cause.

The H&TD program utilizes pooled-funding with State and Local highway agencies. Travel behavior data are routinely supported by non-Federal funds, to the point where FHWA is only contributing around 20% of the total cost.

Technology Transfer (T2):
Technology Transfer (T2) is an important part of the Highway & Transportation Data program. The primary beneficiaries of the activities are: State and Local highway agencies, Academia, and the private sector. Most T2 activities pertain to sharing data related products, technical methods, technical procedures, program and technical guidance to help advance the current state of practice. The output from the research is typically published on the FHWA website following an intense internal review, which can include peer reviews by external partners and stakeholders. The length of time between project completion and posting to the FHWA website depends on the volume and complexity of material to be reviewed.

In addition, research products also get distributed and disseminated by venues offered by the Transportation Research Board (TRB), the American Association of State Highway and Transportation Officials (AASHTO), the University Transportation Centers (UTCs), the Institute of Transportation Engineers (ITE), and the American Society of Civil Engineers (ASCE). These venues typically involve organized workshop, training sessions, and further publication of research results by these organizations.

Additional T2 activities also include direct training and technical assistances by the FHWA to State and local highway agencies through webinars, ad-hoc onsite support, and formal classroom training.

The effectiveness of the T2 activities is measured in improvements in data timeliness, completeness, quality, the adoption of new and more efficient techniques and technologies, reduction of duplicative data collection effort, partnership with third parties and private entities as well as simple output measures like number of workshops and webinars conducted, as well as State and local agency participation.

The benefits accrued by H&TD stakeholders include: improvements in data timeliness, completeness, and quality; reduced data collection effort and cost; new data for input for State and Local transportation models; new analysis methods; new data visualization techniques and tools; and new insights into travel behavior and trends. Ultimately, the benefit of the H&TD program is to enable data driven and data informed decision making with infrastructure planning, safety improvement, and performance accountability.

Specific program outputs anticipated in 2019 are identified in the table below.

Program Objective	Key 2019 Outputs
NPMRDS To ensure all State DOTs and MPOs have quality National Performance Management Research Dataset (NPMRDS) to implement TPM.	• Deliver travel time data for all NHS roadways covering 12 months • Deliver integrated network data • Deliver the integration methods • Provide technical assistance to States and MPOs as needed. Outputs are delivered to State DOTS and MPOs for TPM, safety, and infrastructure utilization.
HPMS To ensure the delivery of the Federal-aid highway program can be carried out with timely and quality data for funding apportionment, safety analysis, performance analysis, and other aspects through Highway Performance Monitoring System (HPMS) data.	• Highway network data • Annualized traffic data • Pavement data (PM2) • Reliability data (PM3) All outputs will be delivered for safety, freight, TPM, infrastructure and other usages
Traffic Monitoring and Traffic Data To deliver the monthly Traffic Volume Trend report and the annual future travel demand projection in a timely manner.	• Legal posted speed data for all NHS roadways will be gathered for benchmarking analysis and safety. • Monthly traffic data (volume, class, and WIM) will be gathered and monthly Traffic Volume Trend report will be delivered. • Bicycle network will be created for safety and other usage. • Deliver the forecasted VMT data as related to travel demand.
All Road Network of Linear Referenced Data To gain a comprehensive set of infrastructure inventory data to facilitate a wide range of program and policy analysis needs.	• Integrated roadway, bridge and bicycle infrastructure facility data will be delivered for infrastructure and safety usage.
Other Section 6028 and Section 150 of USC 23 data To enable the Federal-aid apportionment and wide ranges of analysis including safety, performance, and needs assessment on transportation infrastructure.	• Complete the design of updated finance data collection system. • Deploy the new finance data system with pilot State DOTs and other relevant state agencies. • Deliver annual state specific gasoline and diesel consumption data to support Federal-aid. • Deliver the annual licensed driver data • Deliver the annual registered vehicle data

National Household Travel Survey (NHTS) To deliver a set of comprehensive travel behavior data to support: 1) national policy and program analysis and 2) state DOT and MPO transportation planning and performance management.	• New annualized national travel behavior data will be collected, processed, and published to support safety, infrastructure, and accountability. • In addition, travel behavior data collection method will be disseminated to promote the usage of passive collected data to reduce data collection cost and increase efficiency.
Travel Behavior Data - a critical subset of the NHTS data To deliver a set of passenger origin destination data to support: 1) multimodal (freight and passenger) analysis, safety evaluation, and national policy and program; and, 2) state DOT and MPO transportation planning and performance management.	• Passenger travel origin destination data will be collected for corridor demand analysis, regional demand analysis, freight analysis, and safety exposure analysis.
Specialized Performance Management Data To fulfill data needs for TPM implementation by State DOTs and MPOs.	• Vehicle occupancy data at the state and urban area level will be delivered to all state DOTs and MPOs for TPM accountability usage.
Integrated Transportation Analysis Platform (ITIP) To offer an effective platform for FHWA HQ and Division Offices to carry out TPM	• Deliver an on-line platform to enable FHWA HQs and all division offices to evaluate TPM program and perform other integrated analysis.
Specialized Performance Management Data Tools To offer an efficient platform to State DOTs and MPOs to submit performance management target and progress made data	• Deliver an on-line platform to enable all State DOTs and MPOs to submit and update TPM target data and information to FHWA.
Data Quality and Technical Guidance To develop, innovate and improve methods, approaches and guidance for data collection, processing and application with the ultimate goal of reducing cost, minimize burden and increase quality.	• Update traffic data collection methods and WIM data processing method to support freight program • Pilot one to two WIM demonstration projects with State DOTs • Deliver an updated AADT estimation method through passively collected data and provide States and MPOs guidelines and good practices on procuring third party AADT data.

Evaluation / Performance Measurement:
Program performance is assessed primarily on the basis of project milestones and their effects on the U.S. DOT Strategic Objective performance goals as stated below.

Project milestones include progress made, issue resolved, area explored, schedule followed, budget payout, final deliverables, and overall impact assessment. Project milestones are included in and monitored in the context of individual performance plans, as appropriate. Additionally, progress on projects and activities is evaluated on an annual basis by the leadership team in the office, which may recommend continuation or termination of ongoing projects and activities, based on progress and evolving circumstances. Sub areas, like the timeliness of roadway inventory and traffic data submission from state DOTs, do have goals that are recorded and tracked. In addition, program is also evaluated in the context of how it helps the immediate needs of the office in areas of procedures and guidance as a whole for timely data collection. Outputs of this program will assist State and local highway agencies in more effectively managing their data programs; improving the quality of their data; or enhancing their data analytics and modelling capabilities.

Under US. DOT's Safety goal, Strategic Objective #1: Systemic Safety Approach includes strategies relating to "Data", "Identify Risks", "Collaboration", "Rural Safety", "Leadership", "Evaluation", and "Performance". Each of these strategies relies on the H&TD's program. The H&TD program covers infrastructure inventory data, performance data, traveler behavior data, and other administrative data such as licensed driver and registered vehicle data. These data offer a) safety exposure information for all safety analysis such as the crash and fatality rates per 100 million miles traveled, per million licensed drivers with various age groups by gender, per million registered vehicles by vehicle types and other data dimensions, b) information to decipher crash causes and crash precursors, and c) benchmark information to devise counter measures for safety improvement. Without the H&TD effort, none of these strategies can be carried out. The H&TD program explores new approaches in gaining comprehensive multimodal exposure data to enable more robust safety analysis.

Under the U.S. DOT's Infrastructure goal, both Strategic Objective 2: Life Cycle and Preventive Maintenance and Strategic Objective 4: System Operations and Performance rely on the H&TD program. The inventory data and performance data enables the life cycle analysis. Without such data, reality based analysis would not occur. Travel speed, travel time, pavement condition data under the H&TD program offer direct measures on system operations and performance.

Under the U.S. DOT's Innovation goal, Strategic Objective 1: Development of Innovation, the strategy for "Data" is dependent on the H&TD program. The H&TD program is designed to support data-driven technologies and decision making in real time and data sharing. The H&TD program include exploration of private data sources, potential partnering with private entities for data acquisition and data analysis, and engaging nontraditional partners.

Under the U.S. DOT's Accountability goal, Strategic Objective 2: Mission Efficiency and Support, the strategy for "Program Performance" is an integral part of the H&TD program. One of the key activities with the H&TD program is to streamline all different approaches and methods in collecting data from State and local agencies into one single portal: reducing state and local agency reporting burden and increasing transparency and efficiency. In addition, highway data collected and processed enables the apportionment of the Federal-aid highway account fund to states. Special emphasis has been outlined in the H&TD program to ensure data quality and timeliness.

Every Day Counts (*On-Ramp to Innovation*) Program
$6,500,000

Program Description/Activities:
The Every Day Counts (EDC) Program *(On-Ramp to Innovation)* is a State-based program that identifies and rapidly deploys proven, yet underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce traffic congestion, and improve environmental sustainability. Proven innovations promoted through EDC facilitate greater efficiency at the State and local levels, saving time, money and resources that can be used to deliver more projects.

The EDC program has made a significant positive impact in accelerating the deployment of innovations and in building a culture of innovation within the transportation community. Since its inception, each State has used 14 or more of the 43 innovations promoted through EDC, and some States have adopted more than 30. Many of these innovations are now mainstream, standard practices across the country. This is the ultimate objective of the program, to have innovations integrated into how the State DOTs and local agencies do business that accelerate project delivery, enhance safety, and improve mobility.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. FAST Act § 1444, 6002-6004; 23 U.S.C. 502-503

The FAST Act requires FHWA to continue its innovation partnership, Every Day Counts, and work with stakeholders to identify a new collection of target innovations, best practices, and data at least every two years. [FAST Act § 1444]

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The EDC Program accelerates the deployment of innovations that support all four goals of the DOT Strategic Plan. In addition, many of the innovations advanced under this program are having a significant positive impact on rural communities.

Safety: Reduce Transportation-Related Fatalities and Serious Injuries Across the Transportation System.

List of EDC Innovations advanced, which directly support Safety:

- Adaptive Signal Control
- Automated Traffic Signal Performance Measures (ATSPMs)*
- Data-Driven Safety Analysis*
- High Friction Surface Treatment*
- Intersection and Interchange Geometrics
- National Traffic Incident Management Responder Training
- Road Diets*
- Road Weather Management – Weather-Savvy Roads*
- Safe Transportation for Every Pedestrian (STEP)
- Safety Edge^{SM}*
- Smarter Work Zones
- Using Data to Improve1 Traffic Incident Management

(*) - Innovations that have a direct, positive impact on rural communities.

ATSPMs and Data Driven Safety Analysis (DDSA) are part of the current cycle of EDC and will continue to be deployed during FY 2019. The purpose of ATSPM is to modernize traffic signal management by providing high-resolution data to actively manage performance, which in turn improves safety and customer service while cutting congestion and costs. DDSA uses tools to analyze crash and roadway data to predict the safety impacts of highway projects, enabling agencies to target investments with more confidence and reduce severe crashes on roads.

Infrastructure: Invest in Infrastructure to Ensure Mobility and Accessibility and to Stimulate Economic Growth, Productivity and Competitiveness for American Workers and Businesses.

List of EDC Innovations advanced, which directly support Infrastructure:

- Accelerated Bridge Construction (*)
- Collaborative Hydraulics: Advancing to the Next Generation of Engineering (CHANGE) (*)
- Geosynthetic Reinforced Soil-Integrated Bridge System (*)
- Prefabricated Bridge Elements and Systems (*)
- Slide-in Bridge Construction (*)
- Ultra-High Performance Concrete Connections for Prefabricated Bridge Elements (*)
- 3D Engineered Models for Construction
- 3D Engineered Models: Schedule, Cost and Post-Construction
- Alternative Technical Concepts
- Clarifying the Scope of Preliminary Design
- Construction Manager/General Contractor (*)
- Design-Build (*)
- e-Construction (*)
- e-Construction and Partnering: A Vision for the Future (*)
- Flexibilities in Utility Accommodation and Relocation (*)

- Geospatial Data Collaboration
- Improving DOT and Railroad Coordination (*)
- Intelligent Compaction (*)
- Flexibilities in Utility Accommodation and Relocation (*)
- Intersection and Interchange Geometrics (*)
- Locally Administered Federal-Aid Projects (*)
- Locally Administered Federal-Aid Project: Stakeholder Partnering (*)
- Pavement Preservation (When, Where, and How) (*)
- Warm-Mix Asphalt (*)

(*) – Innovations that have a direct, positive impact on rural communities.

CHANGE; e-Construction and Partnering; and Pavement Preservation (When, Where, and How) are part of the current cycle of EDC and will continue to be deployed during FY 2019. CHANGE enhances project development productivity by improving project-related collaboration through 2D and 3D visualizations, which offers real potential for reducing environmental, regulatory, engineering and other impediments to project delivery. e-Construction enhances project transparency through the use of secure, expedited, and transparent document transmission, distribution, and storage. The reduction or elimination of paper-based project administration activities saves both time and money. Partnering also reduces project costs by minimizing change orders and claims through improved relationships, trust, and communication.

Innovation: Lead in the Development and Deployment of Innovative Practices and Technologies That Improve the Safety and Performance of the Nation's Transportation System.

All of the Innovations advanced under EDC support this strategic goal.

Accountability: Serve the Nation with Reduced Regulatory Burden and Greater Efficiency, Effectiveness and Accountability.

List of EDC Innovations advanced, which directly support Accountability:

- Clarifying the Scope of Preliminary Design (*)
- Community Connections
- Enhanced Technical Assistance with ongoing Environmental Impact Statements (*)
- Flexibilities in Right-of-Way (*)
- Flexibilities in Utility Accommodation and Relocation (*)
- Improving Collaboration and Quality Environmental Documentation (eNEPA and IQED) (*)
- Improving DOT and Railroad Coordination (*)
- Implementing Quality Environmental Documents (*)
- Integrating NEPA and Permitting (*)
- Locally Administered Federal-Aid Project: Stakeholder Partnering (*)
- Locally Administered Federal-Aid Projects (*)
- Planning and Environmental Linkages (*)
- Programmatic Agreements (*)
- Regional Models of Cooperation (*)
- Use of In-Lieu Fee and Mitigation Banking (*)

(*) – Innovations that have a direct, positive impact on rural communities.

Integrating NEPA and Permitting is part of the current cycle of EDC and will continue to be deployed during FY 2019. This initiative allows the various environmental reviews and permitting procedures to be performed concurrently. The resulting synchronization provides for more effective and efficient regulatory reviews, leading to projects with reduced impacts on the environment as well as savings of time and money in the project development processes by reducing duplicative efforts.

Program Objectives:
The EDC Program:

- identifies and rapidly deploys proven, yet underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce traffic congestion, and improve environmental sustainability.
- provides transportation agencies with training, technical support, tools, and resources to advance self-selected innovations in a manner that best meets their needs.

Key FY19 FHWA EDC Activities

Activity	Period of Performance	Partners/Notes
Launch of EDC-5	Ongoing	Roll out of innovations selected for EDC-5 at Regional Summits; States identify their innovations for adoption and corresponding implementation goals; FHWA develops implementation plans and begins technology transfer activities

Collaboration Partners:
Every two years, FHWA issues to public Request for Information to seek input and suggestions from State Transportation Departments, local governments, tribes, private industry and other stakeholders to identify a new collection of innovations to champion that merit accelerated deployment. FHWA refines the list of suggestions received to include the innovations with the greatest potential to have transformative impact on transportation, and engages with key transportation organizations (listed below) to ensure the list of innovations is most reflective of stakeholder demand. After selecting the EDC innovations for each new round, FHWA convenes transportation leaders from across the country at regional summits to discuss and identify opportunities for implementing the innovations that best fit the needs of their respective State transportation programs. Following the summits, States and Locals finalize their selection of innovations, establish performance goals for the level of implementation and adoption over the upcoming two-year cycle, and begin to implement the innovations with the assistance of the technical teams established for each innovation.
On-Ramp to Innovation Stakeholders include:

- *American Association of State Highway and Transportation Officials (AASHTO)*
- *American Council of Engineering Companies (ACEC)*
- *American Road & Transportation Builders Association (ARTBA)*
- *American Society of Civil Engineers (ASCE)*
- *American Public Works Association (APWA)*
- *Associated General Contractors (AGC) of America*
- *Association of Metropolitan Planning Organizations (AMPO)*
- *National Association of County Engineers (NACE)*
- *American Traffic Safety Services Association (ATSSA)*
- *Institute of Transportation Engineers (ITE)*
- *National LTAP Association (NLTAPA)*
- *National Asphalt Pavement Association (NAPA)*
- *The Portland Cement Association (PCA)*
- *ITS America*
- *Transportation Research Board (TRB)*
- *General Public (input included as part of public Request for Innovation at the start of each cycle)*

Benefits of Partnership and Partner Contributions to FHWA Structures R&T Program

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
American Association of State Highway and Transportation Officials (AASHTO)	X		X		X		X		X
American Council of Engineering Companies (ACEC)	X	X					X		
American Road & Transportation Builders Association (ARTBA)	X	X					X		
American Society of Civil Engineers (ASCE)	X	X					X		
American Public Works Association (APWA)	X						X		
Associated General Contractors (AGC) of America	X	X					X		
Association of Metropolitan Planning Organizations (AMPO)	X						X		
National Association of County Engineers (NACE)	X						X		
American Traffic Safety Services Association (ATSSA)	X	X					X		
Institute of Transportation Engineers (ITE)	X	X					X		
National LTAP Association (NLTAPA)	X						X		
National Asphalt Pavement Association (NAPA)		X					X		
The Portland Cement Association (PCA)		X					X		
ITS America	X	X					X		
Transportation Research Board (TRB)		X							

Acquisition/Assistance:
Three general acquisition tools are used to provide support and assistance for the program:

1. Marketing & Communication Support – A competitive multi-year, indefinite delivery/indefinite quantity (IDIQ) contracting mechanism is used to provide marketing and communication (Mar/Com) support for the program.
2. Regional Summit Meeting Support – A competitive multi-year, small business set aside, 8(a) Business Development Program, contracting mechanism is used to provide meeting support for the regional summits held at the start of every 2-year EDC cycle.
3. Technical Services Support – Each innovation is deployed by an Innovation Deployment Team (IDT). IDTs often require additional subject matter experts (SME) to support State technical assistance and/or training requests for the innovation. In general, SMEs are supplied under competitive multi-year, indefinite delivery/indefinite quantity (IDIQ) contracting mechanisms managed by the lead FHWA office (e.g. Program Office or Resource Center).

While the program itself does not leverage non-Federal funds, the outcome of the program – the deployment of innovations – leverages federal and non-federal funds by accelerating project delivery and enhancing safety and mobility.

Technology Transfer (T2):
The EDC Innovation Deployment Teams (IDTs) use a wide range of tools to accelerate the adoption of the market-ready technologies, including: stakeholder engagement, technical assistance, training, in-person and virtual peer-exchanges, collaboration with industry groups to disseminate knowledge and information, and evaluation of deployment methods to determine effectiveness, assess needed improvements, and document outcomes. The IDTs include representatives from a broad range of FHWA staff in the relevant Headquarters program offices, the Resource Center, Division Offices and, where appropriate, stakeholder groups. The IDTs are supported from the Office of Innovative Program Delivery and contractors as required.

Key 2019 FHWA EDC Outputs

Program Objective	**Key 2019 Outputs**
Deployment of EDC-5 innovations	Training, technical assistance, technology transfer activities provided to customers and stakeholders

Evaluation / Performance Measurement:
The EDC program contributes toward achievement of the Department's goal: Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System. The EDC-5 IDTs develop implementation plans for each innovation based on the desired level of adoption or implementation of each State. These plans include performance measures and metrics for each innovation

At the beginning of the 2-year cycle, FHWA prepares a Baseline Report that summarizes each innovation and documents the national implementation goals for each innovation. Every 6 months, the FHWA field division offices report deployment status and noteworthy activities on the innovations selected by their State. FHWA Center for Accelerating Innovation compiles these progress reports on the state-of-the-practice for the current round of EDC innovations and

publishes a national update biannually. The latest progress report covers the first full year of EDC-4, through December 2017.

Maps illustrate the innovation implementation stage in each State. Charts show the number of States that have demonstrated, assessed, or institutionalized the innovation. The charts also compare the December 2017 state of practice to the January 2017 baseline data and December 2018 goals set by States. "State" is used as a general term that includes the State transportation department, metropolitan planning organizations, local governments, tribes, private industry, and other stakeholders in a State or territory. Information is provided for the 50 States, Washington, DC, Puerto Rico, the U.S. Virgin Islands, and Federal Lands Highway (FLH), a total of 54 entities.

The following table defines the innovation deployment stages displayed on the maps and charts.

Innovation Implementation Stages

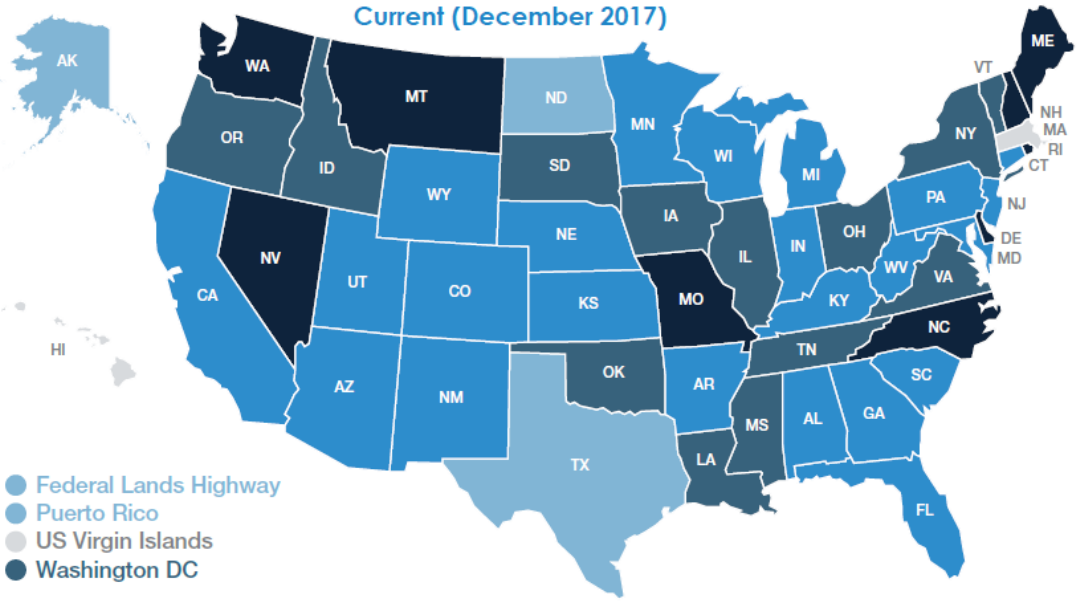
Not Implementing	The State is not using the innovation anywhere in the State and is not interested in pursuing the innovation.
Development Stage	The State is collecting guidance and best practices, building support with partners and stakeholders, and developing an implementation process.
Demonstration Stage	The State is testing and piloting the innovation.
Assessment Stage	The State is assessing the performance of and process for carrying out the innovation and making adjustments to prepare for full deployment.
Institutionalized	The State has adopted the innovation as a standard process or practice and uses it regularly on projects.

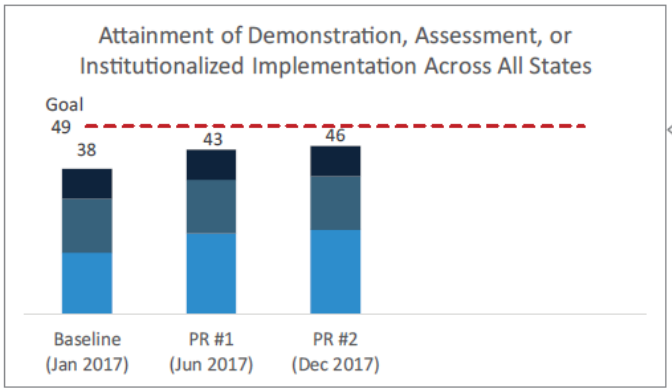
Example:

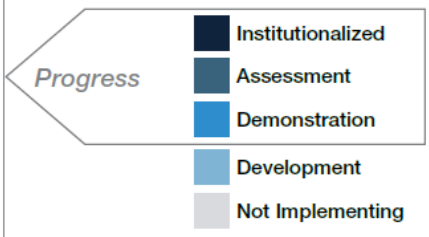
> **Data-driven safety analysis** (DDSA) uses tools to analyze crash and roadway data to predict the safety impacts of highway projects, enabling agencies to target investments with more confidence and reduce severe crashes on roads.
>
> Traditional crash and roadway analysis methods rely mostly on subjective or limited quantitative measures of safety performance. DDSA employs new, evidence-based models that provide agencies with the means to quantify safety impacts. In EDC-4, FHWA will continue to help States incorporate DDSA into processes and policies, but a new focus will be on assisting local agencies in gaining proficiency with DDSA tools.

DDSA includes two approaches that agencies can implement individually or in combination. Predictive analysis helps identify roadway sites with the greatest potential for improvement and quantify the expected safety performance of project alternatives. Systemic analysis uses crash and roadway data to identify roadway features that correlate with particular crash types.

Interest in using DDSA to enhance safety and reduce roadway crashes continues to grow. Three states, FLH, and Puerto Rico are developing implementation plans and learning more about this innovation. Thirty-six states and Washington, DC, are demonstrating and assessing DDSA tools to target safety investments. Nine states have institutionalized DDSA, making it a standard practice in those states.







Innovation Spotlight

State Transportation Innovation Council (STIC) Incentive Program
$5,600,000

Program Description/Activities:
The FHWA State Transportation Innovation Council (STIC) Incentive program provides resources to help foster a culture for innovation and make innovations standard practice in their States. Through the program, funding up to $100,000 per State per Federal fiscal year is made available to support or offset the costs of standardizing innovative practices in a State transportation agency or other public sector STIC stakeholder.

Key components to the success of innovation deployment programs such as EDC are the State-based approach and the State Transportation Innovation Council (STIC) concept. A STIC or other equivalent task force, committee or group brings together public and private transportation stakeholders to evaluate innovations and spearhead their deployment in each State. Each State operates its innovation deployment council, task force, committee or group based on its unique business needs and approaches to meeting those needs. The STIC or an equivalent group puts the transportation community in each State in the driver's seat to comprehensively and strategically consider sources of innovation, select those innovations that best fit its unique program needs, and then quickly put those innovations into practice. A formalized council or group affirms a State's commitment to institutionalize innovations, ensuring innovation deployment will continue as a business practice for years to come—establishing a culture of innovation.

With EDC, SHRP2, and other innovation deployment programs as the driving force nationally, the need for every State to have an innovation deployment council or similar group is essential to ensure that the innovation deployment remains a State-based initiative. States with a strong culture of innovation leverage the resources of the transportation community within the state to get the appropriate innovations into practice quickly. The establishment of a well-organized STIC or equivalent group, defined processes and procedures, and engaged leadership serve as the foundation for fostering a culture of innovation within a state.

Statutory Requirements:
The STIC Incentive program is advanced under the Technology and Innovation Deployment Program (TIDP) (as specified in 23 USC 503(c)), which includes four initiatives:

- accelerated innovation deployment (AID);
- implementation of future strategic highway research program (SHRP2) findings and results;
- accelerated implementation and deployment of pavement technologies; and
- advanced transportation innovation deployment.

The TIDP relates to all aspects of highway transportation, including planning, financing, operation, structures, materials, pavements, environment, construction, and the duration of time between project planning and project delivery. Per 23 U.S.C. 503(c)(1), the goals of TIDP are as follows:

- significantly accelerate the adoption of innovative technologies by the surface transportation community;
- provide leadership and incentives to demonstrate and promote state-of-the-art technologies, elevated performance standards, and new business practices in highway construction processes that result in improved safety, faster construction, reduced congestion from construction, and improved quality and user satisfaction;

- construct longer-lasting highways through the use of innovative technologies and practices that lead to faster construction of efficient and safe highways and bridges;
- improve highway efficiency, safety, mobility, reliability, service life, environmental protection, and sustainability; and
- develop and deploy new tools, techniques, and practices to accelerate the adoption of innovation in all aspects of highway transportation.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The STIC Incentive Program supports all four goals of the DOT Strategic Plan. In addition, many of the innovations advanced under this program are having a significant positive impact on rural communities.

A summary of all STIC Incentive Projects to date is provided at:
https://www.fhwa.dot.gov/innovation/stic/incentive_project/

Program Objectives:
The STIC Incentive Program provides resources to advance innovations into standard practices in a State transportation agency or other public-sector stakeholder and foster a culture of innovation. Each STIC has established a Charter, see template below:

Excerpt: *State Transportation Innovation Council (STIC) Charter Template*
Established (date)

State DOT's, Local Public Agencies, and tribal transportation agencies nationwide own the transportation system and make key decisions on how to deliver projects, as well as what techniques and technologies to use in the operation and safety these systems. The State Transportation Innovation Council (STIC) brings together stakeholders representing all transportation market forces working together to lead innovation in their state transportation program.
Purpose – *This Charter establishes the STIC and defines its mission, scope, membership, and administration.*
Vision - *The STIC fosters a collaborative culture for identification and rapid implementation of innovations to efficiently deliver a high-quality transportation system. Use this section to customize your vision, if needed*
Mission - *Facilitate the identification, evaluation, and rapid implementation of innovations among transportation program delivery professionals at all levels of government and private and non-profit sector to ensure smart, efficient investment in their State's transportation infrastructure. Use this section to customize your mission, if needed*
Scope - *A STIC is a group of representatives from various levels of the transportation community in each State committed to comprehensively and strategically consider all sources of innovation. The*

STIC brings together stakeholders that represent all transportation market forces to work together to lead innovation in their state transportation program.
The STIC provides a platform/venue for the leadership and multi-stakeholder engagement that enables and perpetuates the identification, evaluation, and implementation of innovation in each state. The objectives of the STIC are to identify and recommend ways that innovative technologies and practices can enable the State or local community to more successfully respond to key issues and challenges that impact their transportation program. The STIC acts as a catalyst for the identification and rapid deployment of technologies, techniques and tactics that have been demonstrated in "real world" applications and can offer improved performance/effectiveness in their state or local community. The blend of partners and stakeholders on a STIC enable it to:

- *provide a means of ensuring regular contact between the State DOT, Local Public Agencies, academia, industry, and other transportation sectors.*
- *advise the State CEO on the implementation of the Every Day Counts program and innovation related matters.*
- *act as a liaison among the stakeholders represented by the membership, and may provide a forum for those stakeholders on current and emerging issues in the transportation sector.*
- *provide a forum for discussing and proposing solutions to transportation-related problems.*
- *develop a process to identify technologies, tactics and techniques on which to focus implementation efforts.*
- *mobilize champions within the state who are committed to the evaluation and implementation of identified technologies, tactics and techniques.*
- *provide leadership to promote and support rapid implementation of technologies, tactics and techniques.*
- *monitor performance to ensure innovations move into standard practice.*
- *share information with all stakeholders through meetings, workshops, and conferences.*
- *share achievements and collaborate with the National STIC Network to learn about innovations being advanced throughout the country (i.e. participate in National STIC Network meetings, EDC Regional Summits, Innovation Peer Exchanges, etc).*
- *Use this section to customize your scope, if needed*

Membership - *In addition, subject matter experts and other advisory members may be invited to attend STIC meetings as non-voting members.*
The STIC will be co-chaired by the State CEO, or their delegate, and the FHWA Division Administrator. STIC members are encouraged to rotate representation from their organizations to maintain fresh ideas, sustain energy in promoting innovations, and provide a broader knowledge of the STIC activities.
Innovation Identification, Evaluation, and Implementation - *The STIC enables all participants to evaluate the applicability of a technology, tactic, or technique and identify innovations for implementation. This process provides an objective and transparent approach to the allocation of resources for innovation deployment and communicates the need to change current practice, leading to greater acceptance among the transportation community for innovation implementation.*
Outreach and Communication - *The STIC can most effectively share innovation deployment efforts and successes with the transportation community, public, and legislators by developing and implementing an outreach and communication plan. This plan can aid in communicating the impact and benefits of implementing innovations within the state, local, and tribal governments and demonstrates to policymakers and the travelling public that taxpayer dollars are being efficiently utilized.*
(End Excerpt)

Key FY19 FHWA STIC Activities

Activity	Period of Performance	Partners/Notes
Management of STIC Incentive Program	Ongoing	Review and award of STIC Incentive projects that are submitted on an ongoing basis;
National STIC Network Meeting	Tentative: October 2018 and April 2019	Conduct of two virtual events for FHWA to engage the National STIC Network ; primary outcome is information exchange at the programmatic level

T2 Collaboration Partners:

Each STIC is comprised of a diverse membership; the broader the diversity of the transportation industry represented on the STIC, the greater the opportunity to be comprehensive in performing the actions noted above. As described in the charter template above, The STIC provides a platform/venue for the leadership and multi-stakeholder engagement that enables and perpetuates the identification, evaluation, and implementation of innovation in each state. The objectives of the STIC are to identify and recommend ways that innovative technologies and practices can enable the State or local community to more successfully respond to key issues and challenges that impact their transportation program. STIC membership typically includes the following:

- State DOT
- Federal Highway Administration (FHWA)
- Local Technical Assistance Program (LTAP)
- Local Public Agencies (LPAs)
- Industry Associations (APWA, NACE, NACO, etc…)
- Tribal representation (if applicable)
- Research liaison or Research Advisory Committee (RAC)
- Metropolitan Planning Organizations (MPOs)
- Contractors
- Consultants
- Federal Resource Agency
- University Transportation Center (if applicable)

Benefits of Partnership and Partner Contributions to the FHWA STIC Program

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or	Donation of Material or Services	Funding
State DOT	X		X		X		X		X
Federal Highway Administration (FHWA)	X						X		X
Local Technical Assistance Program (LTAP)	X						X		

Local Public Agencies (LPAs)	X				X		X		X
Industry Associations (APWA, NACE, NACO, etc…)	X						X		
Tribal representation (if applicable)	X						X		
Research liaison or Research Advisory Committee (RAC)	X						X		
Metropolitan Planning Organizations (MPOs)	X						X		
Contractors	X	X					X		
Consultants	X	X					X		
Federal Resource Agency	X				X		X		X
University Transportation Center (if applicable)	X						X		

Acquisition/Assistance:
Through the incentive program, funding up to $100,000 per State per Federal fiscal year is made available to support or offset the costs of standardizing innovative practices in a State DOT or other public sector STIC stakeholder. STIC Incentive funding is subject to the Federal share of 80 percent. *The 20 percent non-Federal match may come from project sponsors or other allowable fund sources.*

Technology Transfer (T2):
State and local highway agencies are the primary beneficiaries of the STIC Incentive Program based on the individual projects.

The STIC Incentive Program's outputs include but aren't limited to:

- Standards, specifications, operating procedures;
- Job aids and similar technical resources;
- Training and education materials (webinars, workshops, etc.); and
- Peer-to-peer information exchanges.

The STIC Program is not represented in USDOT Research Hub and the NTL Digital Library (ROSA P).

Intellectual Property activities are not reported in the Annual USDOT T2 Annual Performance, however, individual STICs can explore the use of intellectual property.

Key 2019 FHWA STIC Outputs

Program Objective	**Key 2019 Outputs**
Standardization of innovations identified by the individual STICs	On a project-by-project basis, outputs could include those described above

Evaluation / Performance Measurement:
Measuring Success - The STIC defines the outcome being sought through the implementation of the innovations and monitors performance to ensure those outcomes are met. By setting goals, the STIC communicates the expected outcome and results from innovation deployment and encourages successful implementation. In working toward achieving these goals, the STICs contributes toward achievement of the Department's goal: Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System.

A summary of output (STIC Incentive Projects) is maintained on the Center for Accelerating Innovations public website: https://www.fhwa.dot.gov/innovation/stic/incentive_project/

From the inception of the STIC incentive program to date, the majority of the funding has been dedicated to further advancing innovations promoted under the EDC program. However, the number of projects proposed that support other innovations of the STICs own choosing is increasing. This general trend indicates that the establishment of a culture of innovation within each state is occurring.

Accelerated Innovation Deployment (AID) Demonstration Program
$6,500,000

Program Description/Activities:
The Accelerated Innovation Deployment (AID) Demonstration Program provides funding to State DOTs, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments to offset the risks associated with the initial deployment of an innovation by that agency. Innovations funded by AID can come from EDC or other sources. Funds are available to cover the full cost of implementation of an innovation on a project, up to the maximum amount of $1 million per each individual award, in areas such as planning, financing, operations, pavements, structures, materials, environment, and construction.
The AID Demonstration Program provides funding to support the pilot/demonstration of innovations on projects by State DOT, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments. Funding recipient reports on experiences and lessons learned from each innovation deployment are shared via the program web site to provide technology transfer.

Statutory Requirements:
This program is authorized in section 503(c)(2)(B)(i) of title 23, United States Code, which requires the Secretary to establish and carry out demonstration programs.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The FHWA AID Demonstration Program supports the Department's Safety, Infrastructure, Innovation and Accountability Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

> Safety/Promoting Safety: The AID Demonstration Program contributes directly to highway safety, on a project-by-project basis, by providing resources to infrastructure owners to implement innovative safety projects that improve the safety of the traveling public. Examples include, but are not limited to, design and construction of roundabouts, diverging diamond interchanges, or other proven interchange geometrics, and implementing road diets.
>
> Infrastructure/Improving Infrastructure: Numerous AID Demonstration grant awards have supported infrastructure related goals. These include projects incorporating Accelerated Bridge Construction (ABC) technologies; the use of compacted concrete pavement, ultra-high-performance concrete, intelligent compaction, warm mix asphalt and e-Construction.

Innovation: The AID Demonstration Program directly contributes to the advancement of innovative technologies and practices by transportation agencies. AID Demonstration projects must pilot practices or technologies which the applicant has not yet used as conventional practice, but intends to implement and adopt as a significant improvement. Through the AID Demonstration Program, applicants are also able to pilot and demonstrate innovations that have not been traditionally used in a surface transportation context. The program then encourages institutionalization of the piloted practice or technology. One example of this is the use of a nanocoating to more rapidly conduct bridge painting operations.

Improving Mobility: The AID Demonstration Program contributes to improving mobility and preserving the environment on a project-by-project basis, through the implementation of innovations such as adaptive signal control; smart work zones; corridor level advance traffic monitoring, and Traffic Incident Management.

Accountability: A number of AID Demonstration Program awards have supported the advancement of greater efficiency and effectiveness within transportation programs, including the implementation of Business Process Management systems and "Practical Solutions" strategies. Additionally, e-Construction tools directly support the overall efficiency of the implementing transportation agencies.

This program impacts and is of benefit to transportation agencies throughout the nation, including those in rural communities. Local governments may apply for the AID Demonstration Program, through the State DOT as a sub-recipient. Consistent with other FHWA funding provided to tribes, any federally recognized tribe is eligible to apply to AID Demonstration Program.

Program Objectives:
The objective of the AID Demonstration program is to accelerate the deployment and adoption of proven innovative practices and technologies, and through enhanced technology transfer encourage a more widespread rate of adoption. FHWA established the AID Demonstration program to provide transportation agencies the resources to mitigate risks associated with first-time or early adoption of innovations on transportation projects. The AID Demonstration Program helps infrastructure owners overcome the conservative culture found within the transportation industry by offsetting some of the financial risks associated with first-time adoption of new technologies or practices.

Key FY19 FHWA AID Activities

Activity	Period of Performance	Partners/Notes
Management of AID Demonstration Program	Ongoing	Review and award of AID Demonstration grant applications on an ongoing basis

Research Collaboration Partners:
State DOTs, federal land management agencies, tribal governments, metropolitan planning organizations, and local governments submit applications for funding to support deployment of innovations on projects of their choosing. Depending on the nature of the individual AID Demonstration projects, consultants and contractors are engaged through their services provided (e.g., design, construction, inspection, operations, etc.).

Benefits of Partnership and Partner Contributions to the FHWA AID Program

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
State DOT	X		X		X				X
Federal Highway Administration (FHWA)	X								X
Local Technical Assistance Program (LTAP)									
Local Public Agencies (LPAs)	X				X				X
Industry Associations (APWA, NACE, NACO, etc…)									
Tribal representation (if applicable)	X				X				
Research liaison or Research Advisory Committee (RAC)									
Metropolitan Planning Organizations (MPOs)	X				X				
Contractors		X			X		X		
Consultants		X			X		X		
Federal Resource Agency	X				X				
University Transportation Center (if applicable)									

Acquisition/Assistance:
The AID Demonstration program utilizes a competitive procurement process. Applications for the AID Demonstration program are accepted under Opportunity Number FHWA-2016-21063 through Grants.gov. As previously discussed, eligible entities are state departments of transportation (DOTs), federal land management agencies, and tribal governments. Metropolitan planning organizations and local governments may apply through the state DOT as sub-recipients. The NOFO provides additional eligibility and application information.

The FHWA uses an evaluation team of technical and professional staff with relevant experience and/or expertise to review each application received by FHWA. The evaluation team reviews, evaluates, and rates the applications. During this process, the evaluation team may contact the applicant to discuss the application and confirm understanding of the requirements for participation in AID Demonstration. Based on the information collected, the evaluation team will prepare a summary assessment rating the application along with the team's recommendation. The summary assessment and recommendation is presented to FHWA senior leadership to make a final determination on the approval of the award. FHWA evaluates complete applications and makes award determinations, on an open, rolling basis until the program ends or funding is no longer available. As stated in the NOFO: "The FHWA expects approximately $10 million to be made available for AID Demonstration in each of Fiscal Years (FY) 2016 through 2020." The AID Demonstration program funds are available at an 80 percent Federal share, which require a minimum mandatory 20 percent cost share.

In addition to the administration of the program as described above, a competitive multi-year, indefinite delivery/indefinite quantity (IDIQ) contracting mechanism is used to provide marketing and communication support for the program.

This program leverages non-Federal funds in two ways. First, there's an 80/20 match requirement and secondly by only funding the portion of the project that implements the innovation it is leveraging the other funds of the project to advance innovation.

Technology Transfer (T2):
The AID Demonstration Program is administered by the FHWA Office of Innovative Program Delivery, Center for Accelerating Innovation. State and local highway agencies are the primary stakeholders and beneficiaries of the AID Demonstration Program based on the individual project grants/awards. The AID Demonstration Program's outputs include but aren't limited to:

- Completed project reports, required as part of the grant award;
- Performance metrics for the innovation implemented on awarded projects;
- Proposed standard operating procedures based on successful project completion and lessons learned;
- Proposed standards and specifications (or proposed revisions to existing standards and specifications) for consideration by AASHTO and/or other standard setting organizations;
- New and/or updated technical guidance;
- Product/project demonstration showcases;
- Training and education materials (webinars, workshops, etc.); and
- Marketing materials.

In FY 2019, FHWA intends to house completed AID Demonstration project reports in the NTL Digital Library (ROSA P).

Key 2019 FHWA AID Outputs

Program Objective	Key 2019 Outputs
Accelerate the deployment and adoption of proven innovative practices and technologies,	AID Demonstration grant awards Completed project reports and knowledge transfer

Evaluation / Performance Measurement:
The AID Demonstration Program contributes toward achievement of the Department's goal: Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System. The key output goal of the AID Demonstration Program is the award of project grants. The FHWA expects approximately $10 million to be made available for AID Demonstration in each of FY 2016 through 2020 from amounts authorized under section 6002 of the FAST Act. FHWA constantly monitors the progress towards awarding grants in accordance with the funding available. This information is available at https://www.fhwa.dot.gov/innovation/grants/projects/ Trend data such as the rate of grant awards over the life of the program is also available at this site.

The target for the AID Demonstration Program for FY 2019 will be to award the maximum number of grants commensurate with the available funding. Given the rate of awards made against the funding available in previous fiscal years, this target is achievable. The key outcome goal of the program is a completed project report (See above link) which documents the impact the innovation had on the delivery of the overall transportation project.

Accelerating Market Readiness (AMR) Program
$2,500,000

Program Description/Activities:
The Accelerating Market Readiness (AMR) program supports promising innovations that have the potential to be considered for accelerated deployment. The AMR program provides resources for the rapid, national assessment of emerging innovations and for the development of objective, written documentation of these assessments. The AMR Program is intended to help advance the innovations to a more complete market-ready status, which in turn should accelerate the adoption of the innovations by transportation agencies under the EDC Program or by other initiatives.

FHWA has historically administered AMR as an internal program to support innovations recommended by program offices or the Turner Fairbank Highway Research Center. While FHWA will continue to use the AMR Program to foster selected innovations suggested from within the agency, in FY 2019 FHWA will expand the program to include innovations from external stakeholders (including but not limited to State DOTs, local and tribal transportation agencies, the private sector, and institutions of higher education), solicited through a Broad Agency Announcement (BAA).

Statutory Requirements:
This program is authorized in section 503(c)(2)(B)(iii) of title 23, United States Code, which requires the Secretary to develop improved tools and methods to accelerate the adoption of proven innovative practices and technologies as standard practices.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

FHWA's AMR Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Examples of current initiatives supported through AMR include the development of an in-situ scour testing device and the "Mobile Solution for Assessment and Reporting" (MSAR) app to support survey and inspection activities required with the FHWA Emergency Relief (ER) and Emergency Relief for Federally Owned Roads (ERFO) programs.
As the AMR Program expands to directly engage external stakeholders by encouraging State DOTs, local and tribal transportation agencies, the private sector, and institutions of higher education to submit topic ideas, specific contributions are expected to be as follows:

> Innovation: The AMR Program directly contributes to the advancement of innovative technologies and practices for more widespread adoption by a variety of transportation agencies.

Safety/Promoting Safety: The AMR Program will contribute directly to highway safety by seeking proposals for innovative technologies that address the following:

- How can human behaviors that increase safety risks be addressed and mitigated?
- How can safety data analysis be used to better guide transportation agencies' decisions?
- How can the disproportionate transportation safety risks in rural communities be mitigated?
- How can advances in automation bring significant safety benefits?

Infrastructure/Improving Infrastructure: The AMR Program will contribute directly to goals for infrastructure by seeking proposals for innovative technologies that address the following:

- How can Federal investments be better targeted toward transportation projects that address high priority infrastructure needs?
- How can State and local resources and private sector engagement be better leveraged?
- How can our transportation system's operations and performance be improved through the entire life cycle of the infrastructure facilities?
- How can the use of innovative maintenance and preservation strategies help restore the transportation infrastructure and assets to a state of good repair?
- How can the infrastructure be planned, constructed and maintained using best operational and risk management practices?

Accountability/Preserving the Environment: The AMR Program will contribute directly to the preservation of the natural and human environment by seeking proposals for innovative technologies or practices that address the following:

- How can project development and delivery processes be improved or streamlined to provide timely benefits to users while safeguarding our communities and maintaining a healthy environment?

This program impacts and benefits transportation agencies throughout the nation, including those in rural communities. Past AMR projects have supported innovations that benefit all transportation stakeholders, and as the program is expanded this will continue to be the case.

Local governments may apply for the AMR Program through the State DOT as a sub-recipient. Consistent with other FHWA funding provided to tribes, any federally recognized tribe is also eligible to apply for AMR Program funding.

Program Objectives:

The AMR program is intended to stimulate and spur the advancement of **emerging and transformative innovations** in the transportation industry by matching these innovations to the transportation organizations interested in testing and evaluating them. The innovations to be supported by AMR program resources are those that:

- significantly advance conventional practice;
- address knowledge and technology gaps;
- significantly advance the state-of-the-art; or
- constitute a sea change in the development and delivery of transportation projects and programs.

The AMR Program is intended to address longstanding challenges that exist in the transportation industry that impede the integration of new innovations into widespread practice. The initial "hand off" of innovative products from the research community to implementers, and the subsequent adoption of these products into practice, can take many years. Once in the domain of the implementers, the products may be piloted, and the results of the pilot documented, but the benefit data compiled is often limited at best and the dissemination of the findings has not traditionally occurred in a fashion that encourages wider piloting (and later adoption) of a product in the transportation community.

The inclusion of patented and proprietary products (P&PP) on transportation projects has been a long- standing challenge for private sector/industry stakeholders: Federal and/or State rules and regulations are often cited as a barrier to obtaining an opportunity to obtain objective perspective on the effectiveness of P&PP. The AMR Program will afford the opportunity for P&PP to be assessed and evaluated in a fair and objective manner, thereby potentially affording private sector/industry stakeholders a "foot in the door" to advancing the readiness of their P&PP.

Key FY19 FHWA AMR Activities

Activity	Period of Performance	Partners/Notes
Management of AMR Program; initial awards resulting from issuance of a Broad Agency Announcement	Ongoing	Partners are internal to FHWA and external with issuance of Broad Agency Announcement soliciting topics/innovations for the program

Research/Technology Transfer Collaboration Partners:
FHWA has used considerable stakeholder input in the development of the AMR Program in its expanded (from internal to include external) form. The regional stakeholder summits held as part of the launch of the fourth cycle of the Every Day Counts Program featured a town hall session, where transportation leaders ---including representatives from the AASHTO Innovation Initiative (AII) and the National State Transportation Innovation Council (STIC) Network---discussed how they made innovation part of the everyday operation of their organizations. To address the feedback received during the round table discussions, FHWA committed to working with its transportation partners to enhance ways for emerging innovations to be fairly evaluated and more rapidly accelerated into use in transportation programs and projects. It is anticipated that work on the inaugural AMR Program awards will begin in FY 2019, with individual periods of performance ranging from 12 to 24 months.

Through the BAA, FHWA will seek out willing State and local transportation agencies or other transportation stakeholders to field test and/or evaluate the proposed emerging technologies. State and local highway agencies are the primary stakeholders and beneficiaries of the AMR program as they will then be provided objective information on these emerging innovations with the goal of more widespread adoption.

The internal DOT and external partners in the AMR Program, and the benefits associated with these partnerships, are summarized as follows:

Partner Organization	User Perspective on Needs	Industry Perspective	Potential External Program Applicant	Potential Internal Program Topics	Conduct of Field Assessments, etc.	Documentation of Findings	Technology Transfer Activities	Advance widespread Adoption of Innovations
AASHTO Innovation Initiative	X					X	X	X
State Departments of Transportation	X		X		X	X		X
Local and Tribal Transportation Agencies	X		X		X	X	X	X
Institutions of Higher Education	X	X	X		X	X	X	
Transportation Industry/Private Sector	X	X	X		X	X	X	X
National STIC Network	X	X					X	X
FHWA Program Offices/Resource Center/TFHRC				X	X	X	X	

Acquisition/Assistance:
With the expected launch of the external component of AMR in Calendar Year 2018, a competitive procurement process will be introduced to the program. FHWA will issue a BAA to solicit ideas from all eligible external sources for participation in the AMR Program. Eligible entities include state departments of transportation (DOTs), federal land management agencies, local and tribal governments, institutions of higher education, and the private sector.

FHWA, in cooperation with a peer review panel (through the AASHTO Innovation Initiative) will evaluate complete applications. FHWA will use the following criteria to evaluate AMR proposals:

- **Relevance to Agency and Department priorities:** Proposals that directly support one or more of the strategic initiatives or national goals of the Department and Agency would receive a higher level of consideration than proposals with a less global or strategic focus.

- Potential for the innovation to ***significantly advance*** conventional transportation industry practice in the selected focus area (enhancing roadway safety, shortening the project delivery process, improving the performance of the infrastructure system).

- ***The potential demand*** for the innovation; the extent to which both the transportation community and the motoring public will benefit from the innovation and there is potential for the innovation to be used routinely in transportation practice considering cost, technology, and institutional feasibility.

- The ***readiness*** of the innovation: the ***innovation is substantially developed*** and is ready for field or full-scale evaluation to bring the innovation to fuller market readiness (TRL 7 or greater).

- ***The potential for the innovation to be included in the EDC program***. The proposed innovation is distinctive or transformational to the degree that would elevate it to be considered for inclusion in the national EDC program as compared to other deployment efforts and activities more typically undertaken by FHWA and/or other transportation organizations.

In addition to these technical criteria, FHWA will consider the overall availability of funding for allocations or awards selected under the BAA. Cost realism and reasonableness shall also be considered to the extent appropriate. The number of and dollar value of awards will depend on the merit of the proposals received.

For FY 19, FHWA expects approximately $2million to be made available for support award of AMR projects from the initial BAA. Up to $1million will be used to support projects proposed and recommended by FHWA program and research offices.

The AMR program funds awarded via assistance agreement or allocation to a State are available at an 80 percent Federal share, which require a minimum mandatory 20 percent cost share. Additionally, the program leverages non-Federal funds as the transportation agencies are providing the resources and the capacity to field or operationally test emerging technologies or practices.

In addition to the procurement process for AMR Program awards, a competitive multi-year, indefinite delivery/indefinite quantity (IDIQ) contracting mechanism is used to provide marketing and communication support for the program.

Technology Transfer (T2):
The AMR program is administered by the FHWA Office of Innovative Program Delivery, Center for Accelerating Innovation with support from the Office of Research, Development and Technology. FHWA works with representatives from the AII and the National STIC Network to develop and design the program. The AMR Program's T2 outputs include but aren't limited to:

- Technical reports; assessment and evaluation reports will be required deliverables for AMR project awards
- New and/or updated technical guidance;
- Training and education materials
- Marketing materials

At present, the AMR program is not represented in the USDOT Research Hub or NTL Digital Library (ROSA P). In 2019, FHWA will initiate work to transfer the information on FHWA AMR Projects as appropriate to the Research Hub and ROSA P.

Key 2019 FHWA AMR Outputs

Program Objective	**Key 2019 Outputs**
Spur the advancement of emerging and transformative innovations in the transportation industry	AMR awards to conduct program activities

Evaluation / Performance Measurement:
The AMR program contributes toward achievement of the Department's goal: Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System. The internal AMR Program is currently performing well and fulfilling the programs statutory purpose and intent. Within this program construct, FHWA gathers and receives feedback from project recipients and their beneficiaries (e.g., the FHWA Divisions and State DOTs for Mobile Solution for Assessment and Reporting application project,). While effective internally, FHWA determined that the program's effectiveness could be significantly enhanced by expanding the program externally.

With the late FY 2018 launch of the AMR Program to better engage external program stakeholders, one immediate output measure is the project awards to be made through the issuance of the BAA, and how the funding available is maximized to support these projects. As activities under AMR Program awards are completed, FHWA will have documentation and data that describes the outcomes of each award, including how the innovation advanced in market readiness status, and how the innovation was integrated into business practices within the transportation community. Tracking of these outcomes will occur through a review of the final project documentation to compare the achieved market readiness level to the initial market readiness level.

Innovative Program Delivery
$890,000

Program Description/Activities:
Innovative Program Delivery (IPD) provides tools, training and technical assistance that support the transportation community's use of cutting-edge financial and procurement strategies to deliver critical infrastructure projects. FHWA's efforts in this area are primarily led by the Center for Innovative Finance Support (CIFS), whose products are often marketed and deployed under the brand of the Secretary's Build America Bureau. These research and technology deployment efforts focus on revenue generation (tolling and value capture), procurement (public-private partnerships and other alternative contracting methods), and innovative finance (Federal project finance tools such as GARVEE Bonds and State Infrastructure Banks). Support for our partners include (1) technical resources, guidebooks and analytical tools, (2) capacity building and outreach, and (3) technical assistance for project implementation.
Technical resources:

- In-depth database of delivery milestones of selected major projects advanced via alternative contracting methods (ACMs). This would build upon an initial database of construction milestones for more than 100 major US highway projects, an effort funded in FY 2018.
- Public policy research into potential organizational structures for newly-established P3 offices within State DOTs. This research would address the opportunity in section 133(b) of title 23, United States Code, which makes Surface Transportation Block Grant Program dollars available to fund a P3 office and pay stipends to private bidders seeking long-term concessions.
- Best practices and implementation tools used by State DOTs to evaluate alternative contracting opportunities when selecting the appropriate delivery method for costly, complex and significant projects.
- Educational materials describing the successful implementation of "value capture" techniques to help finance transportation projects via the incremental property value generated by the project itself. Value capture enables new local funding sources that, in turn, can attract new public or private investment.

Capacity building activities:

- Training for state and local partners on the appropriate use of Federal project finance tools, with an emphasis on opportunities for rural communities.
- Financial and organizational support for the Center for Excellence in Project Finance (CEPF) via a cooperative agreement to be awarded per a new competitive solicitation. The current CEPF, the BATIC Institute: An AASHTO Center for Excellence, offers a program of training, sharing of best practices, and technical assistance to all State Departments of Transportation and their local partner agencies.
- Intensive training for public project sponsors on critical aspects of public-private partnerships (P3s), including life-cycle cost comparisons between alternative delivery methods (Value for Money analysis), model contract provisions for long-term concession agreements, and best practices for competitive procurements. Each training course is based on material developed by the CIFS in recent years with research funding.
- Training for state and local partners on best practices for achieving efficiencies of scale on multiple small projects, such as bridges, via their "bundling" into consolidated design and construction packages. This training is based on research funded via FHWA's Accelerated Market Readiness program.

Technical assistance activities:

- Project-specific assistance to public sponsors assembling financial plans for Federal-aid projects. Building on research conducted in FY 2018, the CIFS will focus on opportunities for using SIBs to enable local and rural communities to finance the non-Federal share of project costs, which can present an inordinate challenge for small public budgets.
- Project-specific assistance to public sponsors implementing a P3 delivery method for a project seeking credit assistance via the TIFIA loan program and/or Private Activity Bonds (PABs). All such assistance would be coordinated through the Build America Bureau (see below) as established via the FAST Act.
- Independent advisory services to State DOTs seeking to establish consistent methods for evaluating alternative contracting methods (ACMs), as described above.

Statutory Requirements:
This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas in order to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.
Several IPD research activities support the authorizations in sections 116(e) and 116(g) of title 49, United States Code, which direct the National Surface Transportation and Innovative Finance Bureau (the "Build America Bureau") to work with DOT modal administrations, including FHWA, to develop and promote best practices for innovative financing and public-private partnerships. These include procurement benchmarks based on data collected from projects receiving Federal credit assistance. Given that most P3 and user-financed loans are for highway projects, the IPD support is essential to the Bureau's implementation of this initiative.
Several IPD capacity building activities support the authorization in section 504(h) of title 23, United States Codes, which establishes a center for excellence in project finance to provide strategic assistance to State Departments of Transportation.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure
Innovation	Improving mobility

Infrastructure: Construction and maintenance of critical national infrastructure lies at the core of the IPD mission. The condition and performance of our nation's roads, bridges and tunnels demand that State and local agencies spend more on infrastructure than their budgets allow. Scarce Federal funds, therefore, must be used efficiently to attract both public and private investors. In looking at rural communities, FHWA seeks to emulate Federal financing programs in sectors such as agriculture and housing, which play significant roles in rural development. Research into FHWA financing opportunities to leverage local participation in Federal-aid projects may open doors for this type of assistance.

Innovation: Regardless of how it is funded or financed, infrastructure will always require proficiency in project delivery. The IPD research on public agency best practices in evaluating innovative (alternative) contracting methods seeks to expand the range of appropriate delivery methods among all States. Alternative contracting methods typically are used less frequently in States with a higher proportion of rural communities, which could benefit from access to contracting approaches that enhance quality as well as cost and schedule reliability.

Program Objectives:

The IPD program begins with the recognition that public infrastructure resources at all levels of government are perpetually under stress, and thus the effectiveness of our project finance and delivery practices are paramount. These practices, in turn, must persistently evolve to exploit the opportunities of a dynamic economy. Given the sprawling number of public agencies in the United States, a potential "market failure" exists each time a project sponsor fails to look beyond local its environs for beneficial new practices. Federally-sponsored research and technology deployment can ease adoption by State and local jurisdictions of unused methods tested elsewhere by their peers.

Specific objectives:

- To increase consideration of innovative finance project revenue options, such as user fees and value capture, via research, training and technical assistance.
- To increase consideration of the P3 delivery option for major projects by providing the U.S. transportation community with the most complete, up-to-date body of knowledge on P3s.
- To support the accrual of P3 knowledge by industry practitioners and advisors in the areas of planning/evaluation, procurement, and monitoring/oversight.

Key FY19 program activities are identified below.

Activity	Period of Performance	Partners/Notes
In-depth database of selected major projects advanced via ACMs.	Jun 2018 – May 2019	Contract funded in FY 18.
Organizational structures for new P3 offices within State DOTs.	Oct 2018 – May 2019	Discussion paper.
Research grants to State DOTs that evaluate ACMs.	Oct 2018 – Mar 2019	Funded by Turner-Fairbank HRC
Value Capture guidebook and training course	Jul 2018 – Dec 2018	Contract funded in FY 18.
Federal project finance tools for rural communities.	May 2018 – Oct 2018	Contract funded in FY 18.
Center for Excellence in Project Finance (CEPF)	Jan 2019 – Dec 2019	New solicitation; Agreement will have 3
P3 intensive training for public sponsors.	Oct 2018 – Sep 2019	Customized using material developed by CIFS
Project bundling training for state and local partners.	Jan 2019 – Dec 2020	Funded by Center for Accelerating Innovation.
Project-specific financial assistance to State, local and rural communities.	Oct 2018 – Sep 2019	Building on work conducted in FY 18.
Project-specific assistance to P3s seeking TIFIA and/or PABs.	Oct 2018 – Sep 2019	Coordinated through the Build America Bureau.
Advisory services to State DOTs evaluating ACMs.	Oct 2018 – Apr 2019	Funded by Turner-Fairbank HRC

Research Collaboration Partners:

The relevance of the IPD program is a direct function of engagement with its stakeholders, the State and local public sponsors seeking the needed technical resources, capacity and information to deliver critical infrastructure. Whether in response to structured CIFS inquiries or via informal but frequent dialogue with FHWA, these practitioners largely shape the research and deployment agenda. This engagement is often facilitated by the network of FHWA Division Offices, which interact daily with public sponsors throughout the nation.

The IPD program partners provide regular communication channels, again both formally and informally:

Benefits of Partnership and Partner Contributions.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
Office of the Secretary of Transportation: Build America Bureau					X	X	X		
Transportation Research Board (TRB), Revenue and Finance Committee	X	X				X	X		
American Association of State Highway & Transpo. Officials (AASHTO)	X				X	X	X		
American Road and Transportation Builders, P3 Division		X					X		
National Governors Association (NGA)	X				X		X		
National Council of State Legislatures (NCSL)	X				X		X		
Association of Metropolitan Planning Organizations (AMPO)	X				X		X		

Acquisition/Assistance:
Access to professional research expertise is key to success for the IPD program. Fortunately, FHWA acquisition processes allow contractors to assemble teams of experts that can be available. The CIFS has collaborated with the FHWA Office of Policy on multi-year Indefinite Delivery Indefinite Quantity (IDIQ) contract awards that allow competitive solicitations for discrete research, training and technical assistance projects. For FY 2019, the IPD program plans to use a Blanket Purchase Agreements (BPA), similar to an IDIQ in its competitive approach, to acquire contractor expertise.

As noted above, the CIFS also administers a cooperative agreement for the Center for Excellence in Project Finance. This agreement requires the grantee (currently AASHTO) to provide a 20 percent share of the project cost against an 80 percent Federal share.

In conducting the research, the CIFS enlists the input of a wide range of industry experts, whose intensive reviews of draft results help shape the final work product. A typical public policy research paper, for instance, will be reviewed by several independent experts – identified from stakeholder groups – prior to completion and distribution.

Technology Transfer (T2):

Engaging in Technology Transfer on a practical level, the IPD program provides information, training, customized workshops, and technical assistance to transportation professionals. Technology transfer efforts are typically lead by FHWA staff in the relevant Headquarters program offices and/or the Resource Center, with support from the Office of Innovative Program Delivery and contractors as required. Stakeholders include:

- Public sector practitioners, at all levels of government, who use the IPD educational tools to build the in-house capacity to evaluate, develop and manage complex procurements such as a long-term P3 concession agreement.
- Private investors, and their financial and legal advisors, who desire a common body of practice in the US, and look to Federal leadership to help establish it.
- Academic teachers and researchers, who use the IPD tools to educate the rising cohort of practitioners and to further their own research into innovative finance and procurement.

Stakeholders often engage initially with the IPD program through the CIFS Internet website, which houses the growing archive of IPD resource materials. These products, such those comprising the P3 Toolkit, are available for download on demand, free of charge. Traffic volumes and patterns on the website are monitored for insight into market interest.

Public agency stakeholders often request specific training on innovative finance and procurement topics. With marketing assistance from the Build America Bureau, the CIFS regularly highlights these opportunities at association gatherings throughout the year. Via the network of FHWA Division Offices, the CIFS conducts annual direct marketing to State DOTs that resulted in a half-dozen customized training workshops in FY 2018 for States considering P3 procurement options.

Evaluation / Performance Measurement:
The IPD research program contributes toward achievement of the Department's goal Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System. Ideally, given its ambitious program objectives, the IPD research program would be able to measure the increased effectiveness of public agencies using innovative finance and procurement tools. This would reflect:

- An improved environment for P3 use, demonstrated by States with a sophisticated P3 policy framework, technical capacity, and procurement programs.
- The appropriate alignment of alternative contracting methods with transportation projects.
- An improved capacity for innovative finance use, demonstrated by States and local governments with the appropriate financial policies and technical capacity.

One indisputable measure is the simple number of States that utilize one or more of these tools. The FHWA Strategic Implementation Plan measures yearly activity by State, which typically shows that about half of all State DOT partners utilize these tools.

In support of these objectives, the IPD program evaluates its pedagogical effectiveness. A 2017 analysis of CIFS website usage, conducted for the FHWA R&T Development Program, shows that "the P3 program serves hundreds of diverse stakeholders in the transportation community. The P3 Toolkit Website reaches 1,500 to 2,500 users per quarter, spiking when new documents, tools, or webinars are introduced. The most active users fall into three groups: state and local transportation agencies; FHWA Division Office staff; and P3 advisory firms who provide legal,

financial, or engineering support. Smaller groups of academics, interest groups, and international users round out the audience."

Key 2019 FHWA Innovative Program Delivey Outputs

Program Objective	**Key 2019 Outputs**
Improved environment for P3 use: States with a sophisticated P3 policy framework, technical capacity, and procurement programs.	• Research study re State DOT P3 offices • Intensive P3 training for State DOTs • Technical assistance to P3 projects
The appropriate alignment of alternative contracting methods (ACMs) with transportation projects.	• Database of major projects using ACMs • Research grants to States using ACMs • Assistance to States evaluating ACMs
An improved capacity for innovative finance use, demonstrated by States and local governments with the appropriate financial policies and technical capacity.	• Value Capture guidebook and training • Federal project finance tools training • Center for Excellence in Project Finance • Technical assistance to State, local, and rural communities

Research Infrastructure, Technology Transfer and Partnerships
$14,000,000

Program Description/Activities:
The FHWA Research Infrastructure Program supports the goals of the USDOT to invest strategically in transportation infrastructure, promote safe and secure transportation, enhance our environment, and create new alliances between the nation's transportation and technology industries. The program monitors legislative developments, helps to coordinate the R&T budget allocation, manages the research agenda development process, maintains the Turner Fairbank Highway Research Center, organizes strategic Research and Technology (R&T) investment, and provides marketing and outreach. This Program's overarching role is to coordinate all elements that support and promote the highway R&T agenda to ensure the FHWA R&T program addresses national needs, meets future demands, and maximizes the strengths of all research entities. This R&T agenda is stakeholder driven, with partners engaged throughout the entire innovation lifecycle process, from agenda setting and planning, through the research, technology development, and innovation deployment phases, to the implementation and assessment stages. The Research Infrastructure, Technology Transfer, and Partnerships Program supports these coordinated efforts across all other programs.

FHWA's Office of Research, Development, and Technology is located at the Turner Fairbank Highway Research Center (TFHRC), a federally owned and operated national research facility in McLean, Virginia. At the TFHRC, staff administers the majority of FHWA's research and development activities in the areas of infrastructure, operations, and safety. Research in areas of Intelligent Transportation Systems (ITS), policy, innovative finance, planning, operations, and the environment is conducted or administered by FHWA offices located at USDOT Headquarters.

In addition to supporting R&T development and deployment activities, the Research Infrastructure, Technology Transfer, and Partnerships Program promotes communication, coordination, and collaboration with FHWA's partners, which are crucial to conducting the right research, doing it well, and delivering solutions when and where they are needed. Communication strategies address the needs of internal and external audiences and cover the depth and breadth of the federal effort for highway research and technology, displaying prudent use of government resources, advancing the state of the practice, and building a case for continued and future funding.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas in order to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others. Section 503 also requires that the Secretary "continue to operate in the Federal Highway Administration a Turner-Fairbank Highway Research Center."

Administration of the FHWA Research and Technology Programs
23 USC 503 states:

503. Research and technology development and deployment

(a) IN GENERAL.—The Secretary shall—

(1) carry out research, development, and deployment activities that encompass the entire innovation lifecycle; and

(2) ensure that all research carried out under this section aligns with the transportation research and development strategic plan of the Secretary under section 508.1

Turner Fairbank Highway Research Center

23 USC 503(b)(7) states:

(7) TURNER-FAIRBANK HIGHWAY RESEARCH CENTER.—

(A) IN GENERAL.—The Secretary shall continue to operate in the Federal Highway Administration a Turner-Fairbank Highway Research Center.

(B) USES OF THE CENTER.—The Turner-Fairbank Highway Research Center shall support—

(i) the conduct of highway research and development relating to emerging highway technology;

(ii) the development of understandings, tools, and techniques that provide solutions to complex technical problems through the development of economical and environmentally sensitive designs, efficient and quality-controlled construction practices, and durable materials;

(iii) the development of innovative highway products and practices; and

(iv) the conduct of long-term, high-risk research to improve the materials used in highway infrastructure.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The FHWA Research Infrastructure, Technology Transfer, and Partnerships Program supports all DOT Strategic goals and Critical Transportation Topic Areas. This Program leads the development and coordination of a national highway research agenda to close critical knowledge gaps, identify collaboration opportunities, and accelerate innovations and technology deployment. To accomplish this, the Research Infrastructure, Technology Transfer, and Partnerships Program coordinates with and supports all other R&T programs, thereby aligning with the respective strategies of those programs.

Program Objectives:

The primary role of the Research Infrastructure, Technology Transfer, and Partnerships Program is to provide leadership, coordination, and support in the development of a national highway research agenda. To accomplish this the Program will continue to foster and promote enhanced coordination of highway research among all stakeholders; communicate, publish, market, and

disseminate research results to appropriate audiences; coordinate strategic resource allocation; and conduct R&T Program Evaluations.

Additionally, the Research Infrastructure, Technology Transfer, and Partnerships Program will maintain and support the operation of the TFHRC. The highway research and development relating to emerging highway technology that occurs at TFHRC is focused on addressing research gaps not addressed by FHWA's partners. TFHRC specifically focuses on long-term, high-risk research to improve the materials used in highway infrastructure; the development of tools and techniques that provide solutions to complex technical problems; and the development of innovative highway products and practices.

The Research Infrastructure, Technology Transfer, and Partnerships Program provides the following services to the overall R&T program:

1. R&T Program Support and Administration:
    - Develop and execute the R&T program strategic direction, policies, and budget to further USDOT and FHWA initiatives.
    - Provide technical support to Congress and their staff members in the development and analysis of legislations and regulatory requirements impacting national research initiatives.
    - Identify and deliver communication and outreach strategies to engage transportation stakeholders in technology transfer and innovation delivery.
2. Communications, Publishing, and Marketing:
    - FHWA Research Library: conducts literature searches and provides technical information, documents, bibliography preparation, electronic resources, and provides knowledge management services of FHWA research reports.
    - Publications, periodicals, and technical reports: Plans, edits, and prepares technical reports and documents for publishing in print or on the web, and publishes the Public Roads magazine. Develops outreach materials to communicate research results to State DOTs and other stakeholders.
    - Develops, manages, and maintains the TFHRC website, which provides public access to program policy, on-going and completed research, laboratory information, and connects you to experts as well as invites visitors to tour the facility and laboratories.
3. TFHRC Laboratory Capacity Building: Supports the technical and scientific needs of researchers, such as installing special hardware or software, maintaining scientific laboratory instruments. Supports the repair or replacement of research equipment resulting from failure or replacement of obsolete or end-of-service-life equipment, enhanced capabilities for existing laboratories.
4. R&T Evaluations Program: The R&T Evaluation Program has been designed to further FHWA's transparency, accessibility, and responsiveness of R&T for stakeholders. The program conducts retrospective and prospective program evaluations of selected FHWA research programs and projects. The impacts of deployed innovations are assessed, which then feed back into setting the agenda, thereby making the full Innovation Lifecycle complete.
5. Support domestic and international partnerships: The FHWA R&T Program works with State DOTs to identify and conduct critical research; coordinates with National highway research organizations on priorities and objectives; collaborates with international organizations by sharing best practices and research results that are transferable or adaptable to the American highway system.

6. Knowledge Management: Supports 140 websites to address critical business topics by conducting day-to-day business and sharing knowledge within FHWA and with external partners including State DOTs and private organizations.

Key FY19 program activities are identified below.

Activity	Period of Performance	Partners/Notes
Conducting strategic planning exercises to identify resource allocation needs and priorities	2019	Research Technology Coordinating Committee (RTTCC); USDOT
Implement new Technology Transfer services to accelerate TFHRC innovations market-readiness and outreach	2019-2022	USDOT
Completing the conversion to the new USDOT content management system	2018-2020	USDOT
Identifying TFHRC research infrastructure improvement opportunities	2019-2020	N/A
Identify the future needs of the R&T Program in preparation for future authorizations	2019-2020	USDOT

Research Collaboration Partners:

The FHWA Research Infrastructure, Technology Transfer, and Partnerships Program supports and/or coordinates partnership activities at the State, national, and international level. Specific partnership activities are listed below:

- Transportation Pooled Fund (TPF) Program: When significant or widespread interest is shown in solving transportation-related problems, research, planning, and technology transfer activities may be jointly funded by several federal, State, regional, and local transportation agencies, academic institutions, foundations, or private firms as a pooled fund study. The FHWA-administered TPF Program allows federal, state, and local agencies and other organizations to combine resources to support transportation research studies.
- National partnerships: FHWA actively seeks cooperation with stakeholders. FHWA participates in TRB standing committees and in the AASHTO Research Advisory Committee. The FHWA sponsors transportation stakeholder events such as the TRB annual meeting.
- International partnerships: International cooperation to conduct research of interest to multiple countries is achieved through a partnership with the Forum of European Highway Research Laboratories (FEHRL) and through other agreements with foreign countries.

Input into the FHWA R&T Agenda and the identification of R&T activities is coordinated through partnerships on many levels. An independent advisory board, the Research and Technology Coordinating Committee (RTCC), which is administered by TRB, provides insight and guidance on the overall R&T agenda and business practices used in setting priorities and program administration. Additionally, FHWA researchers support and participate in AASHTO committees to receive input from the State DOTs on the appropriateness of our research goals and coordinate research efforts based on the relative priorities of the partner agencies. Technical staff also serve as members of various TRB committees related to their area of expertise and responsibility and receive feedback on the Federal role in furthering the research needs of that particular topic area relative to the role of State, local, and non-governmental organizations.

Benefits of Partnership Relations.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
USDOT			X			X			X
TRB	X	X	X		X	X	X		
AASHTO	X		X	X	X	X	X		
State DOTs	X			X	X	X	X		X
University Transportation Centers				X		X	X		
FEHRL				X	X	X	X		

Acquisition/Assistance:
The Research Infrastructure, Technology Transfer, and Partnerships Program utilizes numerous procurement strategies and assistance agreements to accomplish its mission. This includes competitively awarded contracts, cooperative agreements, IDIQs to acquire services utilized on an as needed basis, and interagency agreements. This program also relies on cooperative agreements with TRB to facilitate critical partnership and coordination activities including providing support for the TRB Annual Meeting, the AASHTO NCHRP program, and the Research and Technology Coordinating Committee. Other agreements with International organizations such as the Forum of European National Highway Research Laboratories (FEHRL) facilitate the transfer of knowledge with numerous international highway agencies.

The Research Infrastructure, Technology Transfer, and Partnerships program acquisitions are most often multi-year acquisitions, funded over several fiscal years. Single year contracts, or multi-year contracts fully funded in the year of award are occasionally used for projects and activities of limited scope. "Sole source" acquisitions are used only in the relatively rare circumstance where there truly is only one source for the item or service being procured. In the Research Infrastructure, Technology Transfer, and Partnerships Program sole source acquisitions are used for statutory earmarks such as legislatively mandated studies and with services provided by the National Academies of Science.

The Research Infrastructure, Technology Transfer, and Partnerships Program leverages State and local funds primarily through the Transportation Pooled Fund program. The program also jointly plans some activities with international partners, though no funds are exchanged.

Technology Transfer (T2):
In FY19, the Research Infrastructure, Technology Transfer, and Partnerships program will continue to grow a new suite of services that is aimed at facilitating and accelerating the movement from

prototype to final product, thereby enhancing technology transfer within the FHWA R&T program. The objective of the Technology Transfer Program is to achieve greater success in technology transfer, transition, and commercialization of research products of the FHWA R&T program. The activities under this program will ensure that FHWA R&T is relevant to all stakeholders, including potential adopters, and that the technologies produced through R&T are developed, documented, packaged, and disseminated with user and adopter needs guiding the process. Engaging adopters including State DOTs and local agencies as well as other stakeholders throughout the innovation lifecycle is critical in the Technology Transfer program. Engaging stakeholders effectively increases capacity for research results to create economic and societal benefits and positive impacts.

The Research Infrastructure, Technology Transfer, and Partnerships Program will also continue to manage the public dissemination of information related to the R&T Program. This includes maintenance of R&T websites, the research publication process, and developing informational tools and materials to ensure that our partners and the public are aware of FHWA's progress and products.

Key 2019 FHWA Research Infrastructure, Technology Transfer, and Partnerships Program Outputs

Program Objective	**Key 2019 Outputs**
Develop and promote a new suite of technology transfer tools	Apply new technology transfer acceleration tools to existing FHWA R&T technologies
Align FHWA content management system with DOT requirements	Fully populated content management system
Develop FHWA project management system to collect projects for USDOT requirements	FY 2019 projects populated into project management system
Develop a better FHWA publication tracking mechanism to allow transparency into the publishing phases.	Tool for tracking publications through the publishing process.
Review documents in USDOT ROSA P repository to ensure that FHWA documents are categorized properly.	Documents are categorized properly to increase the likelihood that customers can find FHWA documents in ROSA P searches.
Identify opportunities for and engage in strategic partnerships	Identification of TFHRC research needs where partnerships are beneficial
Engage actual and potential stakeholders to improve awareness of FHWA research priorities, directions, and technology roadmaps and to facilitate implementation of results	Develop and implement a TFHRC marketing and communications plan

Evaluation / Performance Measurement:
The Federal Highway Administration's R&T Evaluation Program is managed within the Research Infrastructure, Technology Transfer, and Partnerships Program and seeks to assess and communicate the benefits of the FHWA Research and Technology program to ensure that we are expending public resources efficiently and effectively. FHWA developed the R&T Evaluation Program with encouragement from the RTCC. The Evaluation Program selects and reviews successfully deployed R&T products to answer questions that include: are we conducting the right research? Are there lessons learned that can improve the conduct of research? Is the research having the desired impact? What is the benefit to the public? Under this program, numerous evaluations have been completed and others are set to be complete in FY19 and FY20.

The R&T Performance Evaluation program utilizes both retrospective and prospective studies to evaluate the performance of selected R&D projects and technologies. The measures of outputs, outcomes and impacts used are project-dependent. Impacts can include crash reductions, lives saved, cost-benefit ratios, etc. This program utilizes the R&T Evaluation Program to provide an objective analysis of the performance and impacts of the FHWA R&T Program as a whole. Depending on the project area, each evaluation collects available baseline and operational data and performs appropriate statistical/ econometric analysis, including trends, cost-benefit and other analyses.

The FHWA R&T evaluation program is designed to assess achievement of the FHWA R&T Agenda which includes the strategic R&T objectives of each research discipline/Office, i.e., Infrastructure, Operations, Safety, Policy, etc. The FHWA R&T Agenda is focused on achieving goals commensurate with the DOT Strategic Plan. Completed evaluations indicate that the FHWA R&T projects studied are achieving their specific objectives and providing valuable new technologies and innovations that increase safety, improve infrastructure, preserve the environment, and enhance mobility. For example, Roundabouts, TIM, Pre-cast concrete, NHTS, and Managing Risk in Rapid Renewal Projects. As a result, the R&T evaluation program supports all relevant performance goals within the USDOT Strategic Plan.

Small Business and Innovation Research
$2,000,000

Program Description/Activities:
The SBIR program is a highly competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT. The SBIR program favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, State DOTs, USDOT, or other federal agencies.

The program is administered by the Volpe Transportation Center. The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations, including the FHWA.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes - On December 31, 2011, the President signed into law the National Defense Reauthorization Act of 2012 (Defense Reauthorization Act), P. L. 112-81. Section 5001, Division E of the Defense Reauthorization Act contains the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Reauthorization Act of 2011 (SBIR/STTR Reauthorization Act), which extended both the SBIR and Small Business Technology Transfer (STIR) programs through September 30, 2017. On November 30, 2016, a 5-year reauthorization was signed by the President, extending the expiration date to September 30, 2022. Funding amounts are established in Law, as noted in the Defense Reauthorization Act (Sec.5102(a)(1)), each year Federal agencies with extramural research and development (R&D) budgets at the Department level that exceed $100 million are required to allocate 3.2 percent of their R&D budget to these programs as listed below. Agencies may exceed these minimum percentages.

Program Alignment with Strategic Goals:
The SBIR program solicits research and technology topics from all FHWA R&T offices annually, including the ITS Joint Program Office. Topics are selected based on the merit, suitability for the SBIR program, as well as consideration of alignment with Agency and Departmental goals. As a result, the SBIR program supports all of the FHWA R&T program offices and, by extension, all of the USDOT Strategic goals.

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Program Objectives:
To encourage small businesses to engage in research or research and development (R/R&D) that has the potential for commercialization and meets federal R/R&D objectives. The SBIR program is uniquely positioned to support both the interests of the Agency as well as the small business. In

this respect, the SBIR programs aims to provide essential funding to small businesses with aim toward commercialization of products that align with Agency and Departmental goals.
The SBIR program offers unique services to the small businesses to aid in their technical and commercial development. Specifically, the SBIR program recently introduced a Commercialization Assistance Program to provide consulting services to the SBIR participants to help conduct market research, commercialization plans, and other services. In addition, in FY19 the FHWA SBIR program will pilot a Technology Readiness Level (TRL) assessment program to help the Small Businesses conduct an independent assessment of the technological status of the innovations developed through the SBIR program.

Key FY19 FHWA SBIR Program Activities

Activity	Period of Performance	Partners/Notes
Technology Readiness Level (TRL) Services Pilot	2019	N/A
Annual Solicitation of Topics	2019	N/A

Research Collaboration Partners:
The FHWA SBIR program is coordinated internally within USDOT and methods and practices are shared with other modes through the Volpe center, which administers the SBIR programs for USDOT.

FHWA SBIR Partners

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or	Funding
USDOT				X	X	X			

Acquisition/Assistance:
The FHWA SBIR program competitively awards contracts to small businesses through an annual or semi-annual solicitation, which is posted on the FedBizOpps.gov website. The SBIR program does not utilize cooperative agreements or grants. All proposals are subject to review by a panel of technical experts. Small businesses may utilize internal or external funds to supplement the Federal contributions. The SBIR Program does not utilize sole source acquisitions.

Phase I projects are generally given a period-of-performance of 6 months. Phase II projects, which are optional, are generally given a period-of-performance of up to 2 years. The period-of-performance for Phase IIB projects, which are also optional, varies but is no more than 2 years.

Small businesses are able to solicit and contribute internal or external funds to supplement the Federal contribution, particularly during the Phase IIB phase. However, there is no requirement for matching funds.

Technology Transfer (T2):
Technology transfer in the SBIR Program is accomplished through the development of innovations and technologies by the small businesses. A primary goal of the SBIR program is to provide funding to small businesses to develop innovations and technologies that have commercial value and meet a strategic need for the department. The intellectual property for the innovations and technologies resides with the small business and thus serves as the motivation for the business to bring it to market. As a result, the SBIR program does not utilize the internal FHWA technology transfer tools used to promote and deploy other innovations in the FHWA R&T program.

Through the Commercialization Assistance Program the USDOT SBIR program provides commercialization services to the small businesses to provide market research, intellectual property protection assistance, and other consulting options to promote the commercial value and discovery of the innovations and technologies. Additionally, the FHWA SBIR program is piloting a new Technology Readiness Level (TRL) assessment service for completed Phase II projects to provide an independent assessment of the maturity level of a particular technology.

Specific program outputs anticipated in 2019 are identified below.

Program Objective	Key 2019 Outputs
Identify and fund technologies and innovations that have commercial value and support Agency and Departmental goals	Select Phase II and Phase IIB projects that show significant promise for commercialization and technology readiness
Pilot a Technology Readiness Level (TRL) program	Independent assessment of technology maturity to aid FHWA in identifying and funding promising technologies and provide the contractor with a review of technology development needs.

Evaluation / Performance Measurement:
The FHWA SBIR program tracks the performance of innovations and technologies by implementing a phased funding approach. The objective of Phase I is to establish the technical merit, feasibility, and commercial potential of the proposed R/R&D efforts and to determine the quality of performance of the small business awardee organization prior to providing further Federal support in Phase II. The objective of Phase II is to continue the R/R&D efforts initiated in Phase I. Funding is based on the results achieved in Phase I and the scientific and technical merit and commercial potential of the project proposed in Phase II. Only Phase I awardees are eligible for a Phase II award. A Phase II awardee may receive one additional, sequential Phase II award to continue the work of an initial Phase II award. These awards are referred to as Phase IIB awards. The intent of the Phase IIB awards is to advance and/or accelerate Phase II SBIR funded technologies towards commercialization. For each phase, a technical proposal and cost estimate is required from the contractor, which is evaluated by a panel of technical experts to determine the feasibility, commercial value, and technological maturity. Program performance is assessed primarily on the basis of project milestones.

Outputs of this program are intended to directly support the USDOT strategic plan by supporting technologies and innovations that show commercial promise and technological maturity in pursuit of those goals. As a result, this cross-cutting innovation development program supports all relevant performance goals identified in the USDOT Strategic Plan.

Exploratory Advanced Research
$4,740,000

Program Description/Activities:
Legislation established an Exploratory Advanced Research (EAR) Program that addresses the need to conduct longer term and higher risk breakthrough research with the potential for transformational improvements to plan, build, renew, and operate safe, congestion free, and environmentally sound transportation systems.

The EAR Program begins with extensive initial stage investigations to scout for, scope, and screen new topics before investing in research. The Program engages stakeholders from evaluating potential research topics through communicating research results. The EAR Program uses expert panels to ensure the technical quality of sponsored research. The panels are composed of Federal, State, academic, and international scientific and engineering experts, who are vetted to avoid conflicts of interest. The panels frequently include members from multiple disciplines to assure that cross applications and novel approaches to research are fully assessed. FHWA understands that EAR Program-funded projects are part of a larger research and development cycle designed to move from basic research through applied research, field testing, pilot deployment, and adoption. FHWA is committed to transitioning the results of EAR Program-funded research projects and takes an active role in continued partnership with external experts in demonstrating results to stakeholders critical to continuing the research and development cycle.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes

23 U.S.C. Section 503, Research and technology development and deployment, paragraph (b)(6) states "The Secretary shall carry out research and development activities relating to exploratory advanced research …" The EAR Program applies proven deliberative and open processes based in legislative and corporate direction. The EAR Program engages experts within and outside the Department to identify potential research topics among new discoveries in science and technology that may address current and emerging needs of the highway transportation industry. These new discoveries often are results from basic research sponsored, for example, by the National Science Foundation and National Energy Labs. The EAR Program conducts extensive investigations into 15 to 20 topics annually to identify three or four where a government investment has the potential for higher impact results. The Program continues to engage experts within and outside the Department during the conduct of Program-funded research, conducts regular screening of results, and supports active efforts to transition results that demonstrate high potential to applied research programs.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Innovation	Improving mobility

The EAR Program works with offices throughout FHWA and in other modal agencies to match advances in science and engineering with critical current and emerging needs. The EAR Program research portfolio provides a balance of investments across critical transportation topics. Examples of current investments include

- New methods in machine learning for analyzing unstructured data to improve highway safety including cybersecurity and privacy.;
- New methods for characterizing and modeling supplementary and alternative materials for pavements and structures to create longer-lasting and more resilient highways and new sensor systems to improve evaluation of and increase the useful lifecycle of existing infrastructure and reduce the requirements for virgin materials thus helping to preserve the environment; and
- Next generation technologies for connected vehicles to improve highway system mobility including for freight operations.

EAR Program research supports needs in urban and rural areas. New methods for analyzing unstructured data, for example, is critical in rural areas where traditional data may be limited making it more difficult for identifying potential safety issues or developing evidence to support safety countermeasures.

Program Objectives:
The EAR Program is the only funding specifically addressing the need for longer-term, higher-risk research in highway transportation. Funding of exploratory advanced research has a direct impact on the upstream supply of potential technologies and processes necessary for continued industry innovation to meet the challenges of improving the safety, operation, and resilience of the U.S. highway system for years to come. The EAR Program addresses persistent issues that could be solved by applying new methods and complex emerging issues where there is no or limited research.

The research conducted under the EAR Program typically has an uncertain payoff that will take too long or with too high a risk to motivate industry alone to fund the research. The government is in a unique position to support early stage research. It is difficult to obtain a return on investment in exploratory research. The time from transitioning from basic science to new technologies or processes that impact practice can take a decade or longer and the eventual application of early stage results can be amorphous providing generalized knowledge that can lead to a range of impactful applications but making it hard for individual entities to obtain returns on investments.

Key FY19 FHWA Exploratory Advanced Research Program Activities

Activity	Period of Performance	Partners/Notes
Initial Stage Investigations	FY 2019	The EAR Program partners broadly across DOT, with other federal agencies, state and local government, academia and industry
Sponsored Breakthrough Research	FY 2019-FY 2022	The EAR Program seeks a balanced portfolio that includes applies advances in science and technology

		across a range of applications reflecting emerging highway industry needs as well as new solutions to persistent issues
Transition of Research Results	FY 2019- FY 2020	The EAR Program regularly screens the portfolio of current projects to identify potential high impact results and focus transition of those results into applied research programs and demonstrations

Research Collaboration Partners:
The EAR Program conducts initial stage investigations of 15 to 20 topics annually. As part of the initial stage investigation process, the EAR Program identifies stakeholders involved in funding and conducting work for each area. Investigations of promising topics often result in extensive consultation of stakeholders through remote and in person workshops and circulation of white papers to assist in scoping the potential opportunity and impact and benefit of government investment in the topic.

Within the Department, the EAR Program regularly works with technical experts in BTS, FMCSA, FAA, FTA, ITS JPO, and NHTSA across the range of EAR Program processes from participating in scoping activities, through serving on technical review panels for EAR Program investments, technical working groups reviewing ongoing EAR Program-funded research, and Technology Readiness Level assessment panels that provide input into the transition of results.

The EAR Program also works with other government agencies. The EAR Program and the NSF Cyber Physical Systems program entered into an MOU in 2012 to coordinate on research, which has resulted in join funding of three connected vehicle projects in 2015 and 2016. The EAR Program also has worked with multiple DOE and NASA labs, NIST, and Army Corps ERDC through Interagency Agreements. For example,

- Under the focus area for "Breakthrough Concepts in Material Science," FHWA has partnered with NIST and Army Corps of Engineers to demonstrate the potential of novel binders for highway transportation structures and pavements that can provide more material choices included alternative to virgin materials.

There also is a strong history of private sector involvement in EAR Program-funded research. Under 23 USC Section 502, cooperative agreements require a minimum 20 percent match. The match may be in kind, such as providing materials, salary costs, equipment, etc.

- Under the focus area for "Connected Highway and Vehicle System Concepts," FHWA is partnering with industry to demonstrate potential for increased mobility from truck platooning. Partners also include FMCSA, Department of Energy, Transport Canada, and CalTrans.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized below.

Partner Organization	User Perspective on Needs	Industry Perspective	Physical Demonstrations	Research Collaboration	Specialized Expertise or	Donation of Material or	Funding
Defense Dept.			X	X	X	X	X
Energy Dept.			X	X	X	X	X
National Institute of Standards and Technology (NIST)				X	X		
NSF				X			X
State Departments of Transportation	X		X	X		X	X
Vehicle mfg./ suppliers	X	X	X	X	X	X	

Acquisition/Assistance:
Around four-fifths of EAR Program funding is awarded as extramural research through broad agency announcements. The solicitations generally include three to four topics. The EAR Program often makes more than one award in each topic reflecting the range of innovative approaches proposed. Most projects range between $0.5 and $2M in government funding and last two to four years. Many of the projects include matching funds, which may be in kin, and include a partnership between academia and industry.
The EAR Program also utilizes interagency agreements and other mechanisms for intramural research at government laboratories. The intramural research generally complements extramural investments, for example, by leveraging unique government research resources. The EAR Program funds these agreements on an annual basis up to five years.

The EAR Program also supports post-doctoral researchers through the NRC Associates Program. The EAR Program funds NRC Associates on an annual basis up to three years.

Technology Transfer (T2):
The EAR Program applies technology readiness level (TRL) assessments to improve transition of results. Unlike applied research program with prescribed work scopes and project deliverables, EAR Program-funded research may be successful while not meeting the proposed objectives by identifying current limits or creating unexpected, useful results. The EAR Program also conducts regular portfolio assessments to identify which projects have a high potential for impact. The use of the TRL assessments along with other analyses such as creating logic maps to illustrate potential paths to implementation allows the EAR Program to create a highly-tailored approach for transitioning transformative project results to appropriate applied research programs in government or industry.

Stakeholders that demonstrate interest in and gain benefits from EAR Program-funded project results include applied research and development programs in government and industry. For example, EAR Program-funded research on

- Vehicle autonomy that took place from 2009 to 2012 received subsequent industry funding and became an option on 2018 model vehicles;

- Agent-based modeling that took place between 2010 and 2014 with subsequent funding from ARPA-E in 2015 now has resulted in two University spun off startup companies providing mobility services; and

- Machine learning and video analytics underway since 2011 provides automated tools for researchers to assess very large data sets in the FHWA Safety Training and Analysis Center

Summaries of EAR Program-funded projects are available on the USDOT Research Hub. FHWA includes intermural projects with EAR Program funding as part of the T2 Annual Performance to OST-R."

Specific program outputs anticipated in 2019 are identified in the table below and are based on expected results from the current Program portfolio of projects.

Program Objective	**Key 2019 Outputs**
Collaborate with stakeholders from multiple disciplines (both inside and outside transportation) to promote and foster creative, innovative thinking	Identify and investigate research on topics that anticipates questions and future needs in the transportation sector. Identify potential researchers who are capable of conducting exploratory advanced research and with whom the Exploratory Advanced Research Program can build partnerships. Identify potential partners with interlocking objectives
Promote, fund, and enable higher-risk research that has a high potential for revolutionary breakthroughs over the long term	Invest in highly innovative ideas from exceptional research teams. Collaborate with outside experts at each stage of the research process to ensure the quality of research.
Demonstrate and communicate the value and impact of exploratory advanced research and promote opportunities to move from advanced to applied research	Transition results to applied research funders in government and industry. Provide access to novel tools and process.

Evaluation / Performance Measurement:
The EAR Program provides a unique contribution to the Departmental Strategic Objective Development of Innovation. The EAR Program conducts research that addresses all USDOT Strategic goals. It seeks advances in technology building partnerships across government, the private sector, and academic institutions to create new research approaches, tools, and data that respond to critical persistent and emerging transportation safety and efficiency needs.

Based on a portfolio screening that took place in FY 2018, the EAR Program is focusing transition of results on

- Hardware-in-the-loop for connected vehicle technologies – Hardware-in-the-loop combines physical and simulated testing providing a safe and cost effective method for scaling connected vehicle. The results include sample system architecture, software elements, and research protocols for use within FHWA applied research programs and by other government, academic, and industry laboratories.

- Massive Data Analytics – New computer science approaches allow for increased automation and improved reliability of assessing structures and unstructured highway safety data for use within the Department and by other government, academic, and industry laboratories.

- Structural Sensor Systems – Integration of new sensor systems with current structural assessment processes can provide methods for extending the lifecycle of existing infrastructure. The EAR Program is working with State DOTs and other asset owners to support continued development and testing of results under real world conditions.

In the near-term, EAR Program success is found in transition of results and follow on investment from other government programs or industry. In the longer-term, continued research and development can result in the use of new tools and techniques and changes in industry practices that are necessary to continue long term improvements in safety, mobility, and durability of the highway transportation system.

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)
$39,000,000

Program Description/Activities:
The Advanced Transportation and Congestion Management Technologies Deployment Initiative (ATCMTD) Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. As the program is aimed at the rapid deployment of advanced technologies, limited expenditures for infrastructure construction is anticipated in grant application. The stated purpose is to reduce costs and improve return on investments; deliver environmental benefits through increased mobility; improve transportation system operations; improve safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and autonomous vehicle technologies. Successful proposals will contain quantifiable system performance objectives, use innovative technologies and strategies, and a plan for long term operation and maintenance of the deployed technologies. Partnering between the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders is encouraged.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. FAST Act Section 6004, 23 U.S.C. 503(c)(4)).

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure

Goals for the ATCMTD Program are directly linked to DOT's Strategic Goals and DOT RD&T Critical Transportation Topics and include:

- Reduced costs and improved return on investments, including through the enhanced use of existing transportation capacity (Infrastructure)
- Delivery of environmental benefits that alleviate congestion and streamline traffic flow (Preserving the Environment)
- Measurement and improvement of the operational performance of the applicable transportation networks (Improving Mobility)
- Reduction in the number and severity of traffic crashes and an increase in driver, passenger, and pedestrian safety (Safety)
- Collection, dissemination, and use of real-time transportation-related information to improve mobility, reduce congestion, and provide for more efficient and accessible transportation, including access to safe, reliable, and affordable connections to employment, education, healthcare, freight facilities, and other services (Improving Mobility)

- Monitoring transportation assets to improve infrastructure management, reduce maintenance costs, prioritize investment decisions, and ensure a state of good repair (Improving Infrastructure)
- Delivery of economic benefits by reducing delays, improving system performance and throughput, and providing for the efficient and reliable movement of people, goods, and services (Improving Mobility)
- Accelerated deployment of vehicle-to-vehicle, vehicle-to-infrastructure, and automated vehicle applications, and autonomous vehicles and other advanced technologies (Innovation)
- Integration of advanced technologies into transportation system management and operations (Innovation)
- Demonstration, quantification, and evaluation of the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, and sustainable movement of people and goods (Safety, Improving Mobility)
- Reproducibility of successful systems and services for technology and knowledge transfer to other locations facing similar challenges (Innovation)

Fixing America's Surface Transportation (FAST) Act Section 6004 instructs the DOT to ensure that the selection of grant recipients represent diverse geographic areas of the United States, including urban and rural areas.

Program Objectives:
The DOT's vision for the ATCMTD initiative is the deployment of advanced technologies and related strategies to address issues and challenges in safety, mobility, sustainability, economic vitality, and air quality that are confronted by transportation systems owners and operators. The advanced technologies are integrated into the routine functions of the location or jurisdiction, and play a critical role in helping agencies and the public address their challenges. Management systems within transportation and across other sectors (e.g., human services, energy, and logistics) share information and data to communicate between agencies and with the public. These management systems provide benefits by maximizing efficiencies based on the intelligent management of assets and the sharing of information using integrated technology solutions. The advanced technology solutions and the lessons learned from their deployment are used in other locations, scaled in scope and size, to increase successful deployments and provide widespread benefits to the public and agencies.

Although proposals are not limited to DOT priorities, the Department is particularly interested in deployment programs and projects in the following Focus Areas:

- Multimodal Integrated Corridor Management (ICM): ICM is the coordination of individual transportation network operations of adjacent facilities across all government or other operations agencies that creates a unified, interconnected, and multimodal system capable of sharing cross-network travel management to safely and efficiently improve the movement of people and goods. All corridor transportation assets and information services (i.e., local, county, regional, State) are brought to bear when prevailing or predicted transportation conditions trigger alerts. Through an ICM approach, transportation agencies manage the corridor as a multimodal system and make operational and safety decisions for the benefit of the entire corridor. The DOT is interested in increasing deployment of ICM.

- Installation of connected vehicle technologies at intersections and pedestrian crossing locations: Deployment of connected vehicle wireless communications technologies at intersections to enhance motorized and non-motorized traveler safety, or actively improve the management, operation, and maintenance of traffic signal systems through real-time data collection and signal control. Example technologies include vehicle-to-infrastructure (V2I) and vehicle-to-pedestrian (V2P) deployments, such as at intersections or midblock pedestrian crossings, to support activities and initiatives of the V2I Deployment Coalition and non-motorized traveler applications, or technologies to support automated traffic signal performance measures. Such technologies should provide information, notifications, and alerts in accessible formats to help all users navigate safely through intersections including providing contextual information for situational awareness and localization. The DOT has been working to accelerate the implementation of technologies that advance these strategies.

- Unified fare collection and payment systems across transportation modes and jurisdictions: Technological advancements in payment systems allow convergence across both publicly-delivered and privately-delivered mobility services. However, field implementations have been achieved only sparingly and in small projects. Convergence will enhance consumer payment options and mode choices and forge partnerships among providers to achieve a seamless, accessible, and flexible transportation network across the Nation. DOT is engaged in efforts that will assist in identifying technical, institutional, and policy solutions to achieve unified transportation payment systems.

- Freight Community System: A Freight Community System (sometimes called Port Community System) is an electronic platform that connects the multiple systems operated by a variety of organizations that make up a freight transportation community, including seaports, airports, rail yards, inland ports, and distribution centers. It is shared in the sense that it is set up, organized and used by firms in the same sector – in this case, a freight community – to provide a neutral and open electronic platform enabling an intelligent and secure exchange of information between public and private stakeholders to improve the efficiency and competitive position of the ports' community(ies). It optimizes, manages, and automates smooth port and logistics processes through a single submission of data by connecting transport and logistics chains. This focus area is important to the departmental goal of integrating freight infrastructure within the surface transportation system, particularly maritime ports, while at the same time providing a platform to reduce the impacts of national freight movement on local communities.

- Technologies to support connected communities: Deployment of technologies for a multimodal transportation system provides Americans with safe, reliable, and affordable connections to employment, education, healthcare, and other essential services. Examples include dynamic ridesharing through the latest communications technologies and social network structures to bring drivers and riders together quickly and efficiently, technologies to mitigate the negative impacts of freight movement on communities, or technologies that support workforce development, particularly for disadvantaged groups, which include persons with visible and hidden disabilities and elderly individuals. These example technologies should consider the elements of universal design and inclusive information and communication technology solutions, and may include deployment of autonomous vehicles

through geographically contained ridesharing pilot programs, including the benefits of the technology with groups that might otherwise have limited transportation options, such as older Americans who no longer drive or those with disabilities or no driver's license. The DOT is interested in using advanced technologies to improve the public's connections to employment, education, healthcare, and other essential services.

- Infrastructure Maintenance, Monitoring, and Condition Assessment: Timely, accurate and efficient assessment of infrastructure condition is critical to effective infrastructure asset management. Current state-of-the-practice technologies for condition assessment represent a good start, but have a variety of limitations. Opportunities for advancement include: implementation of friction management programs founded on highway-speed friction testing; highway speed deflection monitoring for pavement structural evaluation; sensor systems for infrastructure condition monitoring; use of unmanned aerial systems (UAS) for condition inspection; development of holistic and virtual data visualization technologies; and advancement of bridge load rating technologies. Implementation of these emerging technologies will enable improved highway safety and more timely intervention to address structural deficiencies and infrastructure deterioration with relatively low-cost solutions.

- Rural technology deployments: Deployment of advanced technologies to enhance safety, mobility, or economic vitality. Example technologies include improved access to transportation services, corridor freight platooning, mobile work zone alerts, improved roadway weather management, improved emergency response services and traffic incident management, curve warning systems, or animal intrusion detection and warning. The DOT is interested in geographically diverse application of technologies to include rural deployments.

The ATCMTD Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. The stated purpose is to reduce costs and improve return on investments; deliver environmental benefits through increased mobility; improve transportation system operations; improve safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and autonomous vehicle technologies.

Key FY19 program activities are identified below.

Activity	Period of Performance	Partners/Notes
Selection of FY19 grant awards and timely implementation of projects	FY19 to project closeout	Work with grantees to ensure timely implementation of grant awards
Continue award of FY 18 grants and manage FY16, FY17, and FY18 projects	To project closeout (varies)	Work with grantees to ensure timely implementation of grant awards

Research Collaboration Partners:

ATCMTD is not a research program, rather it is a discretionary grant program established in the FAST Act, however, public and stakeholder input is considered in the development of the annual Notice of Funding Opportunity (NOFO).

To be selected for an ATCMTD award, an applicant must be an eligible applicant. Eligible applicants are State or local governments, transit agencies, metropolitan planning organizations (MPO) representing a population of over 200,000, or other political subdivisions of a State or local government (such as publicly owned toll or port authorities), or a multijurisdictional group or consortia of research institutions or academic institutions. Partnership with the private sector or public agencies, including multimodal and multijurisdictional entities, research institutions, organizations representing transportation and technology leaders, or other transportation stakeholders, is encouraged.

Typically, a consortium is a meaningful arrangement with all members involved in planning the overall direction of the group's activities and participating in most aspects of the group; the consortium is a long-term relationship intended to last the full life of the grant. Any application submitted by a sole research or academic institution and that is not part of a consortium will not be considered for selection.

Partnerships with the private sector or public agencies, including multimodal and multijurisdictional entities, research institutions, organizations representing transportation and technology leaders, or other transportation stakeholders, is encouraged. Numerous awards from FY 2016 and 2017 include non-governmental partners. Non-governmental partners traditionally have provided non-Federal matching funds in the form of technical services, hardware, and software.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in the table below.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or	Funding
ATCMTD partners are the individual grant recipients (benefits of partnerships are identified in FAST Act Section 6004 and 23 U.S.C. 503(c)(4)). Benefits of partnership and partner contributions will be detailed in FAST Act-mandated Secretary's report, which is due May 2020.				X					

Acquisition/Assistance:

As a discretionary grant program, the technical review of grant applications and project selections by the Secretary may be considered acquisition methods. The technical review and project selection process is described in the annual Notice of Funding Opportunity (NOFO).

The ATCMTD Program anticipates two sole source acquisitions with U.S. DOT's Volpe Center for technical assistance in the application review process and annual report mandated by the FAST Act. Sole source acquisition is proposed because both these activities are inherently government functions. The technical assistance for the application review process is a single-year acquisition. The technical assistance for publishing the annual ATCMTD report is multi-year as the first report is due in May of 2020. The program supports technology transfer through cooperative agreements between FHWA and the grant recipients. FHWA's Office of Operations ATCMTD Program Manager oversees the U.S. DOT annual report on the effectiveness of grantees' projects in addressing the program goals and objectives. As specified in Section 6004 of the FAST Act, the Federal share is up to 50% of the cost of the project. Leveraging of non-Federal funds above the 50% minimum is considered in the award selection process.

Technology Transfer (T2):

- Annual ATCMTD grant awardees are involved and are the primary beneficiaries. In addition, through publication of the U.S. DOT annual report, information on the awards (e.g. best practices, etc. will be shared on a nationwide level). USDOT's first annual report is due May 2020.
- Technology transfer reports are not applicable, as ATCMTD is a discretionary grant program to deploy advanced technologies and related strategies to address issues and challenges in safety, mobility, sustainability, economic vitality, and air quality that are confronted by transportation systems owners and operators.

Key 2019 FHWA ATCMTD Program Outputs

Program Objective	Key 2019 Outputs
Provide funding to develop model deployment sites for large scale implementation and operation of advanced congestion management technologies.	Selection of FY19 grant awards and timely implementation of projects

Evaluation / Performance Measurement:
Per 23 U.S.C. 503(c)(4)(F), not later than 1 year after receiving an ATCMTD grant, and each year thereafter, the recipient shall submit a report to the Secretary that describes:

i. Deployment and operational costs of the project compared to the benefits and savings the project provides; and

ii. How the project has met the original expectations projected in the deployment plan submitted with the application, such as:

a. data on how the project has helped reduce traffic crashes, congestion, costs, and other benefits of the deployed systems
b. data on the effect of measuring and improving transportation system performance through the deployment of advanced technologies
c. the effectiveness of providing real time integrated traffic, transit, and multimodal transportation information to the public to make informed travel decisions
d. lessons learned and recommendations for future deployment strategies to optimize transportation efficiency and multimodal system performance

This program directly supports both the Infrastructure and Innovation objectives of the 2019-2022 FHWA Strategic Plan. The ATCMTD program outputs enable our partners to maintain transportation networks mobility, which also directly backs Infrastructure Strategic Objective 3 (System Operations and Performance) and the related Alleviate Urban Congestion performance goal. This program facilitates the deployment of advanced technologies solutions to maintain a more reliable transportation system under challenging environments in both urban and rural areas. Likewise, the program promotes transportation systems management in a proactive, integrated, and effective manner to use existing transportation facilities more efficiently.

DOT Strategic Objectives are provided next to the ATCMTD Program goals below.

- Reduced costs and improved return on investments, including through the enhanced use of existing transportation capacity (Infrastructure, Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance)
- Delivery of environmental benefits that alleviate congestion and streamline traffic flow (Infrastructure, Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance)
- Measurement and improvement of the operational performance of the applicable transportation networks (Infrastructure, Strategic Objective 3: System Operations and Performance)
- Reduction in the number and severity of traffic crashes and an increase in driver, passenger, and pedestrian safety (Safety, Strategic Objective 1: Systemic Safety Approach)

- Collection, dissemination, and use of real time transportation related information to improve mobility, reduce congestion, and provide for more efficient and accessible transportation, including access to safe, reliable, and affordable connections to employment, education, healthcare, freight facilities, and other services (Infrastructure, Strategic Objective 3: System Operations and Performance)
- Monitoring transportation assets to improve infrastructure management, reduce maintenance costs, prioritize investment decisions, and ensure a state of good repair (Infrastructure, Strategic Objective 2: Life Cycle and Preventive Maintenance)
- Delivery of economic benefits by reducing delays, improving system performance and throughput, and providing for the efficient and reliable movement of people, goods, and services (Infrastructure, Strategic Objective 4: Economic Competitiveness and Workforce)
- Accelerated deployment of vehicle-to-vehicle, vehicle-to-infrastructure, and automated vehicle applications, and autonomous vehicles and other advanced technologies (Innovation, Strategic Objective 2: Deployment of Innovation)
- Integration of advanced technologies into transportation system management and operations (Infrastructure, Strategic Objective 3: System Operations and Performance)
- Demonstration, quantification, and evaluation of the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, and sustainable movement of people and goods (Infrastructure, Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance)
- Reproducibility of successful systems and services for technology and knowledge transfer to other locations facing similar challenges (Innovation, Strategic Objective 2: Deployment of Innovation)
- Trend data is not yet available. FY 2016 and 2017 grantees are just beginning to provide their quarterly reports (annual report deadlines have not yet occurred). This information will be published in the first U.S. DOT report to be published by May 2020.

Surface Transportation System Funding Alternatives Program
$20,000,000

Program Description/Activities:
Section 6020 of the Fixing America's Surface Transportation (FAST) Act, Pub. L. No. 114-94, authorizes the Secretary of Transportation to establish the Surface Transportation System Funding Alternatives (STSFA) Program. The STSFA Program purpose is to provide grants to States to demonstrate user based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Highway Trust Fund. In Fiscal Year (FY) 2016, $15 million was available. Between FY 2017 through FY2020, the USDOT can award up to $20 million annually for multiple demonstration projects. These grants will make up no more than 50 percent of total proposed project costs, with the remainder coming from non-Federal sources. Further, on August 1 of each year, if there are insufficient grant applications that meet program requirements, any excess funds must be transferred back to FHWA.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes. Specific statutory authority for conducting this effort is found in the Fixing America's Surface Transportation (FAST) Act of 2015, Pub. L. No. 114-94, H.R. 22, § 6020, H.R. 22, 114th Cong. (2015), which authorizes the Secretary of Transportation to "establish a program to provide grants to States to demonstrate user-based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Highway Trust Fund." The purpose of the program is to identify strategies that could supplement or replace the gas tax. The intent is that the gas tax revenues finance the he highway trust fund. The federal gas tax rate has not been raised in over a decade while vehicles have become more fuel efficient and automakers have introduced electric vehicles (EVs), which do not pay a gas tax.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Innovation	Improving mobility

The STSFA program addresses the department's goals for Innovation because it is an innovative approach to maintaining the solvency of the HTF. The purpose of the program is to identify strategies that could supplement or replace the gas tax. Gas tax revenues help sustain the highway trust fund. The federal gas tax rate has not been raised in over a decade while vehicles have become more fuel efficient and automakers have introduced electric vehicles, which do not pay a gas tax. Funds generated from mileage-based user fees can be used to operate and maintain the national highway system.

The Western Road User Charge Consortium conducted a study of the financial impacts of RUC on urban and rural households. For the nine states in the study both vehicle characteristics and predictions of travel behavior varied markedly between urban, mixed, and rural portions of states. Residents of mixed tracts were expected to travel more frequently and longer distances than rural

residents. Rural households in most states only drive slightly longer distances per day than urban residents, but drive in older, less fuel-efficient vehicles, which is expected to lead to higher incidence of the gasoline tax for rural households.

Program Objectives:
The sustainability of the current transportation funding system is in doubt. The STSFA Program aims to explore and test alternate sustainable funding mechanisms for the Highway Trust Fund. The DOT's approach in FY 2017 is to seek applications for full new demonstration projects, for extensions or enhancements of existing demonstration projects. The notice of funding opportunity (NOFO) defined a demonstration project based on part of 23 USC 501(3)(D) and (E): a demonstration project will carry out development, deployment, and testing of the resulting technology or innovation; and will carry out an evaluation of the costs and benefits of the resulting technology or innovation. The type of alternative revenue mechanism proposed is flexible so long as it is user-based.

The purpose of the STSFA program is to provide grants to States to demonstrate user-based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Federal Highway Trust Fund. States awarded funds must address implementation, interoperability, public acceptance and potential hurdles to adoption of the demonstrated user-based alternative revenue mechanism, privacy protection, use of independent and private third-party vendors, congestion mitigation impacts, equity concerns, ease of user compliance, and the reliability and security of technology used.

Key FY19 program activities are identified in the table below. No funds were provided under the STSFA legislative language for administration and evaluation activities, requiring the use of alternative research and deployment funds to support the program. Therefore, these support activities funded through the Transportation Systems Management and Operations program and discussed in the related program description.

Activity	Period of Performance	Partners/Notes
Award of 2018 grants and initiation of projects	FY19	Work with State grantees to ensure timely implementation of grant awards
Publish NOFO to solicit for 2019 STSFA grants and review applications	FY19	Conduct outreach to attract potential applicants
Monitor existing grant projects and collect annual reports	FY18 to closeout	Work with State grantees

Research Collaboration Partners:
HOP staff will work closely with Division Offices to provide technical support to States deploying STSFA demonstration projects.

Division Office POCs provide oversight. Grantees are required to submit quarterly and annual performance and financial reports. Each state executes a Cooperative Agreement. The cooperative agreement is the legal instrument reflecting the relationship between the federal government and a

State or local government. The Division Office and/or STSFA POC participates in conference calls with State partners. The STSFA POC also hosts a roundtable that allows project partners to share lessons learned and seek technical assistance from States that have more experience.

The Mileage Based User Fee Alliance (MBUFA) educates key federal policy-makers and the community at large on the importance of a sustainable funding mechanism for surface transportation through regular meetings and outreach by MBUFA members.

The MBUFA formed in 2010 is a national non-profit organization that brings together government, business, academic, and transportation policy leaders to conduct education and outreach on the potential for mileage-based user fees as an alternative for future funding and improved performance of the U.S. transportation system. As a research and educational organization, MBUFA's primary goals are to:

- Create a constructive learning environment and policy space for collaboration and networking among individuals and groups interested in mileage-based user fees
- Coordinate efforts to build awareness of mileage-based user fee programs in the US and around the world
- Promote research to test the feasibility of mileage-based user fee programs
- Engage community and political leaders around common priorities for transportation funding

MBUFA hosts an annual road user charge conference that features States and countries from other parts of the world that have successfully deployed RUC strategies. The Alliance is also coordinating a site visit to New Zealand to explore their road user charge program, which has been successfully operating for decades.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized below.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding
MBUFA		x					x		
State grantees				X	X				

Acquisition/Assistance:
The program is funded from FY 2016 – 2020. The FHWA Office of Operations annually issues a Notice of Funding Opportunity (NOFO) seeking eligible applicants. The NOFO outlines activities to be carried out using funds provided to meet the following goals:

- To test the design, acceptance, and implementation of user-based alternative revenue mechanisms.

- To improve the functionality of such user-based alternative revenue mechanisms.
- To conduct outreach to increase public awareness regarding the need for alternative funding sources for surface transportation programs and to provide information on possible approaches.
- To provide recommendations regarding adoption and implementation of user-based alternative revenue mechanisms.
- To minimize the administrative cost of any potential user-based alternative revenue mechanisms.
- Minimize the administrative costs associated with the collection of fees.

Though demonstration projects of any size or scope may be proposed, DOT is most interested in funding larger scale demonstrations projects, rather than smaller scale demonstration projects, and in awarding funds to both single State and multistate demonstrations.

In FY 2017, $15.5 million was awarded for STSFA demonstration projects. Section 6020 provides up to $20 million for FY 2017-2020 out of funds set aside in § 6002(a)(1), which authorizes funds for the Highway Research and Development Program in 23 U.S.C. 503(b). The grants are only available to States or groups of States. The DOT's approach in FY 2018 is to seek applications for full new demonstration projects, for extensions or enhancements of existing demonstration projects. For this NOFO, a demonstration project is defined based on the definition of "innovation lifecycle" found in 23 USC 501(3)(D) and (E): a demonstration project will carry out development, deployment, and testing of the resulting technology or innovation; and will carry out an evaluation of the costs and benefits of the resulting technology or innovation. The type of alternative revenue mechanism proposed is flexible so long as it is user-based. The defining legislation does not allow the expenditure of funds to pursue the deployment of a toll project in a corridor. Any revenue collected through a user-based alternative revenue mechanism established using funds provided under this section shall not be considered a toll.

Cost sharing or matching is required, with the maximum Federal share being 50 percent. Awardees must provide at least a 50 percent matching share in cash or in-kind services. Other Federal funds using their appropriate matching share may be leveraged for the deployment but cannot be considered as part of the STSFA matching funds, which must come from non-Federal sources unless otherwise allowed by statute. For a more complete definition, please see the Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards – 2 CFR Part 200 including section 200.306 on Cost Sharing or matching.

The DOT will consider the following funds or contributions as a local match for this program: Non-Federal funds; toll credits under 23 U.S.C.; soft match and in-kind services. Further, State DOTs may use matching strategies available to them under the Federal-aid highway program such as "tapered match." However, the DOT cannot consider the following funds or contributions as a match: Funds already expended (or otherwise encumbered); or Funds for which the source is ultimately a Federal program.

Technology Transfer (T2):

Annual STSFA grant awardees deploy the pilot programs and the citizens of their state as well as other drivers are the primary beneficiaries. Program partner organizations, consisting of government and non-government entities as well as consultants and contractors that provide services and support, are involved in technology transfer with FHWA. In addition, through postings

of biennial reports, information on the awards and the pilot projects, including best practices and lessons learned, will be shared on a nationwide level.

- On May 14, 2018, the BATIC Institute will host a road user charge webinar that will feature some of the current STSFA funded States.
- On May 17, 2018, staff participated in a panel at the WTS Annual conference and share d relevant information about the STSFA program.
- STSFA is not a research program, rather it is a discretionary grant program established in the FAST Act that receives ITS funding through several FHWA research programs. Annual reports from grantees are due within one-year of the execution of a cooperative agreement between the grantee and FHWA. USDOT's first biennial report was due December 2017.
- The proposed use of USDOT's Volpe Center for technical assistance in the application review process and annual report mandated by the FAST Act. Proposals must address implementation, interoperability, public acceptance and potential hurdles to adoption of the demonstrated user-based alternative revenue mechanism, privacy protection, use of independent and private third-party vendors, congestion mitigation impacts, equity concerns, ease of user compliance, and the reliability and security of technology used.
- STSFA is a discretionary grant program designed to provide grants to States to demonstrate user based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Highway Trust Fund.

State transportation and revenue agencies are the program's primary stakeholders, so they are the target audience for most activities. The program office engages with them directly and through organizations such as the MBUFA and TRB. FHWA staff from headquarters and the field offices work with partner organizations in a variety of ways, such as supporting the execution of demonstration projects, conducting webinars, workshops and roundtable discussions; developing written resources, providing technical assistance and support to assist with deployments. In addition to the list of outputs below, the Program office sponsors at least one in person stakeholder meeting each year during TRB. In addition, conference calls are held that allow sharing of successes and lessons learned among partners. These meetings have proven to be invaluable in streamlining deployment processes that have helped the States avoid costly mistakes.

Key 2019 FHWA STSFA Program Outputs

Program Objective	**Key 2019 Outputs**
Provide funding to deploy road user charge strategies designed to supplement or replace the gas tax.	Selection of FY19 grant awards and timely implementation of projects Compile and share results of the deployment projects through annual reports, webinars or presentations, and an evaluation (these activities are funded through the transportation systems management and operations (TSMO) program)

Evaluation / Performance Measurement:
Not later than 1 year after the date on which the first eligible entity receives a grant under this section, and each year thereafter, each recipient of a grant under this section shall submit to the Secretary a report that describes how the demonstration activities carried out with grant funds

meet the objectives described in subsection (c). The grantee must also identify lessons learned for future deployment of alternative revenue mechanisms that utilize a user fee structure. Not later than 2 years after the date of enactment of this Act, and every 2 years thereafter, until the completion of the demonstration activities under this section, the Secretary shall make available to the public on an Internet website a report describing the progress of the demonstration activities.

Each STSFA Grantee is required to submit a quarterly progress report and a financial status report. Full reporting requirements include:

- Project Outcomes and Monitoring Reports. In accordance with 2 CFR 200.327. The Recipient shall submit an electronic copy of a quarterly progress report that includes a Financial Status Report to FHWA.
- Final Report. The Recipient shall provide a final report within ninety (90) days after the termination or expiration of an Agreement.
- Technical assistance
- Webinars
- Workshops
- Peer Exchanges
- Published report by May 2020.

DOT Strategic Objectives apply to the STSFA Program:

- Reduced costs and improved return on investments, through the identification of an alternative revenue source capable of (Infrastructure, Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance);
- Charging by the mile reveals to users how much they drive, which could influence driver behavior. Research suggests that it leads to some people driving less which is an environmental benefit that alleviates congestion and streamlines traffic flow (Infrastructure, Strategic Objective 1: Project Delivery, Planning, Environment, Funding and Finance);
- Deployment of mileage-based user fee technologies and other road user charge related technologies (Innovation, Strategic Objective 2: Deployment of Innovation);
- Reproducibility of successful deployments for technology and knowledge transfer to other locations (Innovation, Strategic Objective 2: Deployment of Innovation).

This information will be published by May 2020.

Section 2 – Program Descriptions, FY 2020

Structures Research & Technology

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated and cohesive Structures Research and Technology (R&T) Program focused on providing tools, technologies and guidance, and supporting updated policies, to improve the safety, structural integrity, longevity, construction processes and cost-effectiveness of highway bridges, tunnels and other structures. As in 2019, activities will include research and development to identify and advance cost-effective use of improved materials (e.g., ultra-high performance concrete (UHPC) and new steel formulations) to improve bridge performance, development and delivery of training and tools to support reliable and effective safety inspection and load rating of bridges and tunnels, as well as improved non-destructive evaluation technologies to support infrastructure condition assessment. The over-arching objectives guiding FHWA's Structures R&T Program are to:

- Achieve and sustain a state of good repair of bridges, tunnels, and other structures.
- Implement and enhance the effectiveness of transportation performance management.
- Deliver projects faster and more efficiently.
- Improve the sustainability of highway infrastructure.

Planned 2020 FHWA Structures R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Develop robust, optimized, cost-effective structural solutions	FY20 work will focus on further refinement of FY19 development efforts, dissemination of developed solutions, and development of new prefabricated system connections that facilitate reduced construction complexity
Develop robust, optimized, cost-effective structural solutions	Supporting use of weathering steel in some environments, while researching promising alternatives for exceptionally aggressive environments.
Advance optimized application of ultra-high performance concrete (UHPC) to address bridge engineering challenges	FY20 work will complete the drafting of structural design guidance for UHPC, thereafter to be delivered to AASHTO for collective consideration and refinement.
Support deployment of safe, reliable bridge structures	FY20 work will focus on supporting AASHTO revisions to the bridge design and construction specifications through delivery of expert insight into structural performance
Identify and develop solutions to address key safety risks in highway tunnels, including natural gas and other alternative fuel vehicles	FY20 work will focus on assisting tunnel owners with decision-making, and research toward solutions addressing additional key challenges.

Activity	Relationship to FY19 Activities
Develop and implement improvements to management and operations of tunnels, including consideration of risk	FY20 work will focus development of updated technical guidance, and development of tunnel event scenario simulator.
Technical guidance to improve infrastructure resilience to all hazards such as seismic, hurricane, flood, coastal storms, and tsunami.	FY20 work will focus on deployment of solutions developed through prior work, and research toward solutions addressing additional key challenges.
Improving infrastructure performance and recovery through post-hazard inspection, engineering investigation, and data collection	FY20 work will focus on stakeholder outreach and resolving issues identified through FY19 deployment efforts.
Develop guidance and protocols for the application of non-destructive testing technology in assessing the condition of bridge decks with overlays	FY20 work will use the information captured in FY19 (pre-overlay bare deck) as a baseline for the analysis and interpretation of a full-scale concrete bridge deck specimen with overlays subjected to dynamic vehicular loadings and environmental loading.
Investigate and document the reliability and return on investment of practical sensing and nondestructive technologies for condition assessment of highway structures.	FY20 work will focus on establishing a guideline founded on the research efforts conducted through FY19, including exploration of the use of UAVs in bridge inspection. FY20 will also focus on NDE technologies that are introduced after the FY19 assessment started.
Develop algorithm and guidelines for analysis, visualization, and interoperation of NDE field data	FY20 work will focus on developing recommendations founded on the work conducted through 2019.
Investigate current state-of-the-art for improving safety and durability related to corrosion of Post Tensioned structures	FY20 work will focus on refining the scope of work on the issues identified through FY19 efforts, and development of updated design guidance.
Develop usage guidance related to corrosion durability of stainless steel reinforcement	FY20 work will focus on refining the scope of work on the issues identified through FY19 efforts, and development of updated design guidance.
Develop usage guidance related to coating durability over different surfaces/substrates	FY20 work will focus on refining the scope of work on the issues identified through FY19 efforts, and development of updated design guidance.
Develop and deliver guidance and trainings in support of effective design, fabrication, construction, safety inspection, management and preservation practices for bridges tunnels and other structures;	Develop new LRFD-based ancillary structures design course Develop specifications and training on proper tightening of anchor rods for ancillary structures Develop guidance and training on bridge and tunnel security design measures
Develop and deliver guidance and training in support of effective bridge and tunnel safety inspection practices	FY20 work will be a continuation of FY19 effort to address updates over a multiyear span

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's 2020 Structures R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Structures R&T Program will contribute directly to highway safety and the Departments Systematic Safety Approach by providing tools, technologies, guidance and training to support infrastructure owners in ensuring that highway bridges, tunnels and other structures are designed, constructed and maintained to safely carry traffic loads and withstand the forces of nature. This includes, but is not limited to, contributions to the Department's Data strategy, as it relates to implementation of the National Bridge and Tunnel Inspection Standards (NBIS and NTIS).

Infrastructure/Improving Infrastructure: The Structures R&T Program supports the Life Cycle and Preventive Maintenance objective through research and development addressing "weak links" in prefabricated bridge construction technologies in support of the Rebuild strategy. Additionally, the program will continue to pursue material and design innovations to improve highway structures and improve methods to evaluate and manage highway structures.

Innovation: The Structures R&T Program supports the Department's Innovation Goal by undertaking research and development in structural design, construction, and maintenance to develop innovative solutions to highway structural engineering challenges. Ultimately, the resulting innovations will improve the state of the practice and result in resilient and adaptable systems to mitigate the impact of hurricanes, floods, and other extreme events on bridges and other structures.

Improving Mobility/Preserving the Environment: The Structures R&T Program contributes to improving mobility and preserving the environment indirectly, by reducing the frequency and duration of maintenance, repair, and reconstruction through improved durability and increased use of accelerated construction practices.

As reflected in the activities identified in the table below, specific problems to be addressed in research to be initiated in FY20 include the development of robust, optimized, cost-effective structural solutions, innovative materials and details, improved engineering tools and techniques, technical guidelines for reducing risks and increasing resilience, inspection techniques including NDE, and associated implementation efforts and training.

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Specifically, 23 USC 502(i) and 23 USC 503(b)(7) direct the Secretary to operate Turner-Fairbank Highway Research Center to conduct highway research and specifically direct the Secretary to develop innovative highway products and practices and conduct long-term, high-risk research to improve the materials used in highway infrastructure. The Structures R&T program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 Structures R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop robust, optimized, cost-effective structural solutions	Universities across United States	Better quality bridges from component and system prefabrication; Lightweight concrete affords reliable structural performance	Tangible outcomes delivered annually including in FY20
Develop robust, optimized, cost-effective structural solutions	Only FHWA has partners across US to gather comprehensive data on weathering steel performance	Guidance on use of weathering steel has previously been developed and supported	Refined guidance in expected in FY20
Advance optimized application of ultra-high performance concrete (UHPC) to address bridge engineering challenges	US Army Corps of Engineers; French Roads and Bridges Laboratory; Universities worldwide	UHPC connections simplify construction of robust bridges; UHPC overlays can rehabilitate bridge decks	Further tangible outcomes to be delivered in FY20
Support deployment of safe, reliable bridge structures	Although others work in this area, FHWA is uniquely unbiased and connected to the needs of the sector when addressing life-safety performance research	Refined design of steel gusset plates; refined construction procedures for concrete post-installed anchors	Tangible outcomes delivered soon after official findings are released for high profile structural failures
Identify and develop solutions to address key safety risks in highway tunnels, including natural gas and other alternative fuel vehicles	Department of Energy has an ongoing research program that can be leveraged	No past investment by FHWA	2020
Develop and implement improvements to management and operations of tunnels, including consideration of risk	Global Benchmarking Study (GBS) in New Zealand and Australia (2017) showed that much can be learned and transferred to U.S.	GBS provided a number of recommendations for implementation	2020

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Technical guidance to improve infrastructure resilience to all hazards such as seismic, hurricane, flood, coastal storms, and tsunami.	There is a state-led pooled fund project on development of tsunami design guidelines that is nearing completion	FHWA has invested in the development of many items, including research and technical guidance	2020
Improving infrastructure performance and recovery through post-hazard inspection, engineering investigation, and data collection	There was a recently completed NCHRP project on Post-event Damage Inspection that can be built upon.	FHWA conducted a stakeholder workshop to define the national needs	2020
Develop guidance and protocols for the application of non-destructive testing technology in assessing the condition of bridge decks with overlays	Limited subjective research studies by a few State DOTs	No quantitative work available.	2020
Investigate and document the reliability and return on investment of practical sensing and nondestructive technologies for condition assessment of highway structures.	Limited research studies by technology providers and other researchers on certain technologies but none have focused on an in-depth and objective reliability investigation and return on investment.	None by the FHWA. Limited laboratory and field investigation by others	2020
Develop algorithm and guidelines for analysis, visualization, and interoperation of NDE field data	There are no systematic research efforts or guidelines nationally.	None	2020

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Investigate current state-of-the-art for improving safety and durability related to corrosion of Post Tensioned structures	State DOTs and commercial companies	Previous work tested and compared the relative corrosion performance for a variety of materials and developed a relative cost/performance database.	2020
Develop usage guidance related to corrosion durability of stainless steel reinforcement	There are no known systematic research efforts	Previous work focused on determining acceptable chloride levels in PT tendon grout to prevent corrosion initiation.	2020
Develop usage guidance related to coating durability over different surfaces/substrates	There are no known systematic research efforts	None	2020
Develop and deliver guidance and training in support of effective bridge and tunnel safety inspection practices	MO DOT is leading a pooled fund project to assist with establishing risk based interval that is indirectly related	Previous updates to guidance and training have been favored by stakeholders.	2020

Pavement & Materials Research & Development

Program Description/Activities:
In 2020, FHWA will continue to conduct a Pavement & Materials R&D program that is closely coordinated with the AIDPT program. It will continue to drive innovation in pavement materials, design, evaluation and management practices, with a focus on advancing performance-related specifications. Activities in 2019 will include discussions and demonstrations of activity outputs to State DOTs, industry and other stakeholders, and 2020 activities will involve further refining and enhancing the results in response to suggestions and other feedback from stakeholders.

Planned 2020 FHWA Pavement & Materials R&D Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Develop and enhance tests and processes to advance PRS	Stakeholder feedback received in FY19 will be used for the enhancements that will be made in FY20.
Develop and enhance tests and processes to advance PEM – Concrete	Stakeholder feedback received in FY19 will be used for the enhancements that will be made in FY20.
Develop and enhance tests and processes to advance PEM – Asphalt	Stakeholder feedback received in FY19 will be used for the enhancements that will be made in FY20.
Assessment of durability of recycled material and industrial byproducts in pavements	Assessment of aging effects on durability; generation of data for development of PRS aging component
Develop and enhance new concrete durability methodologies	Fine-tuning of new testing methodologies, specification development and implementation.
Enable external access to FHWA pavement data	Continued development of the Pavement Research Database System (PRDS) building from feedback obtained through internal and public feedback obtained in FY19
Demonstrate improved pavement durability through increased asphalt pavement compaction	Assessment of aging effects on durability; generation of data for validation of PRS aging component
Advancement of analytical tools for quality control and forensic activities • Asphalt • Concrete	• Research findings and stakeholder feedback will determine future continuance and direction. • Fine-tuning of new concrete testing methodologies, specification development and implementation.
Condition assessment of pavement foundations by using	Upon stakeholders' feedback, FY20 work will focus on establishing best practices founded on the research efforts conducted through FY19.

nondestructive evaluation (NDE) technologies	
Advance effective decision-making in pavement management	Building upon LTPP case studies findings, work with one of more SHAs to demonstrate the concept at SHA's project and network level pavement applications.
Advance effective decision-making for various treatments for pavement preservation	Research findings from projects ending in 2019, combined with stakeholder feedback, will be critical in determining future needs and gaps. Also, the update of the Preservation Research Roadmap, to be updated in 2019, will be key to 2020 efforts.
Enhancing methodology for conducting life cycle cost analysis	Development of the new version of FHWA's RealCost LCCA tool and user manual implementing the prioritized enhancement list
Improve methods to assess pavement structural capacity	Develop effective analysis methodologies for the use of traffic speed deflection data for network level pavement structural evaluation, including practical backcalculation of pavement layer properties, and work with SHAs participating in the proposed VA DOT led pooled fund study on implementation efforts. Evaluate effectiveness of applications of geosynthetics in pavements, such as for base reinforecement
Development of a Unified Pavement Distress Analysis and Prediction System (UPDAPS) for Federal Highway Administration	Initiate Phase 3 effort for the development of UPDAPS tool for implementation.
Advance practices to improve pavement friction for pavement safety.	Continue work toward high friction surface treatments to improve pavement friction characteristics.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's 2020 Pavement & Materials R&D Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Pavement & Materials R&D Program will contribute directly to highway safety and the Department's Systematic Safety Approach by continuing to advance implementation of friction management programs to improve pavement safety. Indirect contributions through durability improvements resulting in fewer work zones.

Infrastructure/Improving Infrastructure: The Pavement & Materials R&D Program supports the Life Cycle and Preventive Maintenance objective through research and development toward improved pavement preservation practices. Additionally, the program will continue to pursue material and design innovations to improve pavement durability.

Innovation: The Pavement & Materials R&D Program supports the Department's Innovation Goal by undertaking research to develop innovative solutions to highway pavement and materials challenges and the ability to rapidly detect and analyze them. Ultimately, the resulting innovations will improve the state of the practice and result in more durable pavements and more optimal use of resources. Additionally, work to advance performance-related specifications opens the door to further innovation on the part of the construction contracting community.

Improving Mobility/Preserving the Environment: The Pavement & Materials R&D Program contributes to improving mobility and preserving the environment indirectly, by reducing the frequency and duration of maintenance, repair, and reconstruction through improved durability, and more optimal use of resources.

As reflected in the activities identified in table below, specific problems to be addressed in research to be initiated in FY20 include the need for more durable paving materials solutions, and for quick and reliable tests that can be used during pavement construction to assess long term quality.

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Specifically, 23 USC 502(i) and 23 USC 503(b)(7) direct the Secretary to operate Turner-Fairbank Highway Research Center to conduct highway research and specifically direct the Secretary to develop innovative highway products and practices and conduct long-term, high-risk research to improve the materials used in highway infrastructure. The Pavement & Materials R&D program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 Pavement & Materials R&D Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop and enhance tests and processes to advance PRS	Australia is developing PRS	The development of fundamentally based tests that provide quick, reliable results upon which contractors are paid is a missing component. Developed approach for evaluating small scale field specimens Regression models relating mix volumetrics to pavement performance	2020
Develop and enhance tests and processes to advance PEM – Concrete	Members of TPF-5(368)	Several new testing methods including SAM, Box test, Vibrating Kelly for evaluating field material	Tangible outcomes are delivered as they become available within the next 2-6 years
Develop and enhance tests and processes to advance PEM – Asphalt	NCHRP, Univ. of Arkansas	Developed fundamentally based asphalt test that needs to be enhanced to provide quick, reliable results during construction	2020
Assessment of durability of recycled materials and industrial byproducts in pavements	NCAT and some SHAs have been examining the localized performance of RAP/RAS mixes.	Focus of studies has been on low to moderate use of RAP/RAS and their short term durability	Data continually shared with PRS developers and other stakeholders
Develop and enhance new concrete durability methodologies	Clemson, Oregon State University and Texas A&M University	Past investments have led to improvements to traditional approaches but not addressed their lengthy test times.	Recommendations for modification of existing specifications (2020) Radically new approach developed by 2021

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Enable external access to FHWA pavement data	Full scale pavement testing facilities such as NCAT and MnROAD have been exploring expanded access to their data sets.	Past investments in pavement research access have enabled improvements in specifications, modeling and design. It has also contributed to educational curricula.	Internal data management, backup and security for pavement research data, as well as public access to portions of the dataset deemed suitable for release.(2020)
Demonstrate improved pavement durability through increased asphalt pavement compaction	None	Past investments have led to improvements in specifications	Understanding of impact of air voids on long term durability. Guidance for developing pay factors 2022
Advancement of analytical tools for quality control and forensic activities	SHAs Michigan Tech	Current methods test asphalt mixes after construction and are time consuming. They rely on laboratory compaction which may be very different from inplace mix volumetrics. Need a quick and easy test to characterize field mixtures during placement. Developed a subjective method for assessing fly ash performance	2020 2020
Condition assessment of pavement foundations by using nondestructive evaluation (NDE) technologies	Limited research studies on certain technologies but none have focused on an in-depth investigation and quantified condition of pavement foundations.	Previous work has focused on short-term solutions (i.e., using overlay for short-term remedy)	2020

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Advance effective decision-making in pavement management		Development of Remaining Service Interval (RSI) concept that has been referenced in 23 CFR Parts 515 and 667 as programmatic tool to allocate funds based on Life-Cycle Costs.	2020
Advance effective decision-making for various treatments for pavement preservation	MnDOT and NCAT are performing limited pavement preservation research.	Future pavement preservation research relies on past research investment and knowledge. Materials, construction methods, and testing procedures partially or completely developed in past research investments will be leveraged in future work.	2020
Enhancing methodology for conducting life cycle cost analysis		The current version of FHWA's RealCost LCCA tool is widely used by SHAs to support long-term cost effective investment decisions	2020
Improve quality assurance practices through the development of risk-based analysis		Quality assurance practices can be more effective with software that allows for risk based analysis of acceptance parameters	2020
Development of a Unified Pavement Distress Analysis and Prediction System (UPDAPS) for Federal Highway Administration		Not applicable.	2021
Improve methods to assess pavement structural capacity		Temperature correction methodology for pavement structural condition data has been	2020

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
		shown to be important for assessing pavement across space and over time and methodologies developed has been shown to be robust based on application to national and international data (Germany and Australia)	
Advance practices to improve pavement friction for pavement safety.	Other countries which conduct continuous, network-level testing	Network level testing can lead to effective identification of areas that need treatment	2020

Accelerated Implementation and Deployment of Pavement Technologies

Program Description/Activities:
In 2020, FHWA will continue to conduct a AIDPT program that is closely coordinated with the Pavement & Materials R&D program. It will continue to drive implementation of innovative pavement technologies, with a focus on advancing performance-related specifications. Demonstration of performance standards will be accomplished through demonstration and shadow projects, implementing new performance tests and procedures. FY 2020 will also address an updated program plan for the asphalt pavement area.

Planned 2020 FHWA AIDPT Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Deployment and Implementation of Performance Engineered Mixtures for Concrete Pavements	FY 20 will focus on further deployment and implementation; Continuation of shadow projects; Improvements to AASHTO PP-84; Identification of implementation barriers
Deployment and Implementation of Performance Engineered Mixtures for Asphalt	FY 20 will focus on further deployment and implementation; Identification of implementation barriers; Guidance on use of performance tests
Provide technical guidance on the use of recycled materials in pavements	FY 20 will focus on development of technical guidance and addressing materials issues not addressed in FY 19
Deploy and deliver workshops and supporting materials to advance "best practices" pavement technology	FY 20 technologies for deployment and implementation will be identified through stakeholder outreach including restructured Technical and Expert Working Groups
Expert and Technical Working Groups to gather stakeholder feedback on technical topics	FY 20 will focus on the continuation of obtaining stakeholder feedback
Mobile Concrete Testing Trailer	New contract with a focus on deployment of performance engineered mixes for concrete
Mobile Asphalt Testing Trailer	New contract with a focus on providing back-to-basics education to States and deployment of performance tests to support performance engineered mixes for asphalt
Provide technical guidance to support implementation of improved pavement management systems	FY 20 will focus on implementation of protocols for collecting pavement data and continuation of technical support for improved pavement management systems
Provide technical support and develop resources for pavement sustainability considerations	FY 20 will focus on implementation of life-cycle cost analysis benchmarking tool
Develop and deploy techniques to improvement pavement design practices	FY 20 will focus on implementation of protocols for evaluating pavement foundation condition

Activity	Relationship to FY19 Activities
Provide technical support and develop resources for pavement preservation considerations	FY 20 will focus on continuation of technical support for assessing and implementing pavement preservation techniques
Advance key concepts and tools for Quality Assurance	FY 20 will focus on continuation of technical support for implementing quality assurance best practices

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's 2020 AIDPT Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The AIDPT Program will contribute directly to highway safety and the Department's Systematic Safety Approach by continuing to advance implementation of friction management programs to improve pavement safety. Indirect contributions will come about through durability improvements that will result in fewer work zones.

Infrastructure/Improving Infrastructure: The AIDPT Program supports the Life Cycle and Preventive Maintenance objective through efforts to accelerate implementation of improved pavement preservation practices. Additionally, the program will continue to advance material and design innovations to improve pavement durability.

Innovation: The AIDPT Program supports the Department's Innovation Goal by accelerating the deployment of innovative pavement technologies. Furthermore, by advancing performance-related specifications, the program opens the door to further innovation on the part of the construction contracting community.

Improving Mobility/Preserving the Environment: The AIDPT Program contributes to improving mobility and preserving the environment indirectly, by accelerating deployment of technologies and practices that will reduce the frequency and duration of maintenance, repair, and reconstruction through improved durability, and more optimal use of resources.

As reflected in the activities identified in the table below specific pavement technology implementation and deployment activities initiated in FY20 include the advancement of performance engineered mixture design for both concrete and asphalt. This is a significant step forward as it moves the state-of-practice away from prescriptive specifications to performance specifications. Benefits include more durable materials and pavements and allowing contractors to innovate and potential cost savings for both the State and contractor. Additionally, a more defined

program on pavement preservation will be identified in FY19. This will result in deployment activities in FY20 that address preserving our nations pavement assets in a cost-effective manner.

This program is authorized in section 503(c)(3) of title 23, United States Code, which require the Secretary to establish and implement a program under the technology and innovation deployment program to promote, implement, deploy, demonstrate, showcase, support, and document the application of innovative pavement technologies, practices, performance, and benefits. The AIDPT program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

Additional information about the planned FY20 AIDPT Program investments is provided below.

Activities	Others Conducting Research in this Area	Results from Past Deployment Efforts	Projected Delivery Date for Tangible Outcomes
Deployment and Implementation of Performance Engineered Mixtures for Concrete Pavements	Oregon State University, Oklahoma State University	National standards published for procedures and tests; Initiation of State shadow projects	2020 and ongoing
Deployment and Implementation of Performance Engineered Mixtures for Asphalt	NCHRP	Advanced equipment and protocols standards	2020 and ongoing
Provide technical guidance on the use of recycled materials in pavements	Oklahoma State University, Michigan Tech, University of North Carolina-Charlotte	Identification of new tests and changes to existing AASHTO specifications	2020 and ongoing
Demonstrate improved pavement durability through increased asphalt pavement compaction	None	Documentation of State specifications changed and report highlighting best practices	2020

Activities	Others Conducting Research in this Area	Results from Past Deployment Efforts	Projected Delivery Date for Tangible Outcomes
Deploy and deliver workshops and supporting materials to advance "best practices" pavement technology	None	Implementation of technologies, increased education and awareness	2020 and ongoing
Expert and Technical Working Groups to gather stakeholder feedback on technical topics	None	Stakeholder buy-in to program initiatives and activities	2020 and ongoing
Mobile Concrete Testing Trailer	None	Test implementation, Specification changes and State technical assistance	2020 and ongoing
Mobile Asphalt Testing Trailer	None	Test improvements and State technical assistance	2020 and ongoing
Provide technical guidance to support implementation of improved pavement management systems	None	State technical assistance, increased education and awareness	2020 and ongoing
Provide technical support and develop resources for pavement sustainability considerations	None	State technical assistance, increased education and awareness	2020 and ongoing
Develop and deploy techniques to improvement pavement design practices	None	New activity	2020 and ongoing
Provide technical support and develop resources for pavement preservation considerations	None	State technical assistance, increased education and awareness	2020 and ongoing
Advance key concepts and tools for Quality Assurance	None	State technical assistance, increased	2020 and ongoing

Transportation Performance Management and Asset Management

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated and cohesive TPM and AM R&T Program focused on providing tools, technologies and informational guides, and supporting updated policies, to advance effective management of highway infrastructure and system performance. As in 2019, activities include research and development to identify and advance performance and AM and improve preservation and maintenance practices, as well as develop and deliver training, support technology transfer and other support initiatives to advance comprehensive and effective implementation of transportation performance and asset management.

Planned 2020 FHWA TPM and AM R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Design and implement a comprehensive TPM and AM capacity building program	FY 20 work will continue many of the activities from FY19, such as providing forums for information sharing and exchange, delivery of in person and remote training and education, peer exchanges, etc. topics will vary depending on program maturity and customer and stakeholder needs.
Conduct needs assessments, policy and impact analysis research and surveys	FY 20 will continue and build upon research findings to support State and local governments successful implementation of TPM practices and principles
Enhance transportation performance website, enhancement of internal business applications to provide performance information, and continued development of a States' progress reporting portal	FY 20 work will support enhancements to the performance website, further refinement of existing standards of operations (SOP) and development of new SOPs based on analysis of critical gap areas; and data collection portal enhancements
Develop analytical tools to support States' and MPOs' TPM and AM implementation	In FY 20 work will continue to support enhancement to existing analytical tools and to develop new based off customer and stakeholder needs.
Develop a series of technical informational resources and guidebooks that can be used by State DOTs and MPOs to assist them in carrying out the practice of TPM and AM	FY 20 work will continue to support development of guidebooks and other critical resources based off on customer and stakeholder needs
Employ Innovative Communication and Outreach Activities	FY 20 work will continue to utilize innovative practices to develop and disseminate communication and outreach materials in support of TPM implementation
Employ innovative approaches and methodologies to training development and delivery	FY 20 work will continue support repurposing of existing materials to improve access to and internalization of TPM topics, such as data management and analysis.

Activity	Relationship to FY19 Activities
Develop Bridge Preservation best practices case studies and guides that can be used by State DOTs, MPOs, and Local Agencies	FY 20 work to continue to develop noteworthy practices of strategies for effective timing of preservation treatments and guides for bridge owners to use
National Deployment of SHRP2 "guidelines for preservation of high-traffic-volume roadways"	FY 20 work to continue to deploy guidelines for preservation of high-traffic volume roadways
Providing technical assistance and expertise to advance new practices in TPM, AM and preservation at national meetings and conferences to support FHWA Strategic Plan and to co-sponsor events such as the national AM conference	Continue to cooperate with partners to advance the state of the practice for TPM, AM, bridge and pavement preservation
Research and advance best practices for pavement utility cuts and utility tracking	FY20 activity to focus on the integration of utility location information into digital as-builts
Develop and deploy assessment methods for resilient pavements	Expansion of decision tool to concrete pavements
Promote data integration by advancing the use of Building Information Models (BIM) for highway infrastructure	Using the data integration framework developed in FY19, address key gaps in data standardization
Undertake study to summarize the State DOT's 10-year investment strategies and projected condition of the Interstate system and NHS pavements, bridges, and other assets based on review, compiling, and analysis of the 52 State DOT AM plans submitted to FHWA for certification. This study is to also include analysis of the State DOT freight plans and safety plans to reach conclusions on the NHS in 2030.	Builds from FY 2019 activities to develop a baseline based on State DOT TAMPs of the state of the practice of AM with projections of pavement and bridge conditions based on the State DOTs investment strategies, funding availability and goals
Develop informational resources for the management and maintenance of assets related to advancing technologies for autonomous vehicles and other operational systems.	Develop best practice resources for the key design and maintenance topics identified in FY19
Develop informational resources on developing life-cycle plans for assets other than pavements and bridges	Continue to develop and refine criteria for States to manage other assets (In addition to pavements and bridges) for their whole-life
Transportation Asset Preservation Portal Pooled Fund	FY 20 work will continue the development of web portal
Identification of Effective Next Generation Performance Measures and Asset and Performance Management Methodologies to Support MAP-21 Performance Management Requirements	FY20 activity will consist of working with additional SHAs to demonstrate and implement tools.

Activity	Relationship to FY19 Activities
Capacity building for resilience, operations, and maintenance.	Guidance for analyzing the factors that impact the condition and performance of pavements and bridges and recommendations focused on investment strategies to address these issues.
Updating of NHI-134063, Maintenance Leadership Academy	Pilot and deliver the training course developed in FY19

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's 2020 TPM and AM R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The TPM and AM R&T Program will contribute directly to highway safety and the Departments Systematic Safety Approach by providing tools, technologies, guidance and training to support infrastructure owners in effectively managing transportation system performance. This includes, but is not limited to, contributions to the Department's Data strategy, as it relates to implementation of Transportation Performance Management.

Infrastructure/Improving Infrastructure: The TPM&AM R&T Program supports the Life Cycle and Preservation objective through research and development addressing "weak links" in AM, preservation and maintenance practices. Focus areas continue to include, advancing AM practices, including the implementation of risk-based AM plans for developing the investment strategies to address infrastructure condition targets. FHWA continues to work with States and MPOs to increase the health and longevity of the Nation's highways by assessing vulnerabilities, considering communities and resilience in the transportation planning process, incorporating resilience in AM plans, and addressing resilience in project development and design.

Innovation: The TPM&AM R&T Program supports the Department's Innovation Goal by continuing to undertake research and development toward providing critical data needed for improved decision-making, developing analytic tools to address critical performance gaps, and providing for a greater level of transparency in communicating transportation performance. Additionally, efforts to advance BIM for Infrastructure will enable SHAs to better integrate their data for improved decision-making for their assets. Lastly, work will be conducted so that agencies can be prepared for autonomous vehicles from a design, maintenance and AM perspective.

Improving Mobility/Preserving the Environment: The TPM&AM R&T Program continues to contribute to improving mobility and preserving the environment indirectly. By advancing more effective management of the transportation system and by advancing a performance-based Federal-aid highway program (that includes targets focused on system reliability, congestion, and emissions), the program will reduce the occurrence of impaired mobility and activities that are detrimental to the environment.

As reflected in the activities identified in the table below, specific problems to be addressed in research to be initiated in FY20 include development of data integration methods to allow for the inclusion of digital as-builts into SHA management systems; analysis of the impacts of flooded pavements; guidance on how agencies prepare and maintain their infrastructure for autonomous vehicles findings from study to summarize the State DOT's 10-year investment strategies and projected condition of the Interstate system and NHS pavements, bridges, and other assets based on review, compiling, and analysis of the 52 State DOT AM plans submitted to FHWA for certification, and identification of Effective Next Generation Performance Measures and Asset and Performance Management Methodologies to Support TPM implementation.

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Specifically, 23 USC 502(i) and 23 USC 503(b)(7) direct the Secretary to operate Turner-Fairbank Highway Research Center to conduct highway research and specifically direct the Secretary to develop innovative highway products and practices and conduct long-term, high-risk research to improve the materials used in highway infrastructure. The TPM R&T program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 TPM and AM R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Design and implement a comprehensive TPM capacity building program	RIDOT led and AASHTO administered pooled fund study on TPM capacity building	A suite of NHI courses have been developed to support TPM & AM implementation. In addition, regional TPM workshops were held and are available on demand. A TPM toolkit that includes an implementation guidebook and self-assessment tool are available via an online portal that was developed in partnership with AASHTO to facilitate information and resource sharing and exchange. Additional resources will be developed based on stakeholder needs.	Ongoing
Conduct needs assessments, policy and impact analysis research and surveys	RIDOT led and AASHTO administered pooled fund study on TPM capacity building, TRB and NCHRP	FHWA Divisions were surveyed to determine state of readiness to implement TPM; target setting and ensuring pavement data quality were identified for targeted resource development and delivery. State by state interviews will be conducted to determine impact and gauge current readiness status for next phase of resource development. Will continue to monitor and evaluate customer feedback received from training deliveries and technical assistance and will revise program deliverables to accommodate stakeholder needs.	Ongoing
Develop and enhance transportation performance website, enhancement of internal business applications to provide performance information, and continue development of a State progress reporting portal	RIDOT led and AASHTO administered pooled fund study on TPM capacity building	Performance website will feature performance data provided directly from States to provide context for current and future performance. Tools to assist with comparative analytics will build upon results of an NCHRP benchmarking study will be pursued in partnership with AASHTO	Ongoing

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop analytical tools to support States' and MPOs' TPM and AM implementation	RIDOT led and AASHTO administered pooled fund study on TPM capacity building, TRB and NCHRP	Online portal is under development to facilitate performance reporting. Design is based on user needs and tester feedback. Resources are under development to assist States with analysis needed for determining project and program trade-offs, benefit costs, and other data usability and management decision making. Resources pursued are based on repeated requests for technical assistance in these areas.	Ongoing
Develop a series of technical informational resources and guidebooks that can be used by State DOTs and MPOs to assist them in carrying out the practice of performance and AM	TRB and NCHRP	Technical informational resources related to performance based planning have been identified to support State and MPOs selection and programming of projects for meeting system performance targets.	Ongoing
Employ Innovative Communication and Outreach Activities	RIDOT led and AASHTO administered pooled fund study on TPM capacity building,	Communication and outreach campaigns communicate policy and rulemaking initiatives and requirements, related benefits, and facilitate access to these and other available and planned resources and events. Polling and social media have been used to monitor and gauge user acceptance and feedback.	Ongoing
Employ innovative methods for developing and delivering training and educational material	RIDOT led and AASHTO administered pooled fund study on TPM capacity building,	The majority of instructor led course materials are being converted to video clips and web-based training to increase user access to these materials based on feedback from AASHTO and others.	Ongoing

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop and deploy of pavement preservation best practices	NCAT and MN Road are conducting pavement preservation experiments	Prior studies have focused on best practices to design and construct treatments but have been lacking in information on optimizing the timing for preservation treatments.	2020
Providing technical assistance and expertise to advance new practices in TPM, AM and preservation at national meetings and conferences	N/A	N/A	Ongoing
Research and advance best practices for pavement utility cuts and utility tracking	None	Construction projects can be accelerated if agency and contractors have reliable information on the location of utilities within the ROW	2021
Develop and deploy assessment methods for resilient pavements	None	Economic impacts may outweigh damage considerations when decisions are made to open roads that have been flooded. Methods to objectively balance these considerations are needed	2020
Promote data integration by advancing the use of Building Information Models (BIM) for highway infrastructure	EU BIM Task Group	Lack of data standardization is impeding data integration	2022

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Undertake study to summarize the State DOT's 10-year investment strategies and projected condition of the Interstate system and NHS pavements, bridges, and other assets based on review, compiling, and analysis of the 52 State DOT AM plans submitted to FHWA for certification. This study is to also include analysis of the State DOT freight plans and safety plans to reach conclusions on the NHS in 2030.	None	Awaiting completion of the 2018 and 2019 AM Plans (TAMPs)	2020
Develop informational resources for the management and maintenance of assets related to advancing technologies for autonomous vehicles and other operational systems.	Individual agencies are beginning to assess how their operations may be impacted by autonomous vehicles	Work has been done on how to integrate highway infrastructure with autonomous vehicles, but a comprehensive study on how they impact the infrastructure is needed	2020
Develop informational resources on developing life-cycle plans for assets other than pavements and bridges	None	Work continues to advance the state-of-the-practice	2020
Identification of Effective Next Generation Performance Measures and Asset and Performance Management Methodologies to Support MAP-21 Performance Management Requirements	None	Related NCHRP studies	2020 and beyond

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Capacity building for resilience, operations, and maintenance.	N/A	Will leverage related NCHRP studies	2020 and beyond
Updating of NHI-134063, maintenance leadership academy, and overall training academy assessment for updating	N/A	N/A	2020 and beyond

Construction and Project Management Research and Technology

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated and cohesive Construction and Project Management Research and Technology (R&T) Program focused on providing tools, technologies and guidance, and supporting updated policies, to improve highway construction and project management practices. Activities are expected to include research and development to advance technologies and practices that accelerate highway construction, improve the quality (and therefore durability) of the end product, and support effective management of construction projects.

Planned 2020 FHWA Construction and Project Management R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Assess and enhance technologies to non-destructively locate utilities	Validate the technologies identifies in FY19 in a lab setting
Develop and demonstrate the return on investment of Building Information Modeling (BIM) for highway construction	Develop case studies to demonstrate and promote the ROI for BIM
Develop and share construction management best practices	Demonstrate and promote what was developed in FY19
Develop training on bridge construction inspection	Pilot and deliver the training course developed in FY19
Develop an updated and innovative web-based schedule management course	Pilot and deliver web-based, 'gamified' schedule management course
Conduct probabilistic, risk-based cost estimate reviews to validate major project cost and schedules	Independent validation of cost estimates an additional 10 -15 major projects
Promote best practices for quality assurance on accelerated bridge construction (ABC)	Continue sharing of best practices
Evaluation of FHWA's Major Projects Program for improved delivery and performance	Report on potential improvements in major projects delivery and performance
Promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection	Continue sharing of best practices and providing input to FAA on UAS experience in highway construction
Develop and consolidate major project information systems to facilitate monitoring of major projects requirements	Establishment of streamlined data and information systems for major projects

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's 2020 Construction and Project Management R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Construction and Project Management R&T Program will contribute directly to highway safety and the Department's Systematic Safety Approach by providing tools, technologies, guidance and training to support infrastructure owners in accelerating highway construction, thereby reducing highway users' exposure to construction work zones. For example, the use of automated machine guidance on projects reduces worker exposure to hazards.

Infrastructure/Improving Infrastructure: The Construction and Project Management R&T Program supports the Life Cycle and Preventive Maintenance objective through research and technology initiatives that improve the quality (and therefore durability of highway infrastructure. For example, the program is developing training on bridge construction inspection and carrying out research to demonstrate best practices for quality assurance on accelerated bridge construction (ABC) projects.

Innovation: The Construction and Project Management R&T Program supports the Department's Innovation Goal by advancing innovative highway construction and project management practices. For example, the program will assess technologies to non-destructively locate utilities on projects to avoid disruptions and conflicts during construction. In addition, work is ongoing to advance the use of Building Information Modeling (BIM) for highway construction and promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection.

Improving Mobility/Preserving the Environment: The Construction and Project Management R&T Program contributes to improving mobility and preserving the environment indirectly, by reducing the frequency and duration of maintenance, repair, and reconstruction through increased use of accelerated construction practices and improved durability.

As reflected in the activities identified in the table below, specific problems to be addressed in research to be initiated in FY20 include accelerated project delivery, improved efficiencies in construction and improved safety for those on the project and the travelling public.

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities

covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Specifically, 23 USC 502(i) and 23 USC 503(b)(7) direct the Secretary to operate Turner-Fairbank Highway Research Center to conduct highway research and specifically direct the Secretary to develop innovative highway products and practices and conduct long-term, high-risk research to improve the materials used in highway infrastructure. The Construction and Project Management R&T program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 Construction and Project Management R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Assess and enhance technologies to non-destructively locate utilities	Utility industry, SHRPII	SHRPII identified potential technologies that were not market ready	2021
Develop and demonstrate the return on investment of Building Information Modeling (BIM) for highway construction	United Kingdom, EU BIM Task Group	UK found 15-20% government savings after their BIM mandate	2020
Develop and share construction management best practices	NCHRP	General findings on construction management approaches	2019

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop training on bridge construction inspection	AASHTO TC3	Previously developed training was not as in depth	2020
Develop an updated and innovative web-based schedule management course	Primavera (Oracle)	Current training promotes a proprietary software	2020
Conduct probabilistic, risk-based cost estimate reviews to validate major project cost and schedules	State DOTs	Determination that major projects' cost estimates are reasonable	2020
Promote best practices for quality assurance on accelerated bridge construction (ABC)	None	N/A	2020
Evaluation of FHWA's Major Projects Program for improved delivery and performance	None	N/A	2020
Promote best practices for using unmanned aerial systems (UAS) in highway construction and inspection	State DOTs, AGC, NCHRP Domestic Scan	Many are not following FAA's Part 107 requirements	2020
Develop and consolidate major project information systems to facilitate monitoring of major projects requirements	None	N/A	2020

Geotechnical and Hydraulics Research & Technology

Program Description/Activities:
Building upon the previously described Program Descriptions and activities in Section 1, the 2020 Program will continue to provide a coordinated and cohesive approach to research, development and technology activities to improve the geotechnical and hydraulic performance (safety, durability, resiliency and cost-effectiveness) of highway infrastructure. The Program also plans to begin the establishment of a management system framework for highway geotechnical assets and investigate probabilistic bridge foundation scour design. The table below presents planned 2020 Program activities, and their relationship to FY19 activities.

When planning for and engaging in these FY 2020 activities, recognize that some of these activities reflect on-going research and development efforts that take many years to undertake and produce outcomes. Others may represent an anticipated start of efforts or initiatives not found in FY 2019 activities or tables. Still others may represent emerging issues and priorities as a result of external events. The important point is that the Program dynamic and flexible engagement and management approach allows efficient and effective incorporation of the myriad types and breadth of discipline function areas and transportation system needs.

Key FY20 FHWA Program Activities

Activity	Relationship to FY19 Activities
Reliability Based Design and Construction of Geotechnical Structures – Foundation Elements, Construction Materials, Design Methods, and QA Procedures	Expansion to develop/refine load factors for earth retaining structures like that for large diameter open-end piles.
Develop design specifications for pavement hydraulics and highway drainage to mitigate hydroplaning	In addition, hydroplaning risk on multilane pavements (focus in FY19) advancements in Computational Fluid Dynamics modeling will continue to simulate permeable pavements and the impacts on of water film thickness to assess hydroplaning risk.
Develop solutions and design guidelines for hydrological (changes in rain fall and flood frequency) impacts on highway infrastructure	The research in FY19 looked at stationary precipitation frequency updates for the state of TX only. In FY20 non-stationary precipitation frequency trends using rainfall data from the Northeast U.S. will be investigated.
Develop solutions to key challenges associated with flow modeling for bridge and culvert hydraulics	Several field cases representing complex bridge and culvert hydraulics challenges will be modeled using FHWA's recommended flow modeling analysis tool and results will be compared with Computational Fluid Dynamics.

Activity	Relationship to FY19 Activities
Develop the next generation design tools for bridge scour, stream stability and scour protection/countermeasures.	This study is a continuation of the work conducted in FY19 for validating the next generation scour prediction tools. Field soil (bed material) erosion resistance data determined through in-situ testing at multiple bridge locations will be used to ground proof the new design methodology.
Geotechnical Performance Measures and Risk Management	Testing on additional bridges in collaboration with the Long-Term Infrastructure R&T Program to develop a correlation between bridge approach performance and deterioration of bridge decks.
Advanced Automated Geotechnical Data Collection and Instrumentation	Continued long-term monitoring of the bridges to better understand and document long-term performance in super/substructure interaction and serviceability; also, to advance and promote the use of automated data collection systems and instrumentation for use in performance management of geotechnical structures.
Evaluate Geosynthetics for Use in Pavement Design	Expansion to additional applications of geosynthetics in pavements, such as for base reinforcement, to develop permanent road foundation solutions
Develop design specifications for coastal highways and bridges impacted by extreme events	This is continuation of the study initated in FY19 to predict wave forces on bridge substructures. Computational Fluid Dynamics modeling validated through physical experiments will be used to expand the testing range of critical varibales impacting wave loads on bridge substructures.
Site and Laboratory Characterization and Transformations of Geotechnical Materials	Development and Synthesis of available transformations as well as further evaluation the strength of aggregates for more using a different testing device for more accurate transformations in design parameters.
Assessment of Corrosion for Buried Metallic Foundations and Elements	Continuation of the project through the evaluation of corrosion mechanisms and deterioration rates to document the life-cycle and long-term performance of buried steel elements (e.g. retaining walls, pile foundations for bridges, culverts, ground anchors, guardrail posts, etc.)
Road Foundation Contamination and Drainage: In-Service Evaluation and Best Practice Recommendations	An ongoing TPF study to evaluate the condition of existing pavement foundation layers to better establish life-cycle costs, develop advanced testing protocols for the integrity evaluation of existing roadways.
Develop Baseline Soil Constitutive Models	This is a new study that aims to improve the predictive behavior of geomaterials and interaction with other highway structures under a variety of different loading conditions.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

The Program's FY2020 goals continue to support the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions as follows.

Safety/Promoting Safety: The Program will contribute directly to highway safety through mitigating hydroplaning risk and improving vehicle stability by researching sheet flow over permeable pavements. The Program also recently contributed and continues to contribute to safety in the development and deployment of automated data collection systems which eliminates the need for technicians to repeatedly enter traffic zones reducing exposure and risk to them and the traveling public. In addition, there are plans to further evaluate the use of Unmanned Aerial Vehicles (UAVs) for geohazards and performance assessments.

Infrastructure/Improving Infrastructure: The Program plans to continue to engage in efforts to support and improve infrastructure. In FY 2020, we plan to move forward on initial efforts such as seeking to to maintain a resilient highway infrastructure by the investigation of corrosion rates of buried steel elements in various environments to improve design and service life and maintenance cycle predictions for bridge foundations, retaining walls, guardrails and other transportation assets.

Likewise, producing a more accurate scour estimation approach by taking advantage of erosion resistant soil layers could move a bridge currently designated as scour critical to a "stable" scour status. As an element of FHWA's next generation scour program, the Program will use data from the In-Situ Scour Testing Device, obtained from multiple bridge project sites, to improve scour depth estimates for foundation design of new bridges, resulting in reducedreduce foundation costs. The In-Situ Scour Testing Device will be also utilized for existing bridges to reanalyze scour critical bridges.

Innovation: The Program supports the Department's Innovation Goal by continuing to expand the use of technology (Argonne National Laboratories supercomputing facilities and robotics) to improve the quality and efficiency of the research that is conducted. This will lead to new advancements in computational flow dynamics and soil modeling to expand the test range for parametric analyses in research. For example: Several hundreds of flow and soil simulations will be conducted for various bridge foundation configurations to assess the probability of failure under many different loading scenarios and conditions.

The Program will continue to advance and promote geotechnical exploration techniques for cost effective project delivery and improved risk management; and the continued

development and deployment of products supporting the Pooled-Fund development of the Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS), and the SHRP2 products GeoTechTools and Service Limit State Design Calibration. Using these tools, the Program will test bridges with various design details for the bridge and approach way and plans to correlate the results to overall long-term bridge performance.In addition, evaluating the efficiency of design methods for large diameter foundation elements allows agencies to more cost effectively deliver bridge programs.

Improving Mobility: The Program will support better representations of the interaction between transportation assets and the riverine or coastal environments. Massive storm events like Hurricanes Katrina, Harvey and Irma flooded roadways, severely disrupting the mobility of the impacted area. Next- generation hydraulic modeling tools will provide better hydraulic evaluations leading to improved collaboration between cities and State DOTs to forecast flow paths and assess the impacts of flooding near critical transportation assets.

Preserving the Environment: The Program will develop nature based features to protect riverine and coastal infrastructure. The Program will continue to provide technical assistance after flooding and geohazard events.

As reflected in the activities identified in the table below, specific problems to be addressed in research to be initiated in FY20 include the need for the development of advanced 3D computational models to better predict performance of geotechnical assets and Computational Fluid Dynamics as a key research tool to investigate hydraulic hazards affecting highway infrastructure.

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Specifically, 23 USC 502(i) and 23 USC 503(b)(7) direct the Secretary to operate Turner-Fairbank Highway Research Center to conduct highway research and specifically direct the Secretary to develop innovative highway products and practices and conduct long-term, high-risk research to improve the materials used in highway infrastructure. The Program directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or

- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

The table below provides additional information about the planned FY20 Program investments. Note that while others may be conducting similar planned research, an important aspect of the Program is to understand the significance of the problem in deciding the national leadership role required to advance the state-of-the-practice for widespread acceptance and the development of new guidance. The identification of other related research is another important of aspect of the Program to build upon similar work and to avoid unnecessary duplication. Additionally, most other research organizations do not have the capabilities and capacity of the Program at the national scale or the ability to form collaborative partnerships necessary for widespread acceptance of civil engineering research results beyond the local level.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Reliability Based Design and Construction of Geotechnical Structures– Foundation Elements, Construction Materials, Design Methods, and QA Procedures	None. Others in Industry and Academia researching geo-structures, but not focusing in this particular aspect of design and construction.	Resistance factors were calibrated for large diameter open-end piles and load factors were developed for the service limit state design of foundations; similar study to evaluate load and resistance factors for earth retaining structures.	FY24
Develop design specifications for pavement hydraulics and highway drainage to mitigate hydroplaning	None. Academia (NCHRP 15-55) looking at aspects of hydroplaning, but not focusing on modern pavements and hydrodynamics	Research in the past did not address impacts of hydroplaning on multi-lane roads. Also, the rapid advancements in Computational Fluid Dynamics to model permeable pavements was neglected in the past.	FY23
Develop solutions and design guidelines for hydrological (changes in rain fall and flood frequency) impacts on highway infrastructure	None.	US rainfall maps for TX and Northeast are outdated and have to be updated. Also, the impacts on non stationarity of rainfall data is unknown and has to be researched.	FY22

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop solutions to key challenges associated with flow modeling for bridge and culvert hydraulics	None.	EDC-4 "CHANGE" promotes the use of 2D modeling. Several features of the 2D model have to be improved and validated with Computational Fluid Dynamics.	FY23
Develop the next generation design tools for bridge scour, stream stability and scour protection/countermeasures	None. Others in Academia may conduct various scour studies, but none with national applicability or overall technical robustness. FHWA research incorporates NCHRP outcomes as appropriate.	Current bridge scour estimates are overly conservative mainly because of over simplifying riverbed materials. Uniform bed materials are assumed neglecting erosion resistant soil layers. Also, the hydraulic erosion forces and as they decay with depth was not considered in the past.	FY24
Geotechnical Performance Measures and Risk Management	None. Others in Academia may conduct various research, but not involving these issues and challenges.	A study on the use of inertial profilers to quantify the bump at the end of the bridge supports the findings that shallow foundations result in a smoother bridge approach transitions.	FY20
Advanced Automated Geotechnical Data Collection and Instrumentation	None. Others in Industry may be researching geosynthetics, but not focusing on this particular aspect.	Previous work demonstrates the efficiency of automated data collection systems for the health monitoring of geotechnical assets. Results of long-term testing for bridges supported by GRS provided recommended limits on deformations for serviceability requirements.	FY20
Evaluate Geosynthetics for Use in Pavement Design	None. Others in Industry and Academia researching geosynthetics, but not focusing on this	None to date; project ongoing.	FY20

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
	particular aspect of pavement design.		
Develop design specifications for coastal highways and bridges impacted by extreme events	None.	There is a concern tying down bridge decks to mitigate wave forces. The load path of the forces could harmfully impact the bridge substructure resulting in huge substructure replacement costs.	FY23
Site and Laboratory Characterization and Transformations of Geotechnical Materials	None. Others in Academia may be researching geomaterials, but not focusing on these particular design aspect and issues.	Findings on a study related to the characterization of the strength-deformation characteristics of open-graded structural backfills suggest that current design practices produce over-conservative and unrealistic strength parameters leading to ineffective and more costly geotechnical structures.	FY24
Assessment of Corrosion for Buried Metallic Foundations and Elements	None. Consultants, State DOTs, other Government Agencies may investigate corrosion, however none applying research to transportation foundation issues and structures.	None to date; project ongoing.	FY21
Road Foundation Contamination and Drainage: In-Service Evaluation and Best Practice Recommendations	None. Others in Industry and Academia researching foundations, but not focusing on this particular aspect of pavement practice.	None to date; project ongoing.	FY24

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Lonevelop Baseline Soil Constitutive Models	None. Others in Academia may be researching geomaterials, but not focusing on these particular constitutive model issues and improvements.	Through preliminary analysis, it was found that currently available constitutive models needed modification to support structural backfills for geotechnical features; work ongoing to finalize an inventory of soil input parameters in a new model for commonly used aggregates.	FY22

Long-Term Infrastructure Performance

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated and cohesive Long-Term Infrastructure Performance Program to improve the safety, structural integrity, longevity, and cost-effectiveness of highway pavements and bridges. The over-arching objectives guiding FHWA's LTIP Programs are to:

- Collect highway infrastructure performance data.
- Store, manage, and provide easy access to the collected data.
- Perform data analysis projects that would allow highway engineers and managers to better understand the performance of pavements and bridges; which, in turn, enables the development of more effective tools to assist state and local government agencies responsible to design, construct, maintain, and preserve the highway infrastructure in efficiently managing those assets.

Planned FY 2020 FHWA LTIP Programs activities, and their relationship to FY 2019 activities are presented below.

Activity	Relationship to FY19 Activities
Collect Long-Term Pavement Performance (LTPP) data from in-service highway test sections representing the most commonly used pavement types and designs and the range of traffic and climatic conditions on the National Highway System.	The Long-Term Infrastructure Performance Programs were designed to span decades. Their goal is to monitor/assess the performance of pavements and bridges over the long-term. Therefore, activities within these programs build on previous years.
Store, manage, and provide easy access to LTPP data, reports, tools, and products.	
Apply the LTPP data to enhance the understanding of pavement performance.	
Collect Long-Term Bridge Performance (LTBP) data on most common bridge types within the U.S.	
Store, manage, and provide easy access to LTBP data, reports, tools, and products.	
Apply the LTBP data to enhance the understanding of bridge performance.	

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's FY 2020 LTIP Programs support the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The LTIP Programs contribute indirectly to highway safety and the Department's Systematic Safety Approach through contributions to improved design and more effective infrastructure management, resulting in reduced risk of failure and work zone exposure.

Infrastructure/Improving Infrastructure: The LTIP Programs supports the Life Cycle and Preventive Maintenance objective by enabling more effective management of infrastructure performance.

Innovation: The LTIP Programs supports the Department's Innovation Goal through development of innovations needed to support data collection that have broader applicability, and by providing data to support development of improved design procedures and other solutions to pavement and bridge engineering challenges.

Improving Mobility/Preserving the Environment: The LTIP Programs contribute to improving mobility and preserving the environment indirectly, by enabling improved design and more effective infrastructure management, thereby reducing the frequency and duration of maintenance, repair, and reconstruction, and reducing the risk of failure.

This program is authorized in sections 502 and 503 of title 23, United States Code, which require the Secretary to carry out highway research, development, and technology deployment activities covering a broad range of topic areas to improve highway safety, improve infrastructure integrity, strengthen transportation planning and environmental decision-making, reducing congestion, and enhancing freight productivity, among others.

Specifically, 23 USC 502(i) and 23 USC 503(b)(7) direct the Secretary to operate Turner-Fairbank Highway Research Center to conduct highway research and specifically direct the Secretary to develop innovative highway products and practices and conduct long-term, high-risk research to improve the materials used in highway infrastructure. The LTIP Programs directly supports the strategic goals relating to Infrastructure and Innovation contained in the FY18-22 DOT Strategic plan.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 LTIP Programs investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Collect Long-Term Pavement Performance (LTPP) data from in-service highway test sections representing the most commonly used pavement types and designs and the range of traffic and climatic conditions on the National Highway System.	FHWA is the only organization that collects research quality pavement performance data at a national level.	Past investment in the LTPP program have yielded innovative methods for designing, maintaining, and rehabilitating highway pavements. Savings that exceed program investment by many folds have been realized. Additional information regarding benefits generated by the LTPP Program is located at: https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/16013/16013.pdf	LTPP data are collected continuously.
Store, manage, and provide easy access to LTPP data, reports, tools, and products.	N/A		Pavement Performance data are published annually during July.
Apply the LTPP data to enhance the understanding of pavement performance.	FHWA initiates at least one study a year. Others (state DOTs, Universities, Industry) utilize the LTPP data to perform additional studies.		Tangible outcomes (tools, products, reports, tech briefs, etc.) are produced throughout the year. During the first part of FY20, the final report for the Advancement of Curl and Warp

			study will be published.
Collect Long-Term Bridge Performance (LTBP) data on most common bridge types within the U.S.	FHWA is the only organization that collects research quality bridge performance data at a national level.	Lifecycles for highway bridges span decades. Current design standards specify a 75-year service life for typical bridges. Studying bridge deterioration remains in its infancy. It is expected that within the coming five years, enough data will be collected to start producing useful results. Indirect benefits have been realized through the establishment of bridge assessment protocols, bridge design and construction historical timeline, and a bridge portal that enables bridge asset managers to easily access bridge data on a national level.	LTBP data are collected continuously.
Store, manage, and provide easy access to LTBP data, reports, tools, and products.	N/A		Bridge Performance data are published annually.
Apply the LTBP data to enhance the understanding of bridge performance.	FHWA initiates at least one study a year. Others (state DOTs, Universities, Industry) utilize the LTBP data to perform additional studies.		It is expected that within the coming five years, enough data will be collected to produce meaningful results.

Safety Program Delivery

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated Safety Program Delivery Program focused on providing guidance, policies, tools and technical assistance to improve safety. Through the HSIP and other efforts, FHWA will continue to encourage a data-driven, performance-based approach to save lives. Efforts in 2020 will build upon the 2019 activities and ensure alignment with the DOT and FHWA's strategic plans.

Key FY20 FHWA Safety Program Delivery R&T Program Activities

Activity	Relationship to FY19 Activities
Develop regulatory proposals, guidance and perform legislative program activities	These activities assist in the communication of the laws, regulations and program eligibility requirements and are conducted routinely. New in 2020, FHWA will notify States if they met or made significant progress toward their safety performance targets.
Identify, develop and deliver technical assistance to States on implementing a performance based safety program	These activities focus on the needs of our stakeholders and address emerging safety needs and challenges.
Build stakeholder professional capacity by developing webinars, peer exchanges and products	These activities emerge out of needs assessments, surveys, stakeholder communication and other methods. For example, based on the 2019 National Safety Professional Summit, new safety needs will be identified and addressed.
Implement a continuous improvement plan and make needed adjustments	Critique and feedback is a central component of all activities. Measuring stakeholder program implementation and evaluating safety delivery methods will continue and program adjustments made.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Safety Program Delivery primarily supports the Department's Safety goal and the RD&T Critical Transportation Topic of Promoting Safety. FHWA's Safety Program Delivery secondarily addresses the Department's Infrastructure, Innovation and Accountability Goals and contributes secondarily to the RD&T Critical Transportation Topics of improving infrastructure and improving mobility.

The goals and purpose of the Safety Program Delivery Program provide vision and helps to focus attention and resources. While the goals and purpose of the program don't change, the activities remain fluid and are flexible to adjust to changing needs.

- Safety: The Safety Program Delivery research focuses on strengthening States' abilities to implement a performance driven safety program by sharing information, training, and assistance. The program seeks to increase technical capacity of transportation safety professionals at all levels of government to advance safety programs. The program fosters a safety culture not only through technical assistance but through marketing and communications programs.
- Infrastructure – The Safety Program Delivery research promotes an integrated, multidisciplinary (4E's) approach to safety in all phases of program and project development including transportation planning. It includes evaluation and assessment of road owners' capabilities which enable target training and technical assistance to fill gaps. It includes providing technical assistance and training to State DOTs to insure effective, data driven infrastructure safety projects that lead to alternative infrastructure designs.
- Innovation – The Safety Program Delivery research promotes the development and use of innovative tools to support decisions using a data-driven approach in managing highway safety.
- Mobility – The Safety Program Delivery research program supports efforts that reduce crashes which in turns improves the mobility of all people on our public roads.
- Accountability – The Safety Program Delivery research program includes evaluation of various safety programs such as the SHSP and HSIP as well as the tracking and support of Safety Transportation Performance Management. The program provides support for states in developing targets and assistance to states that fail to meet targets.
- Rural impact – The Safety Program Delivery research program develops tools and technical assistance of great value to rural areas. Examples include rail highway grade crossing technical assistance, marketing and communication materials specifically for local public agencies, working with local associations such as the National Association of County Engineers (NACE) to identify needs and provide technical assistance as well. For states that trigger the high risk rural road (HRRR) rule, the safety program can delivery assistance.

Additional information about the planned FY20 Safety Program Delivery R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Develop regulatory proposals, guidance and perform legislative program activities	N/A	Fulfills legislated requirements	On-going
Identify, develop and deliver technical assistance to States on implementing a performance based safety program	N/A	Increased adoption of innovative methods and awareness of noteworthy practices at the State and local level	On-going
Build stakeholder professional capacity by developing webinars, peer exchanges and products	N/A	Increased adoption of innovative methods and awareness of noteworthy practices at the State and local level	On-going
Implement a continuous improvement plan and make needed adjustments	N/A	Allows for strategic adjustment to ensure products and services address the needs of State and local agencies	On-going

Safety Design and Operations

Program Description/Activities:
The FY 2019 Program Description (see above) also applies to FY 2020. Planned FY 2020 FHWA Safety Design and Operations Program activities, and their relationship to FY 2019 activities are presented below. Note that these activities generally continue to build our knowledge base of safety improvements and will fill information gaps. They do not necessarily directly connect to specific projects in FY 2019, but they are all related to enhancing our knowledge of key road safety issues.

Key FY20 FHWA Safety Design and Operations R&T Program Activities

Activity	Relationship to FY19 Activities
Re-application of traveler information data collection at intersections via mobile devices for intersection safety	Continues to build off existing intersection safety activities in FY2019 and prior years.
Developing Crash Modification Factors for Enhanced Delineation Practices	Will develop new CMFs through an existing Pooled Fund study. New CMFs will be selected in FY 2020.
Perform research-focused crash testing, develop, validate, & maintain Finite Element (FE) Models, and conduct modeling, simulation for crash data analysis	Enhance the knowledge to prevent run-off-road crashes
Expand and Update the Alternative Intersections Informational Guides Series	This is a new activity that will build off new findings (from FY2019 and other recent years) concerning alternative intersections.
Safety Study on Pedestrian Activated Crossing Signs	This study will increase our knowledge of safety options for pedestrians. This topic addresses a longstanding gap in the pedestrian safety.
Establish different geometric locations where pavement friction thresholds are higher than tangent sections.	Based on crash data and risk found in measurement and analysis. This project continues to build our knowledge base for this treatment. This builds off existing programmatic activities in FY2019 to address these safety issues.
Testing of revised traffic control devices or technologies or updated standards and guidance to align infrastructure with connected and automated vehicle needs.	Moves research recommendations to development or practice phase. This project continues to build our knowledge base for this treatment. This builds off existing programmatic activities in FY2019 to address these safety issues.
Accelerate implementation of data-driven safety plans for reducing rural roadway departures.	Ensure safety plans are implemented to move treatments from theory to the roadway. This builds off existing activities in FY2019 to address rural road safety.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Safety Design and Operations program supports the same goals year in and year out. The same information provided for FY 2019 is applicable here regarding DOT Strategic areas. However, some activities do change from year to year.

FHWA's Safety Design and Operations program supports the Department's Safety, Infrastructure, and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Safety/Promoting Safety: The Safety Design and Operations program develops the infrastructure research to improve the safety of the Nation's roadways by focusing on priority technical areas to address National safety data trends and Departmental/Agency policy initiatives. This includes research promoting safer roadway design by evaluating, documenting and promoting new approaches to road design that enhances road safety through proven safety countermeasures – many of which are developed to address the disproportionate risk of fatal and injury crashes in rural communities.

Infrastructure/Improving Infrastructure: The Safety Design and Operations program considers the interrelationships between paving techniques/methods and surface characteristics that have documented positive impacts on safety performance. The program also life-cycle cost analysis for infrastructure investment decision-making that considers safety by evaluating, documenting and promoting performance-based approaches to roadway and intersection planning and design decisions made as part of project development and delivery

Innovation: The program supports demonstrations of advanced vehicle automation technologies to assess existing infrastructure design and operation practices and considering the value of current infrastructure safety strategies and treatments for the future. The Safety Design & Operations program also seeks to ensure that Automated Vehicles do not negatively affect other road users, namely pedestrians and bicyclists. Additional projects are planned under the specific technical areas that focus on improved road design and operation to better facilitate automated vehicles while maintaining safety for vehicle occupants (i.e., examining TCDs and road geometry to improve lane-keeping and navigation).

Improving Mobility / Preserving the Environment: The Safety Design and Operations program creates guidance to support performance-related selection, design, and specification of transportation system components and safety enhancements to support the Transportation Performance Management (TPM) goals and, specifically, Safety Performance

Management. The program further considers how to develop, apply, and evaluate performance-based safety standards to inform policies, procedures and guidance concerning design standards, application of traffic control devices, and safety hardware testing and funding eligibility.

Additional information about the planned FY20 Safety Design and Operations R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Re-application of traveler information data collection at intersections via mobile devices for intersection safety	NA	NA	2021
Developing Crash Modification Factors (CMFs) for Enhanced Delineation Practices	Safety research community works with States. This program allows comparisons of results.	CMFs are sensitive to some geographic conditions. Statistical practices can harmonize differences.	2022
Perform research-focused crash testing, develop, validate, & maintain Finite Element (FE) Models, and conduct modeling, simulation for crash data analysis	FE Models developed by vehicle industry are proprietary. Program produces only FE Models for research community and safety device manufacturers.	FE Models allow states to rigorously analyze safety devices prior to purchase.	Ongoing with periodic rollout, generally every 18 months.
Expand and Update the Alternative Intersections Informational Guides Series	Several State DOTs working with FHWA, AASHTO, and TRB	Proven safety benefits reported nationwide	2021
Safety Study on Pedestrian Activated Crossing Signs	NA	Such signage is proven to alert drivers to presence of pedestrians in sensitive locations.	2022
Establish different geometric locations where pavement friction thresholds are higher than tangent sections.	State participants in Pooled Fund Study on Evaluation of Low Cost Safety Improvements (40 States)	High Friction Surface Treatment is proven to be effective in preventing some run-off-road crashes.	2023
Testing of revised traffic control devices or technologies or updated	Traffic Control Device Pooled Fund participant States (over 20 States)	Preliminary research suggests some practices for	2024

standards and guidance to align infrastructure with connected and automated vehicle needs.		signage and roadway marking.	
Accelerate implementation of data-driven safety plans for reducing rural roadway departures.	Several State DOTs working with FHWA, AASHTO, and TRB	Data Driven Safety Analysis was part of the Every Day Counts Program for 2 years.	2021

Safety Data and Analysis

Program Description/Activities:
The Safety Data and Analysis program area focuses on the use of safety data to inform highway investment decision making based on crash experience, crash potential, crash rate, or other data-supported means. The scope of the program includes research, development, and technology (RD&T) to improve State and local safety data systems commonly record crash, roadway inventory, and traffic volume data. The program enhances our State and local partners' capability to use safety data systems for analysis and evaluation supporting highway investment decision making. The program also includes analyses supporting FHWA safety policy decision making.
Planned 2020 FHWA Safety Data and Analysis Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Safety Data Analysis for Planning to implement advanced safety analysis methods.	Based on some of the work of the Evaluation of Low Cost Safety Improvements Pooled Fund Study.
Implement Highway Safety Information System VII to develop new analyses for creating safety countermeasures	Work with a hybrid of data sets that have been maintained with existing states and new data sets from public and private sources.
Update the Interactive Highway Safety Design Model (IHSDM) tool to provide decision makers better information so they can make cost effective decisions	Improved cost analysis based on user feedback and assessment.
SHRP2 Naturalistic Driving Study Pooled Fund: Advancing Implementable Solutions	Development of research products based on needs described by participating states.
Safety Data and Analysis Tool development	Based on needs identified in the data capability assessment
Promote, train and assist States in the development of safety data business plans and advancing States' capabilities for safety data collection, analysis and integration	• Advance States data capabilities through the delivery of technical assistance • Pilot in two States the guide on estimating data on non-Federal aid roads • Develop tools, resources and materials for data driven safety analysis
Roadway Safety Data and Analysis Technical Assistance Program	• Provide customizable technical assistance from subject matter experts to State and local agencies
Roadway Data Improvement Program	• Conduct RDIP assessments with State DOTs

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

FHWA's Safety Data and Analysis program supports the Department's Safety, Infrastructure, Innovation and Accountability Strategic Goals, and contributes to three DOT RD&T Critical Transportation Topics. Specific contributions as follows:

Safety/Promoting Safety: Through the Safety Data and Analysis Program, FHWA has lead Federal responsibility to encourage and support State and local highway agencies in the improvement of roadway inventory and traffic volume components of safety data systems, and supporting crash data improvement. The program also establishes processes for integrating roadway inventory and traffic volume data with crash data through geolocation to a highway base map that provides a geospatial referencing system for all public roads. Improved data on all roads, whether urban or rural, leads to accurate problem identification, analysis, and effective safety countermeasure development. Much of the safety research stems from detailed analysis on the causal factors for crashes. The Highway Safety Information System (HSIS) provides a detailed crash data coupled with high resolution roadway characteristics to enable such analyses.

Infrastructure/Improving Infrastructure: The program advances tools in safety data analyses that lead towards improving the infrastructure. The program supporting Highway Safety Improvement Program (HSIP) planning, implementation and evaluation efforts through the analysis of safety data available through various partners, establishing national level benchmarks. The program also performs data analysis that benefits the explicit, quantitative consideration of safety in planning, programming, project development, and operations decision making. The program established the Model Inventory of Roadway Elements (MIRE) as a guideline to help state agencies improve their roadway and traffic data inventories.

Innovation: The evaluation focus of the Safety Data and Analysis program advances the state-of-practice in safety evaluation. These analyses lead to countermeasure evaluation and crash modification factor (CMF) development, delivery, and use. This leads to making effective decisions, particularly on rural roads where safety deficiencies are more pronounced, about how to obtain more reliable data on the effectiveness of crash countermeasures. The program continually evaluates programs and processes for improving safety data, and enhancing the analysis and evaluation capabilities at the State and local levels. Recently the Safety Training and Analysis Center (STAC) was created to study Naturalistic Driving Study data collected through the second Strategic Highway Research Program (SHRP2). This data captured the driver behavior and the movement of vehicles through everyday driving experiences, enabling new research into how crashes can be avoided.

Improving Mobility: The Safety Data and Analysis program focus on improving geospatial resolution of data, and general description of the roadway network so that it can be analyzed through reliable statistical methods, has led to the creation of information descriptors that are valuable for improving mobility.

Accountability: as road owners and operators gather and use more data and information for decision making, they will become more accountable to the public.

Rural Communities: with a disproportionate rate of fatalities in rural areas, any activities to promulgate the scientific, data-driven approach to safety will save lives in those areas. Several emphasis areas in the Safety Data and Analysis program are highly relevant to rural safety, including a special set aside in the MIRE FDE for describing rural roads, and the use of the Systemic Approach to Safety.

Additional information about the planned FY20 Safety Data and Analysis Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Safety Data Analysis for Planning to implement advanced safety analysis methods.	NCHRP Program participants	Cost effective performance based practical design can help with improving vulnerable user safety	2022 (Interim results available)
Implement Highway Safety Information System VII to develop new analyses for creating safety countermeasures	Participating HSIS Liaison State Agencies (CA, NC, ME, OH, MN, IL, WA) and potentially other States	Motorcycle Crash Causation Data in Orange County, CA from 2011- 2016 Roadway Lighting databased from CA, DE, MN, NC, VT, VA, and WA	2023 (Interim results available)

Update the Interactive Highway Safety Design Model (IHSDM) tool to provide decision makers better information so they can make cost effective decisions	IHSDM User Community	Expansion to wide range of facility types including rural 2-lane highways; rural multilane highways; urban/suburban arterials; and freeway segments and interchange components	2022 (Annual updates released every Fall)
SHRP2 Naturalistic Driving Study Pooled Fund: Advancing Implementable Solutions	None that are specifically focused on roadway safety countermeasure development	Prior similar research identified pedestrian and work zone improvements	2022 (Interim results available)

Human Factors Analytics

Program Description/Activities:
The purpose of the Human Factors (HF) program at FHWA's Turner-Fairbank Highway Research Center (TFHRC) is to better understand the relationship between roadway users, infrastructure, and vehicles. Human Factor Analytics encompasses human factors research and related activities. Human factors studies consider how drivers, pedestrians and special users' needs can be met through improved roadway designs and better roadway/vehicle integration. HF research looks at how people respond to highly visible, easy to read signs, improved pavement markings, CV/AV technology, innovative operational changes, and safer streets with improved walkability.

US crash report data identifies human error as a factor in approximately 94% of vehicle crashes (1). Human factors research is a cross–cutting field that routinely conducts both applied and more fundamental investigations for projects in areas such as traffic control device effectiveness, novel intersection designs, and pedestrian & bicyclist safety, to help reduce vehicle crashes resulting from human behavior and error. The HF Laboratory at TFHRC includes the Highway Driving Simulator (HDS), two Field Research Vehicles, the Highway Sign Design Lab, the MiniSim™ driving simulator, and the Virtual Reality Lab.

Planned 2020 FHWA Human Factors Analytics Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Traffic Control Device Pooled Fund Studies	FY20 work with continue to conduct signing and marking studies in coordination with member State priorities
Continued research in driver acceptance of vehicle automation applications	Build on research regarding Level 1 acceptance, to Level 2 automated vehicle application testing
Build Level 3-4 capable Automated Vehicle for field research	Build on prior Level 2 field research vehicle capability
Upgrade Highway Driving Simulator capabilities to model Level 3-4 vehicle automation	Build on prior Level 2 Highway Driving Simulator capability

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Human Factors Analytics supports the Department's Safety, Infrastructure, and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Safety/Promoting Safety: Many of our Human Factors research projects promote safer roadway design by evaluating and improving the design of roadway signing, and researching how emerging vehicle technologies can improve roadway safety and decrease crash frequency and severity. Human factors alternative intersection and interchange evaluation research is also focused on improving roadway safety, while simultaneously improving roadway efficiency.

Infrastructure/Improving Infrastructure: All our HF projects collect and analyze human performance and behavior data as a basis for decision making, technology evaluation and implementation, guidelines, recommendations, and policy creation. This includes projects in all our research areas, including Connected and Automated Vehicles (CAV), Traffic Control Devices and signing research, SHRP2 research, roadway user behavior (including traveler information research), and roadway design evaluation (including alternative intersection and interchange evaluation research). Our projects and research studies include a variety of driving performance data including data from the driving simulators, field research vehicles, sign laboratory, and test track that are collected and analyzed to answer specific research questions.

Innovation: Automated Vehicles (as well as Connected Vehicles) are important areas for the Human Factors program and active areas of research. AVs has been an important area in the HF program in the last four years, and this will continue to be a very important and dynamic area for the program. The Human Factors Analytics program is coordinating within the Department on "Driver Acceptance of Vehicle Automation for Function-Specific Automation Applications". This project builds on a previous multi-year program on "Cooperative Adaptive Cruise Control (CACC): Investigation of Key Human Factors Issues".

Improving Mobility / Preserving the Environment: The design enhancements assessed through Human Factors Analytics enabled the rapid deployment of innovative alternative intersection designs. Some of these alternative intersection designs, such as the Restricted Crossing U-Turn specifically helps with high speed rural roadways where vehicles entering on minor roads are at risk of life threating right-angle crashes. Human Factors Analytics supported design evaluations that enabled these alternative intersection designs to be promoted among the FHWA Safety program's Proven Safety Countermeasures.

Rural Impact: Prior research activities looked into the application of alternative intersection designs for rural locations. One design, the Restricted Centerline U-Turn (RCUT), was developed based on simulation work to understand how traffic flows for minor roadways would be affected as they intersect fast moving arterial highways. Visualization work enables roadway designers understand how design choices affect safety while providing valuable tools for building local community support.

Additional information about the planned FY20 Human Factors Analytics Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Traveler information for Non-Recurring Events	Limited similar research in other academic organizations	Properly composed traveler information can reduce secondary crashes and minimize delay	FY2020/2021
Safety experiments with L2 AV	Similar research in other academic and contractor organizations, but not as focused on interactions with infrastructure	Past research results have suggested both safety and operational benefits from L1 applications.	FY2021
Driver Acceptance of Vehicle Automation	Limited similar research in other academic organizations	Higher levels of acceptance and trust can improve system performance and increase deployment rates	FY2020/2021
InterchangeSE: a Federated Multi-Modal Simulation Environment	Limited similar research in other academic organizations	Multi-modal simulation research is a new area of investigation, but shows promise for incorporating more roadway user types into simulation research. This will improve the realism and utility of simulation research and thereby improve roadway safety.	FY2021
Traffic Control Device Pooled Fund Studies	Similar research conducted by contractors and other academic organizations, but not coordinated with States on a national level	Improved comprehension, and legibility of TCD signing. Have provided needed data to MUTCD.	FY2020/2021

Transportation Systems Management and Operations

Program Description/Activities:

Foundation for Successful Operations. In 2020, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing the state-of-the-art institutional structures to ensure that advanced and emerging innovative operational strategies and technologies are successfully delivered and sustained for the benefit of the American public and the business sector. This program will provide the tools and organizational support to enable agencies to evaluate, plan, fund, design, and capitalize on emerging cost-effective transportation technologies and operational strategies to improve reliability, mobility, safety, and economic competitiveness. This program will build on 2019 efforts and further enhance planning and operations functions to improve and strengthen the key institutional underpinnings and linkages, enhance the Performance-Based Planning and Programming process, further ensure that the business processes, staff expertise, and investment prioritization methods are sufficiently robust, providing critical insights, research, and resources on public and private innovative operations funding opportunities, further supporting investment trade-off decisions through better, more comprehensive analysis benefits and cost, and further ensuring that agencies can objectively assess organizational capabilities and develop targeted action plans for improvement. As in 2019, activities will include organizational capability assessments for operations, resources for supporting effective delivery of TSMO programs, and TSMO's role in Smart Communities.

Data-Driven Operations Decision-Making. In 2020, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focusing on the estimation and evaluation of transportation impacts of operations strategies using data management and analytics, analysis modeling and simulation tools, and transportation performance management techniques. FHWA will further develop resources for researchers and practitioners; provide resources on innovative strategies and technologies to improve data and performance measures and management practices that lead to improved transportation operations; collaborate with industry partners to adopt newly developed tools, capabilities, and resources in commercial software, agency processes and procedures, and industry-wide state of practice; develop management support systems to improve the efficiency and effectiveness of both operational and organizational performance; develop data business planning resources; develop congestion reporting and operations performance measures and management tools and resources; and improve both planning-level and real-time operational decision-making.

This program area will continue to develop and support data management and business planning, analysis tools, and performance management for decision-making, including implementation assistance for innovative concepts listed under this Priority Research and Technology Area (PRTA), and support the storing and documenting of data acquired from operations projects, and making them accessible to the public.

Implementing Operations Strategies. In 2020, FHWA will continue to conduct a coordinated and cohesive Research and Technology (R&T) Program focusing on the use and deployment of operational strategies and practices to improve the performance of existing transportation infrastructure. This program will continue to target a range of traffic, demand, and parking management tools and strategies that agencies can employ to reduce congestion, improve safety

and improve travel time reliability. The program will continue to effectively apply and integrate readily available (but perhaps underutilized) and innovative operational strategies, practices, and technologies for more efficient day-to-day management of the surface transportation system.

The program will continue to advance operational strategies and tools including traffic control, traveler information, pricing, shared use mobility, integrated corridor management (ICM), active transportation and demand management (ATDM), traffic control device application, traffic management centers, and parking management systems. This program will continue to assist and support agencies to advance their current state of operations to a more proactive, integrated, performance-driven, and holistic approach to traffic management and operations.

Activities in 2020 will enable FHWA to address needs of agencies in using our transportation assets by developing strategies, policies, resources, and training; compiling best practices; organizing peer exchanges; and conducting applied research that help agencies more effectively manage their facilities using proactive, dynamic, and performance-driven approach to traffic management and operations.

Planned 2020 FHWA Transportation Management and Operations R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Conduct targeted outreach and technology transfer of reliability measurement tools, SHRP 2 reliability products, the application of organizational capability maturity frameworks, and transportation performance data for Planning for Operations	• Peer exchanges/workshops on applying the Operations Capability Maturity Model Framework. In some locations, the frameworks will be applied a second time and enable comparisons against the baseline from 2018-19. In other places the frameworks will be applied for the first time. • Continue the outreach and technology transfer to advance the state-of-the practice.
Develop tools and support resources to monitor national transportation system performance and conduct outreach and technology transfer to advance state and local agency performance management capabilities.	• Will use the tools developed to improved and add new functionality for emerging technologies. • Continuation – as implementation of PM3 measures continues, areas for additional resources will be identified and addressed.
Conduct targeted outreach and technology transfer, including peer-to-peer learning opportunities and technical assistance and resources to advance the state-of-the-practice and improve the capabilities of agencies for developing and delivering Transportation System Management and Operations (TSMO) programs.	Continue the outreach and technology transfer to advance the state-of-the practice.

Administer and support the delivery of the Surface Transportation System Funding Alternatives (STSFA) grant program and evaluate program outcomes.	Continue to administer and support the STSFA grant program and evaluate program outcomes.
Develop and disseminate resources to enable holistic analyses of operational improvement benefits at system, network, and facility levels. Utilize the methods to develop tools and decision support systems to enable agencies to address both operational/tactical and executive/organizational decisions. Share results of reliability data and analysis tool deployment projects and grow deployment of reliability evaluations in systems planning and operational activities. Provide technical assistance to advance the practice on data analytics/business intelligence, post project evaluation using empirical data, and multi-objective tradeoff analysis.	This research builds from the analysis tools developed to improve/enhance and add functionality for emerging technologies. It also builds on the framework developed to build the tools necessary for decision support to improve decision-making.
Develop the capabilities, tools, and guidance to enable more proactive, dynamic, integrated and performance-driven management and operations.	Continue the research and technology transfer to advance the state-of-the art and state-of-the-practice.
Conduct targeted outreach and technology transfer on best practices and lessons learned to promote and advance automated traffic signal performance measures and provide assistance and resources to support state and local agency Traffic Signal Management Plans. Deliver training that addresses workforce capability and objectives and performance-based approaches to managing traffic signal systems.	• Continue the technology transfer and best practices to advance the state-of-the practice. • Incorporates 2018-2019 updates to Model Systems Engineering Guidance for Signal Systems, Automated Traffic Signal Performance Measures and Adaptive Signal Control to support technology transfer, outreach and training and application of Systems Engineering and ITS Architecture to Traffic Signal Systems.
Develop revisions/updates to 2009 MUTCD, manage technical corrections, and support the administration of MUTCD statutory requirements and implementation support activities	Continue to support of the administration of the MUTCD statutory requirements and implementation support activities.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure
Innovation	Improving mobility

Infrastructure: FHWA's Transportation Systems Management and Operations R&T Program closely supports the Department's Infrastructure Strategic Goal, and aligns with the DOT RD&T Critical Transportation Topics of Improving System Management and Operations. The TSMO Research Program improves system reliability and enhances performance of the transportation system. Particularly, the research supports strategies that focus on operational improvements intended to maintain and, in some cases, restore the performance of existing transportation system before extra capacity is needed. This may enable transportation agencies to "stretch" their funding to benefit more areas and customers. The TSMO research also helps agencies to balance transportation system supply and demand and provides flexible solutions to match changing conditions, to reduce the need for excess infrastructure capacity during non-peak times. Finally, it helps agencies make informed decisions about the management of infrastructure related resources, such as snow and ice treatments, and how to plan for future system needs using performance metrics that account for travel conditions on specific route segments and from a systems perspective, including the potential for travel mode shift.

Innovation: TSMO applications rely heavily on technology and innovation, taking advantage of new data sources and advances in consumer applications, as well as innovations in traffic assets, such as traffic signal controllers, sensors, and communication devices.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 Transportation Management and Operations R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Continue to develop and expand the data resource testbed (DRT) that will provide analysis resources, procedures, interface, and support to allow the public or FHWA staff to access and use the data generated and saved from FHWA projects.	Universities, crowdsourced data vendors.	Development and validation of analytical tools, evaluation of potential operational improvements and emerging technologies.	2020
Provide the services and supplies deemed necessary to develop and implement a Data Resource Testbed for Saxton Transportation Operations Lab for storing, documenting and accessing/sharing data from past and ongoing projects.		Development and validation of analytical tools, evaluation of potential operational improvements and emerging technologies.	2020
Develop resources on National Performance Measure Research Data Set (NPMRDS) and Performance Measure (PM3) travel time measure/target setting-related topics.	Universities, crowdsourced data vendors.	A variety of data and analytical resources have been developed that have led to results that are inconsistent or of questionable quality that do not support national level monitoring and evaluation the transportation system.	2020

Connected and Automated Vehicles

Program Description/Activities:
Planned 2020 FHWA Connected and Automated Vehicles R&T Program activities, and their relationship to FY19 activities are summarized in the table below and in the supporting narratives.

Determining an ADS and Roadways Integration Path: The FHWA Office of Operations and Office of Operations Research will build off the research conducted during FY 19 by identifying, discussing, and drafting a path for integration of ADS and roadways. The National Dialogue discussions will transition from defining the concept to the identification of steps that will facilitate stakeholders to start to implement elements of the concept. Part of implementation will still need to include roadway attribute prototyping, testing and evaluation that can support actual real-world interactions among ADS, roadway attributes, and other road users. Investigation and learning will be the focus as stakeholders collaborate on alternative scenarios that will provide insight regarding the determination of a collaborative path forward.

National Dialogue Integration Scenarios: This research will build off the First Stage Concept of Operations to identify various operational scenarios and corresponding integrations scenarios. The scenarios will be discussed and refined through National Dialogue collaborative discussions. The stakeholders will also prioritize scenarios and assist in the development of integration scenario tests and evaluations. The results of the tests and evaluations will determine what scenarios support what paths to integration and how each path impacts each stakeholder.

Innovative Modular Roadway Scenario Configuration Development: This research builds from the development of innovative techniques and methods to mimic roadway attributes to bring the innovations and techniques together in specific scenario configurations. The first phase of this research will be to identify generic operational scenarios and test the different techniques and methods in combinations that present a mimicked operational environment. Additional test will be conducted in relation to how easily and quickly the techniques and methods can be reconfigured to represent a different mimicked operational environment.

Integration Scenarios Testing and Evaluation Tools: To test and evaluate alternative integration scenarios, testing and evaluation tools need to be designed and developed. It is envisioned that current planning, operations, and automation simulation and modeling tools will form the foundation of the tools need for integration scenario testing and evaluations. This research will identify the needs and requirements for integration testing tools and work with tool developers to develop prototype tools that National Dialogue stakeholders can review and assess regarding usefulness and usability. A set of test integration scenarios will be used to facilitate the stakeholders' assessment that will result in a ranking of the tools. After the tools are ranked, FHWA and the stakeholders will develop an integration scenario test and evaluation plan. The plan will identify the tools that will be used to assess the set of scenarios and the results will be compared to support both an assessment of the tools used and a preliminary assessment of integration scenario alternatives.

Comprehensive Roadway and ADS Data Assessment and Digital Infrastructure Development: Many have identified the need for both static and dynamic data exchanges between the roadway and ADS to facilitate safe and efficient operations. The development of a database of traffic regulations is one example of these data. This research builds off the ADS Operational Behavior and

Traffic Regulation Information work but takes a holistic look at the data needs between ADS and roadways to investigate the development of a digital infrastructure that can support the sharing and consumption between roadways and ADS. The investigation will identify and define the different data needs in relation to different integration scenarios; assess data element definitions and formats; determine the sharing and consumption operations; and develop alternative digital infrastructures. Digital infrastructure profiles will be developed that identify the operational needs that include storage, processing, management, update, and interfaces. National Dialogue stakeholders will be consulted to assess the alternative digital infrastructures to assess the pros and cons in relation to the various stakeholders' perspectives, e.g. automakers production cycles, Department of Transportations' data collection cycles, traffic regulation change cycles. The investigation will down select to the most promising digital infrastructure for further testing and evaluation.

Integrating Connected Vehicles into Systems Management and Operations: The proposed research for FY2020 will continue a focus on generating guidance and information to support public agencies considering projects, actions or information to enhance the capabilities of their organization and systems to share and use electronic messages with CAVs and devices. Agencies can integrate and use this information to improve how they actively manage and operate traffic management systems and TMCs and to share this information with other systems. The proposed FY2020 projects will explore the development and use of advanced technologies, scalable tools, methods, and practices to enable the sharing and use these new sources of electronic messages to improve the performance of the trips of individual travelers, CAVs, and the facilities managed by these systems.

Cooperative Automated Driving Systems. The proposed research for FY 2020 will also enable performance testing and evaluation of Level 3-4 automated vehicles. his research will continue to make use of test tracks operated by FHWA, FHWA's federal partners, and other ADS proving grounds as well as limited operation on active roadways as living laboratories in partnership with states and other roadway owner operators. Continued development of cooperative automated driving systems will include interrupted flow use cases and applications to address operations challenges such as emergency management, incidents, poor weather, and work zones.

Key FY20 FHWA Connected and Automated Vehicles R&T Program Activities

Activity	Relationship to FY19 Activities
National Dialogue Integration Scenarios	This research will build off the First Stage Concept of Operations to identify various operational scenario and corresponding integrations scenarios.
Innovative Modular Roadway Scenario Configuration Development	This research builds from the development of innovative and techniques and methods to mimic roadway attributes.
Integration Scenarios Testing and Evaluation Tools	This research will build off the First Stage Concept of Operations to support the testing and evaluation of integration scenarios.
Comprehensive Roadway and ADS Data Assessment and Digital Infrastructure Development	This research builds off the traffic regulation database work but takes a holistic look at the data needs between ADS and roadways.

Integrate ADS into Emergency and Incident Management Strategies	The larger research effort in 2020 will advance the first responder community as a whole, based on what is learned and identified as key strategies from FY18-19 research.
Integrating Connected Vehicles and Devices Used by Travelers into Traffic Management and Control Conduct phase 3 proof-of-concept test to evaluate the ability to share and use data between mobile devices, connected vehicles, ITS devices, and traffic management systems as travelers complete trips within public right-of-way for different use cases.	The proposed testing to be conducted will use the use cases, electronic messages and requirements identified in the concept of operations and requirements guidance developed in FY2019 project and use the updated V2I/D2X Hub software platform (FY2018 ITS Project) in the development and conduct of this proof-of-concept test. Develop guidance and outreach material using the information prepared in FY2018 and FY2019 projects to support agencies using the updated V2I/D2X Hub software platform and to integrate the sharing of electronic messages with connected mobile devices and vehicles into the design and operation of traffic management systems.
Integrating Connected Vehicles and Devices Used by Travelers into Traffic Management and Control Develop guidance (e.g., Connected and Automated Vehicle Guidance, transit priority, messages and data elements for use cases), information (e.g., outreach material, issues to consider in future industry standards, requirements and messages to include in updates to ITS National ITS Architecture), testing (e.g., speed harmonization, traffic incident management), and collaboration with industry (e.g., Connected Vehicle Guidance, Cooperative Automated Transportation Coalition, CV Pooled Fund Study) to support the consideration, integration and use of data between connected mobile devices, connected vehicles, ITS devices, and traffic management systems.	Develop guidance and outreach material using the information produced in FY2018 and FY2019 projects to support agencies incorporating advanced technologies and issues to consider to send, collect, and use electronic messages with connected mobile devices and CAVs and integrate this information in the development of the concepts of operation, requirements, selection of technologies, and design of the next generation of traffic management systems and TMCs.

Transitioning from Legacy to Next Generation Traffic Management Systems and Traffic Management Centers (TMCs) Develop technical guidance (e.g., AI and machine learning, expandable open source software platforms) and information (e.g., outreach material on technical issues (e.g., concept of operations, requirements) to support public agencies planning for and pursuing the development and ultimate deployment of the next generation of traffic management systems and TMCs with the capability to collect, use, and share electronic messages with connected vehicles and devices.	Develop technical guidance and outreach material for the next generation traffic management system and TMCs.
Understand Automated Vehicle Performance Characteristics HOP and HRDO continues to conduct research to support automated vehicle early deployment, collaborating across FHWA and with our modal partners. Research priorities have been identified to advance applications and capabilities from concept development to prototyping to field testing. Deployment use cases and performance characteristics are being defined for applications that achieve Level 3-4 performance. These will build upon research FHWA has conducted for Level 2 applications, but will also utilize evolving automated vehicle platforms developed by OEM's or other technology providers. Integration of these automated vehicle use cases with transportation management strategies and systems will continue.	FHWA will utilize automated vehicle platforms developed by OEM's and other technology providers to test applications with the potential to benefit public sector stakeholders. This testing, and assessments by other research partners, will be used to define performance characteristics of emerging automated vehicle systems.
Optimized system-wide performance enabled by automated vehicles Advanced Analysis, Modeling, and Simulation (AMS) framework and capabilities will be used to assess the impacts of automated vehicles on operations and the potential for cooperative automated vehicles to improve performance. Human factors research and impact on both automated vehicle drivers themselves as well as the drivers of surrounding vehicles will need to be understood. Research results and lessons learned will feed planning, policy, and deployment guidance and Knowledge and Technology Transfer (KTT) activities to expedite national implementation.	Better understanding of the functional performance expected or possible from automated vehicles, including vehicles with higher levels of automation, will allow more mature and accurate models to be calibrated and used to assess performance impacts. Stakeholders will be able to use these models to support their operational plans and investment decisions.

Automated Vehicle Deployment Readiness Infrastructure owners/operators, planners, the private sector, and the public need to be informed and prepared for automated vehicle deployment and implementation. FHWA will engage these stakeholders through Knowledge and Technical Transfer (KTT) activities sharing research results, best practices, training, and deployment guidance as demanded. Automated vehicle technology showcases and driver clinics will be conducted to demonstrate automated vehicle benefits and capabilities as they are connected to and cooperating with the infrastructure and transportation system. Research results will inform federal policy, planning, and deployment guidance.	Continues major stakeholder engagement programs with increasingly sharper data on the impacts and consequences of automated vehicles on the transportation system.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving infrastructure Preserving the environment
Innovation	Improving mobility

Determining the most appropriate path for ADS and roadway integration will address the Safety, Infrastructure, and innovation DOT Strategic Goals. The paths that are developed and analyzed will provide insight regarding how each services safety, infrastructure, and innovation. Stakeholder involvement and evaluation capabilities will be key to understanding what paths or paths should be followed and how DOT can infuse the safety, infrastructure, and innovation goals as we integrate automation into our transportation system.
In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Presents the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 Connected and Automated Vehicle R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Saxton Lab testbed vehicles, devices, infrastructure, advanced data collection and analytics, and open data sharing capabilities	UTC's	Automated vehicle research by UTC's has been stymied by lack of performance characteristics, open systems, and test results.	2020
Performance testing and evaluation of Level 3-4 automated vehicles	OEM's and other technology providers	Performance of ADS has not been shared by industry and so public sector stakeholders cannot assess performance impacts and need for infrastructure investments.	2021
Development of interrupted flow connected automated vehicle use cases and applications	Unknown	Potential application of connected automated vehicle technologies to improve operations under EMS, incidents, poor weather, or in work zones has not been assessed.	2021
Assessment of geometric design or infrastructure improvement musts for automated vehicles	State DOT's and UTC's	Automated vehicle performance can be improved by infrastructure that is consistent by design and through maintenance.	2022
Stakeholder communication, showcases, driver clinics, and KTT for automated vehicles	ITS America, AASHTO, ITE	Neither drivers nor infrastructure owner operators are prepared for the introduction of automated vehicles.	2021

Managing Disruptions to Operations

Program Description/Activities:
In FY2020, several activities from FY2019 will continue and will need more funds to complete research, development, and deployment.

There will be continued engagement of stakeholders, training, and other outreach activities to better manage disruptions to operations and advance state-of-the-practice in the areas of work zone management (WZM), traffic and emergency management (TI&EM), and road weather management (RWM).

Road Weather Management:
In FY2020, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing RWM strategies, technologies and practices to minimize any adverse weather related impacts on highway infrastructure and performance. This program will build on FY2019 activates by continuing to develop tools and strategies that enable weather-responsive decision-making, analysis and use of weather data and connected vehicle (CV) technologies, effective messaging based on better understanding of traveler behavior, and performance management strategies based on consideration of resilience and large range changes in weather patterns.

RWM program plans to start new activities to fully demonstrate the value of integrated models that combine weather, road conditions, traffic, work zones, incidents and other impacts to predict road conditions and enable more proactive traffic and maintenance management.

Traffic Incident & Event Management:
In FY2020, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing TI&EM strategies, technologies and practices to minimize any adverse traffic incident and special events related impacts on highway infrastructure and performance. This program will build on FY2019 activates by continuing to develop tools and strategies based on better use of incident/crash data and other performance measures, benefit-cost analysis, and CV and integrated Computer Aided Dispatch technologies.

TI&EM program plans to start new activities to promote use of integrated sources in a big data approach to advance traffic incident management.

Work Zone Management:
In FY2020, FHWA will continue to conduct a coordinated and cohesive Research and Technology Program focused on advancing WZM strategies, technologies and practices to minimize any adverse work zone related impacts on highway infrastructure and performance. This program will build on FY2019 activates by continuing to develop tools and strategies based on work zone safety and activity data, performance measures, safety countermeasures including use of positive protection, and planning/implementation of ITS and other CV technologies.

WZM program plans to start new activities to advance work zone data management strategies by developing Work Zone Data Exchange (WZDE) and explore ways to track Work Zone Activity Data.

Key FY20 FHWA Managing Disruptions to Operations R&T Program Activities

Activity	Relationship to FY19 Activities
Road Weather Management	
Develop tools and strategies to enable more effective system management under adverse weather, including analysis and use of road weather data, standards, and weather-responsive decision support tools that build upon vehicle-based technology advancements and effectively change driver/operator behavior	This research builds on activities completed in FY19 to further develop and enhance tools and strategies
Develop and measure performance standards for road weather management, including strategies that consider resilience and longer-range changes in weather patterns	FY19 activities will have developed tools to enable operating agencies to better consider resilience in their programs. This effort will work these partners to utilize the tools
Conduct targeted outreach and technology transfer of Road Weather Management products (e.g., performance management tool, vehicle data translator, integrated modeling for road condition prediction, etc.) through Every Day Counts 5, Capability Maturity Framework workshops, stakeholder meetings, etc.	Ongoing activities to advance the state-of-the-practice
New tasks to fully demonstrate the value of integrated models that combine weather, road conditions, traffic, work zones, incidents and other impacts to predict road conditions and enable more proactive traffic and maintenance management	FY19 activities will have tested the integrated models in one city (Kansas City). This effort will demonstrate the ability to port it to another metropolitan will build on current Integrated Modeling for Road Condition Prediction project
Traffic Incident and Event Management	
Use multi-discipline responder crash data, and integrate it with emerging connected and automated vehicle and other technologies (e.g., integrated Computer Aided Dispatch) to meet responders' needs and improve incident response	These tasks will continue the research, technology transfer and advance the state of the practice building on various tasks from FY 2018 and 2019.
Promote continued deployment of state and local traffic incident management (TIM) programs including extensive coordination across the TIM community	Ongoing activities to advance the state-of-the-practice
New tasks to promote use of integrated sources in a big data approach to advance traffic incident management.	These tasks will build on current work under EDC-4 (Using Data to Improve TIM) activities
Work Zone Management (WZM)	
Advance work zone management strategies and improve traffic models that incorporate vehicle-based technology advancements and data driven decision-making	This task builds on research completed on effective Transportation Management Plan (TMP) related strategies, connected vehicles, and traffic models to analyze innovative work zone strategies.

Manage work zone grants to ensure products are effective and meet stakeholders' needs	Continuation of activities to ensure effective and timely completion of deliverables
Advance WZM state-of-the-practice through a range of stakeholder engagement activities that focus on gaps in implementation (e.g., state-specific Capability Maturity Framework and targeted engagement workshops, process reviews, regional round tables, etc.)	Ongoing activities to advance the state-of-the-practice
New tasks to advance work zone data management strategies by developing Work Zone Data Exchange (WZDE) and exploring ways to track Work Zone Activity Data	These tasks will build on current Work Zone Data Initiative.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving infrastructure Preserving the environment
Innovation	Improving mobility

FHWA's Managing Disruptions to Operations R & T Program supports the Department's Safety, Infrastructure and Innovation Strategic Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: The Managing Disruptions to Operations Program contributes to highway safety by providing tools, technologies/devices, resources, and training to minimize safety impacts (crashes, fatalities, injuries) of road construction, adverse weather, and traffic incidents on all road users including highway workers and emergency responders. The Manual on Uniform Traffic Control Devices improves safety by ensuring consistent use of traffic control devices in a way that accommodates road user expectancy.

Infrastructure/Improving Infrastructure: The Managing Disruptions to Operations Program supports this goal by ensuring impact of these disruptions are appropriately considered during life cycle cost analysis and other infrastructure investment analysis and decisions. Rebuilding our infrastructure, including traffic control devices, must be done in a manner that minimizes the impacts to those who rely on the system every day. This program area finds that balance between reconstruction, safety, and mobility.

Innovation: The Managing Disruptions on Operations Program supports this goal by undertaking research and development in the areas of automated and connected vehicles; data driven technologies and decision-making; experimentation of novel traffic control devices, and safety, durability, and resiliency of transportation systems. This effort is vital to improving the state-of-the-practice and mitigating impacts resulting from road construction, adverse weather, and traffic incidents.

Improving Mobility/Preserving the Environment: The Managing Disruptions on Operations Program contributes to improved mobility and ensuring the network is resilient by reducing duration and frequency of roadwork; effectively/consistently using traffic control devices; restoring roadway capacity and thus minimizing traffic delays, fuel usage, and emissions; and reducing the use of treatment materials for snow and ice control.

In accordance with 23 USC 502(a)(3), the nature of the work that FHWA will pursue under this program:

- Is of national significance;
- Delivers a clear public benefit and occurs where private sector investment is less than optimal;
- Supports a Federal stewardship role in assuring that State and local governments use national resources efficiently;
- Meets and addresses current or emerging needs;
- Addresses current gaps in research;
- Presents the best means to align resources with multiyear plans and priorities; or
- Offers the best means to support Federal policy goals compared to other policy alternatives.

As such, the research and technical assistance does not provide or is not intended to provide the immediate profit potential required to motivate private investment.

Additional information about the planned FY20 Safety Program Delivery R&T Program investments is provided below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Road Weather Management	There are no other agencies or offices within USDOT addressing the impacts of weather on transportation maintenance and operations. There are some State DOT-led pooled fund studies that are conducting small scale projects. Additionally, the Transportation Research Board's National Cooperative Highway Research Program will occasionally conduct research in this area, but it is relatively rare.	Developing and deploying advanced management strategies have proven successful to date and speak to the need to build upon them, especially as extreme weather events become more frequent	2020-2022
Traffic Incident &	While there are efforts in NHTSA and FMCSA to engage the law enforcement and other	Strengthening the working relationship between transportation and	2020

Event Management	emergency management communities, they are not conducting research in this area. Additionally, the Transportation Research Board's National Cooperative Highway Research Program will occasionally conduct research in this area, but it is relatively rare.	emergency management personnel has been effective to reduce incident response and management time. Recent efforts to incorporate a data driven approach show promise to be even more effective	
Work Zone Management	There are no other agencies or offices within USDOT addressing the safety and mobility impacts of work zones. There are some State DOT-led pooled fund studies that are conducting small scale projects. Additionally, the Transportation Research Board's National Cooperative Highway Research Program will occasionally conduct research in this area, but it is relatively rare. Finally, some within the academic community conduct smaller scale research. We monitor those projects closely to ensure that our efforts are complementary.	Promoting a comprehensive approach to Work Zone Management has been effective at reducing crashes and improving mobility. This has been enhanced through the use of advanced technologies. The changing vehicle fleet (i.e., connected and automated vehicles), especially through complex environments such as work zones presents new challenges that need to be addressed.	2020-2022

Freight Management and Operations RD&T

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated and cohesive Freight Management and Operations Research, Development, and Technology (RD&T) Program to improve the physical components of the highway system that support goods movement, including roads, bridges, pavement, parking facilities, and other components. These objectives seek to better understand how freight movement impacts—and is impacted by—this infrastructure.

Planned 2020 Freight Management and Operations RD&T Program activities seek assess the condition and performance of key freight infrastructure, and to provide guidance that permits States and other stakeholders to incorporate freight infrastructure improvement projects into transportation program delivery. Overall, this Program aims to ensure safe, durable, and high performing infrastructure, as well as identify solutions to mitigate or address the negative impacts of freight transportation.

As in 2019, activities will include developing data-driven tools that States/other stakeholders can use to better assess the operating condition, capacity, performance, and use of the freight transportation system. These activities will also address the need to develop strategies that assess the impact of freight movement, while helping stakeholders more effectively incorporate freight infrastructure considerations into transportation planning/project development, such as truck parking needs.

Planned 2020 FHWA Structures R&T Program activities, and their relationship to FY19 activities are presented below.

Key FY20 FHWA Freight Management and Operations RD&T Program Activities

Activity	Relationship to FY19 Activities
Improved understanding of truck bottleneck analysis, congestion, and performance.	FY20 work will focus on deployment of solutions developed through prior work, and research toward solutions addressing additional key challenges identified through performance measures analysis, synthesis of state freight plans to identify best practices, emerging issues, freight corridors.
Truck parking needs and gap analysis	FY 20 work will focus on a follow up to the findings of the Jason's Law Survey and ongoing research and stakeholder outreach related to truck parking.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure
Innovation	Improving mobility

Additional Information About Planned FY20 Freight Management and Operations RD&T Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Improved understanding of truck bottleneck analysis, congestion, and performance.	American Transportation Research Institute (ATRI), State DOTs, NAS	Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report (2015) assisted analysts with identifying and analyzing truck performance in general and truck freight bottlenecks. TRB's National Cooperative Highway Research Program (NCHRP) Research Report 854: Guide for Identifying, Classifying, Evaluating, and Mitigating Truck Freight Bottlenecks (2017) provides transportation agencies state-of-the-practice information on truck freight bottlenecks using truck probe data rather than traditional travel demand models. Truck Freight Bottleneck Reporting Guidebook (under review 2018). The purpose of this guidebook is to support compliance by States with the truck freight bottleneck reporting required by 23 U.S.C. 150(e)(4). The guidebook reviews the truck freight bottleneck reporting requirements and offers guidance based on noteworthy practices from around the country on freight bottleneck analysis as part of broader freight planning efforts.	2021
Truck parking needs and gap analysis	AASHTO, State DOTs	2015 Jason's Law Survey described the areas necessary to assess and measure in order to develop a more comprehensive grasp of truck parking and to establish consistent measurement areas so that a national picture can be developed. National Coalition on Truck Parking was formed in 2015 as a response to a documented need for truck parking solutions. Stakeholders engaged in the Coalition represent the trucking industry, commercial vehicle safety officials, State departments of transportation (DOTs), and commercial truck stop owners and operators. Coalition is currently identifying priority implementation actions through Working Groups.	2021

Truck Size and Weight RD&T Program

Program Description/Activities:
In 2020, FHWA will continue to conduct a coordinated and cohesive Truck Size and Weight Research, Development and Technology (RD&T) Program focused on providing other FHWA, other federal agencies, States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. As in 2019, 2020 activities will include research on effective truck size and weight data use across States and supporting States in harmonizing oversize and overweight (OS/OW) permitting requirements. This Program will support FHWA's oversight efforts on State-enforced Federal size and weight truck/bus standards for travel on Interstate highways and the national network. TSW research will also examine the operations and safety of alternative truck configurations and oversize/overweight (OS/OW) vehicles.

2020 Activities will include implementing the highest priority elements of the CTSWL Research Plan. While these activities have not yet been determined, they would include research pertaining to the five topic areas identified in the 2016 Study. For example, activities could include: development of enhanced bridge deterioration models that can account for impacts of alternative truck configurations; development of more accurate models that States and others can use to identify impacts of heavy trucks on pavements; commodity analysis of truck types, and safety impact assessments.

Planned 2020 cohesive Truck Size and Weight RD&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Implementation of Comprehensive Truck Size and Weight Limits (CTSWL) Research Roadmap	Better data collection techniques to assess large truck operations. Improved bridge and pavement deterioration models. Better safety data collection and assessment of larger truck operations.
Analysis and Dissemination of Truck Size and Weight Data to Support Harmonization and Permitting Requirements	Development of Emergency Route Corridor Analysis and Interactive Map. Implementation of Emergency Response and Recovery Pre-Clearance Alerting demonstration project.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure
Innovation	Improving mobility
Accountability	

Promoting Safety: Today, approximately 12 States require Pilot Car Certification. States use the guidelines developed through FHWA, to support their certification requirements; however, these requirements vary from state to state. As a result, pilot car operators in the U.S. have to navigate a complex web of requirements when making a multi-state move. FHWA research in this program area will support harmonization among states through collaboration with stakeholders on a framework for a national certification program for pilot car drivers escorting loads moving on oversize/overweight state and local permits. The outcome of this work will improve safety on the national highways as well contribute to infrastructure preservation. Research actives will include research, review, and analysis of existing pilot/ escort vehicle operator (P/EVO) training materials, laws and rules relevant to P/EVOs, and case studies and other information focused on the movement of oversize loads.

Infrastructure/Improving Infrastructure: The Truck Size and Weight RD&T Program addresses alternative truck configurations on the highway system and highway operations. Activities will include cost-benefit assessments of alternative truck configurations or OS/OW freight vehicles, and general analysis of alternative truck configuration impacts on freight infrastructure, safety, and operations.

The draft National Freight Strategic Plan (NFSP) provides important context for truck size and weight research. The NFSP acknowledges that lack of uniformity across State truck size and weight regulations may be a potential barrier to efficient freight movements. It also notes a need for truck size and weight research specifically to assess tradeoffs involved in raising weight limits or allowing longer combination trucks on national highways. Outside DOT, National Cooperative Highway Research Program (NCHRP) analyses have provided a foundation for this topic area. The Truck Size and Weight RD&T Program supports addressing these gaps in research and data.

Innovation/Improving Mobility: The Truck Size and Weight RD&T Program will provide States and other stakeholders with information needed to create the safest and most efficient permitting and enforcement systems possible to ensure fluid freight movement across State borders. Activities will include research on effective truck size and weight data use across States and supporting States in harmonizing OS/OW permitting requirements.

The Truck Size and Weight RD&T Program will support practitioners to plan for, prioritize, and implement projects that benefit goods movement. Truck Size and Weight RD&T Program activities include producing resource on what information is needed for analysis of freight vehicle size and weight, and examining methods for inventorying and applying these data.

Truck Size and Weight RD&T Program efforts aim to better understand the impacts of alternative truck configurations on freight infrastructure, safety, and operations, through data collection and development of data-driven tools and analytical techniques. Additionally, there is an effort to identify key TSW-related research needs relating to pavement, bridge, mode shift, safety, and enforcement. The combination of these activities will lead to improved technical and implementation resources for stakeholder decision-making and analysis.

Additional Information About Planned FY20 Freight Management and Operations RD&T Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Implementation of Comprehensive Truck Size and Weight Limits (CTSWL) Research Roadmap	NAS, FMCSA, State DOTs	Comprehensive Truck Size and Weight Limits Study (2015) recommended to make a genuine, measurable improvement in the knowledge needed in the subject areas, more robust study effort should start with the design of a research program that can identify the areas, mechanisms, and practices needed to establish new data sets and models to advance the state of practice. This research plan is being developed by an expert panel led by NAS, and will include a realistic estimation of timelines and costs.	2022
Analysis and Dissemination of Truck Size and Weight Data to Support Harmonization and Permitting Requirements	FMCSA, State DOTs	In the past, the American Association of State Highway Transportation Officials (AASHTO) and FHWA have collaborated on research related to harmonization of state truck permitting requirements. In recent years, the research emphasis has focused on obtaining initial successes in areas of harmonization considered by both state officials and industry representatives as being realistic candidates for short-term harmonization. Past research has resulted in adoption of permitting processes and practices by States that increases the level of consistency for the interstate motor carrier industry.	2022

Accelerating Project Delivery

Program Description/Activities:
The FHWA will build on FY19 efforts in the Accelerating Project Delivery program by continuing to work with the Volpe Center, resource agencies with National Transportation Liaisons, the USIECR, and commercial contractors to address ongoing and emerging needs for innovations to expedite project delivery. Building on FY19 work to improve environmental review and permitting processes and reduce regulatory timeframes and costs, the FY20 research efforts will expand on DOT and FHWA priorities to reform existing processes. These efforts will help FHWA deliver transportation projects more quickly and efficiently while safeguarding our communities and maintaining a healthy environment. The program will continue to support improving the NEPA process and improving coordination and communication between Federal and State agencies, the public, and other stakeholders to create efficiencies in project review and development. In FY20, the program will continue to accelerate project delivery through interagency collaboration, capacity building for environmental practitioners, integrating planning and environmental processes, and disseminating information about environmental program and process efficiencies.

Planned 2020 FHWA Structures R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Accelerating Project Delivery Services	In FY20, this activity will continue FY19 efforts related to regulatory reform and permitting efficiencies through rulemaking, guidance, and programmatic approaches.
National Liaison Program	In FY20, this activity will continue FY19 efforts related to regulatory reform and permitting efficiencies through rulemaking, guidance, and programmatic approaches.
PAPAI	In FY20, HEPE will continue FY19 efforts to manage PAPAI to track environmental review timelines and align with permitting dashboard priorities.
eNEPA	In FY20, HEPE will continue FY19 efforts to manage eNEPA as an environmental review collaboration tool for FHWA and permitting and regulatory agencies to make concurrent reviews more efficient.
Studies on Historic Properties and Tribal Consultation	In FY20, this activity will continue activities that HEPE anticipates initiating in FY19 to create efficiencies in the consultation process to comply with Section 106 of the National Historic Preservation Act and its implementing regulations.
NEPA Assignment Program	In FY20, this activity will continue FY19 efforts to support activities to standardize NEPA assignment processes, including assisting with State DOT applications, audits, and monitoring in accordance with the Surface Transportation Delivery Program Statute and Regulations
Permitting and Mitigation	In FY20, HEPE will continue FY19 efforts to find efficiencies in environmental review to meet permitting and mitigation requirements.

Planning and Environmental Linkages (PEL)	In FY20, HEPE will continue FY19 work with the Office of Planning (HEPP) to develop ways to expedite project delivery and environmental review by studying ways to conduct environmental studies during the planning process and incorporate those studies into environmental documents.
NEPA document timelines	In FY20, HEPE anticipates continue work it plans to start in FY19 to develop tools for project sponsors and FHWA to meet new requirements for NEPA document timelines
Stormwater studies	In FY20, HEPE will continue FY19 efforts to conduct field studies with State DOTs to enhance technology transfer and study the performance of tools developed to meet stormwater permitting requirements.
Project Delivery Innovations	In FY20, HEPE will respond to emerging related to environmental review. This will be similar to efforts HEPE will begin in FY19, but the topics may change based on input from stakeholders. Leadership, and any new or changing legal requirements.
Tools to forward Executive Order 13807	In FY20, HEPE anticipates that it will continue to advance efforts it has begun to meet new requirements under the EO.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Accelerating Project Delivery supports the Department's Infrastructure, Innovation and Accountability Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

Infrastructure/Improving Infrastructure: The Accelerating Project Delivery research program addresses DOT goals of Infrastructure, Innovation, and Accountability through strategies such as coordination, partnerships, regulation updates, controlling regulatory costs, program performance, information technology development, and by developing a workforce trained to understand the various ways to accelerate project delivery and expedite environmental and permitting processes and decisionmaking.

The program addresses the problems caused by environmental review and permit process delays by developing tools to remove or reduce these barriers. By investing in these activities, we accelerate surface transportation project delivery. These investment benefit stakeholders and the traveling public who use highway facilities. FHWA takes the lead in researching ways to accelerate project delivery. Other entities that research this topic include the Transportation Research Board, the American Association of State Highway and Transportation Officials, individual State DOTs, and University Transportation Centers. FHWA coordinates with all of these entities to avoid duplication in research and to leverage

their resources to collaborate on research projects or build on their work. As the Operating Administration, responsible for delivering the Federal aid program, FHWA focuses on the Accelerating Project Delivery research on activities outside the purview of these other entities, such as research to implement and inform policy, guidance, and regulations. FHWA has worked on this research program for decades, continuing to build on past work and adding new activities to meet changing laws and policies as well as to address new and emerging issues in environmental review and permitting practices. The program has multiple tangible outcomes annually. Most of these products are the culmination of multi-year efforts. Examples of recent outcomes are the bridge permitting 144(c) checklist for State DOTs to determine if a USCG permit is required pursuant to 23 U.S.C. 144, the Indiana and long-nose bat programmatic agreement and programmatic biological opinion, and the "Red Book: Synchronizing Environmental Reviews for Transportation and Other Infrastructure Projects" https://www.environment.fhwa.dot.gov/strmlng/Redbook_2015.asp, and various policy and guidance documents.

Additional information about the planned FY20 Accelerating Project Delivery Program investments is provided in the table below

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Accelerating Project Delivery Services	None – This is inherently governmental work	Past investments in agreements with Volpe have been the most efficient means of conducting inherently governmental work that changes regularly to include rulemaking, permitting and regulatory reform, innovations in expediting project delivery, and other policy development.	Delivery dates will vary from tangible outcomes within one day to tangible outcomes that are the culmination of multi-year efforts.
National Liaison Program	None – This is inherently governmental work	Past investments in HEPE's six liaison dedicated staff regularly contribute to innovations to create efficiencies in permitting, expediting project delivery, and regulatory reform through developing new programmatic approaches and policies	Delivery dates will vary between tangible outcomes within one day to tangible outcomes that are the culmination of multi-year efforts.
PAPAI	None – This is specific to FHWA	The tool has been useful for tracking NEPA timelines to respond to multiple inquiries from Congress and the Administration	Delivery dates will vary from tangible outcomes within one month to tangible outcomes that are the culmination of multi-year efforts.

eNEPA	None – This is specific to FHWA	Participating States and Federal agencies find the tool useful	Delivery dates will vary from tangible outcomes within one month to tangible outcomes that are the culmination of multi-year efforts.
Studies on Historic Properties and Tribal Consultation	AASHTO, but the data are not complete or current	Past investment in work with the USIECR has resulted in efficiencies in tribal consultation for State DOTs	Delivery dates for a national scan of tribal consultation will be not later than the end of FY20. Deliverables from USIECR vary with stakeholder needs
NEPA Assignment Program	State DOTs, but FHWA is lead for inherently government functions	Past investments have helped support this program, but there is increasing need for support as more State DOTs opt to participate in NEPA Assignment	Delivery dates will vary between tangible outcomes within one month to tangible outcomes that are the culmination of multi-year efforts
Permitting and Mitigation	AASHTO, TRB, State DOTs, but FHWA is lead for inherently government functions	Past investments on ways to improve permitting and mitigation have resulted in innovations that expedite environmental review	Delivery dates will vary between tangible outcomes within one month to tangible outcomes that are the culmination of multi-year efforts
Planning and Environmental Linkages (PEL)	None – This is specific to FHWA	Past investments have advanced the state of knowledge and practice in PEL to meet statutory requirements to expedite environmental reviews	Delivery dates will vary between tangible outcomes within one month to tangible outcomes that are the culmination of multi-year efforts
NEPA document timelines	Other Federal agencies, with regard to their roles, but HEPE is lead for FHWA	Past investments related to expediting environmental reviews have resulted in multiple guidance, tools, and policies to help project sponsors meet timeline goals	Delivery dates will vary between tangible outcomes within one month to tangible outcomes that are the culmination of multi-year efforts

Stormwater studies	EPA and State DOTs in partnership with FHWA, but FHWA is lead for highway projects	Past investments have advanced the state of knowledge and practice in stormwater permitting efficiencies	Delivery dates for tangible outcomes vary, but projects are usually completed within 3 years of initiation
Project Delivery Innovations	Unknown/Usually none – This topic deals with emerging issues in environmental review for highway projects.	Past investments have varied but usually result in advancing the state of knowledge and may advance new practices in expediting environmental review for a given topic area	tangible outcomes vary, but projects are usually completed within 3 years of initiation
Tools to forward Executive Order 13807	Other Federal agencies, with regard to their roles, but HEPE is lead for FHWA	This topic is new in FY18 and there are no data yet to measure the outcomes of past investments	Delivery dates will vary between tangible outcomes within one month to tangible outcomes that are the culmination efforts lasting a year or more

Performance Based Planning

Program Description/Activities:
In FY 2020, FHWA will continue to conduct performance based planning research that will build upon the FY 2019 efforts. Increased emphasis will be placed on performance management within the Federal-aid highway program and examine the implementation and results of performance-based approaches in statewide, metropolitan, and nonmetropolitan transportation planning. Performance management will improve project and program delivery, inform investment decision-making, and provide greater transparency and accountability to the public.

Planned 2020 FHWA Performance Based Planning R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Continue to identify and disseminate best practices in integrating PBPP into required statewide and metropolitan planning documents and processes through peer exchanges and case study research.	Monitor best practices as transportation agencies enter into the first and second rounds of submitting PBPP plans, targets, and performance reports.
Continue to examine the impacts of emerging technologies on PBPP requirements and the existing and future transportation system through exploratory modeling, GIS, and other innovations	Adapt research to reflect the rapidly evolving environment of emerging technologies such as connected and autonomous vehicles.
Continue to explore new data sources and analysis techniques to provide necessary information on how emerging technologies might impact metropolitan and statewide travel trends that feed into the PBPP.	Examine the effectiveness of new data sources and analysis techniques to adjust research as necessary
Examine how PBPP can support a data-driven, performance-based approach to decision-making for safety, asset management, economic resiliency, freight movement, congestion management, system reliability, and air quality through scenario planning and exploratory modeling research.	Continue efforts in this multi-year initiative.
Examine how PBPP can enhance the safety, durability, and resiliency of the transportation system.	Continue efforts in this multi-year initiative.
Development of a framework for the integration of PBPP into National Economic Networks (NEN) to increase collaboration and coordination beyond traditional jurisdictional boundaries.	Measure the effectiveness of NEN frameworks and explore new opportunities to strengthen multi-jurisdictional collaboration, planning, and data-sharing.
Explore how PBPP can accelerate project delivery through planning and environmental linkages, effective public involvement, and community connections considerations.	Continue efforts in this multi-year initiative.

Explore PBPP's impact on data-sharing and analysis to enhance the efficient movement of people and freight across international borders (Mexico and Canada)	Continue efforts in this multi-year initiative.
Examine how PBPP can enhance a state or local communities' ability to withstand economic shocks to maintain and grow a strong economy	Continue efforts in this multi-year initiative.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Performance based planning supports each of the Department's goals and contributes to all USDOT RD&T Critical Transportation Topics. Contributions include:

Safety/Promoting Safety: States are required to use a performance based process through the development of data-driven, Strategic Highway Safety Plans (SHSPs), which involve tracking safety indicators, and identifying emphasis areas and strategies. Each State's Highway Safety Improvement Program (HSIP) should be consistent with the SHSP, and includes collecting and maintaining data, conducting studies, establishing priorities, and implementing and evaluating the effectiveness of safety improvements. This research will provide tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to achieve desired performance outcomes for the multimodal transportation system.

Infrastructure/Improving Infrastructure: Research will highlight the emphasis on performance management within the Federal-aid highway program, and requires use of performance-based approaches in statewide, metropolitan, and nonmetropolitan transportation planning. This research will provide examples of effective practices to help practitioners advance these approaches in their own planning and programming activities; promote and maintain the highway infrastructure asset system in a state of good repair; identify tools, technologies, and guidance for States and MPOs; and offer capacity building opportunities that plan and prioritize investments, accelerates project delivery; and effectively improves connectivity, accessibility, safety, and convenience for all users, including those in rural areas.

Innovation/Improving Mobility: Within the context of performance based planning, the scenario planning approach helps visualize and demonstrate, in both qualitative and quantitative terms, how the combination of various strategies would help meet performance targets. Research will allow for the consideration of how various factors, such as revenue constraints, demographic trends, economic shifts or technological innovation can affect a state or region and its transportation system performance. Potential regional investment strategies for the planning horizon include different packages of investments in transit,

highway capacity, ITS, and travel demand management strategies, or system preservation. Research will also assess new modes and technologies, notably automated vehicles and automated driving systems linked to data driven decision-making.

Accountability/Preserving the Environment: Performance based planning encourages planners to evaluate and recommend strategies, projects, and programs to policy-makers based on anticipated system-wide impacts and support for goals. This research will provide tools, technologies, guidance, and training to support States, MPOs, and other transportation agencies (including rural communities) to achieve improved mobility while preserving the natural and human environments.

Modeling

Program Description/Activities:
For FY 2020, modeling research will build upon the FY 2019 research to support the administration and implementation of FHWA's air quality and highway noise programs, and future legislature, regulatory and policy development for these program areas: air quality and Clean Air Act requirements; highway traffic noise; Congestion Mitigation and Air Quality Improvement (CMAQ) Program; air quality analysis and assessment; and environmental mitigation strategies. Research activities include: advancing the practice of near-road air quality modeling applications and analysis, enhancements to the CMAQ public access system functions, and updating and supporting the Traffic Noise Model applications and guidance while exploring the potential of roadside structures and vegetation to reduce traffic related air quality and noise impacts.

Key FY20 FHWA Modeling Program Activities

Activity	Relationship to FY19 Activities
Implementation of FHWA's air quality and highway noise programs	Continuation of research efforts in FY19
Legislature, regulatory and policy development	Continuation of research efforts in FY19 New effort: Identify areas to reduce regulatory and analytical burden
Advance the practice of near-road air quality modeling	Continuation of research efforts in FY19
Enhancements to the CMAQ public access system	Modification: Develop new reporting formats to accommodate the CMAQ Performance Measure requirements. Add enhanced query functions.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Modeling supports the Department's Infrastructure, Innovation, and Accountability Goals and all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

> Infrastructure/Improving Infrastructure: Air quality, highway traffic noise and travel demand modeling research will focus on technologies, tools, analysis methods, and performance management approaches to accelerate the environment review process, and to effectively and efficiently analyze the impacts of projects on the environment and communities. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies so that transportation projects, will be delivered more quickly

and efficiently while maintaining a healthy environment, safeguarding our communities and stimulating economic growth. The research will also provide tools and other resources to assist State and local transportation partners to measure the performance of the transportation system.

Innovation/Improving Mobility: Modeling research will advance the state-of-the practice by developing and deploying analytic methods and tools for air quality, highway traffic noise and travel demand forecasting analyses. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies in the areas of air quality, highway traffic noise and travel demand forecasting.

Accountability/Preserving the Environment: Modeling research will develop tools, methods and guidance to support a clearer understanding of the complex relationship between transportation and the environment, especially in the areas of air quality, highway traffic noise, and travel demand forecasting process. It will promote more informed transportation decision making that improves transportation planning, programming, operations, and coordination. This research will provide tools and methods to identify approaches in reducing regulatory burden of air quality and highway noise analyses and accelerating the project development processes.

Additional information about the planned FY20 Modeling Program investments is presented below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Implementation of FHWA's air quality and highway noise programs	EPA, TRB, Academia	Release of the final TNM 3.0	Complete noise analysis tools in support of the new noise model – August 2020
	EPA, Academia	Monitor to Model comparisons; Meteorological data processing	Follow up research to disseminate new modeling techniques into PM hot-spot analysis – September 2020
Legislature, regulatory and policy development			Provide technical assistance where necessary
Advance the practice of near-road air quality modeling	EPA, State DOTs	Road dust in emissions modeling; Brake wear and tire wear research	Develop tools for near road emissions estimations – September 2020
	EPA, State DOTs	National Traffic Data Tools	Follow up research to improve traffic data inputs to MOVES using additional data sources – September 2020

	TRB, EPA, State DOTs	Synthesis of heavy duty truck age distributions	Research on mitigation options for highway projects involving heavy duty trucks – September 2020
	EPA, Health Effects Institute		Complete synthesis of factors affecting health effects of near road related air and noise emissions. The synthesis will support future policy development
Enhancements to the CMAQ public access system			Complete development of CMAQ Performance Measure reporting capability – June 2018

Resiliency

Program Description/Activities:
In FY20, this program area focuses will continue development and deployment of tools, techniques, strategies and methodologies for assessing sustainability and resiliency. Increased emphasis will be placed on deployment of completed research products in partnership with State DOTs, MPOs, FLMAs, and others. FHWA will also continue work with other Federal agencies to better predict and estimate the future levels of exposure of infrastructure to extreme weather events including changes in precipitation patterns, temperature, and cyclonic storm surge and waves.

Planned 2020 FHWA Resiliency R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Develop and deploy of tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs	Utilize complete improved hydrological and hydraulic analysis tools and methods to incorporate research results Deliver results through training, workshops and technical assistance.
Support expansion of alternative fuel corridors through technical assistance and training	Build on past designation efforts to provide technical assistance and training needed to expand alternative fuel corridor designations
Partner with State DOTs and others to improve tools and methods through demonstration projects and applied research	Initiate new round of resiliency and durability demonstration projects to advance state of the practice in anticipating and building projects to incorporate resilience
Update training on engineering highways in coastal and riverine environments	Incorporate research results into existing and new training courses, workshops
Explore flexibilities in right-of-way use when quantifying existing operational and safety concerns.	Continue technical assistance and training efforts with State DOTs and others

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

Resiliency supports the Department's Infrastructure and Innovation Goals and all DOT RD&T Critical Transportation Topics. Specific contributions are as follows:

> Infrastructure/Improving Infrastructure: In the Infrastructure Goal, under Strategic Objective 2: Life Cycle and Preventive Maintenance, the Plan states that "DOT will increase

its effectiveness in ensuring that infrastructure is resilient enough to withstand extreme weather…which could otherwise disrupt the transportation network and require major reconstruction." Our past work is highlighted as an example in support of this objective under the "Sustainable Highways Initiative."

Innovation/Improving Mobility: In the Innovation Goal, under Strategic Initiative 1: Development of Innovation, the Plan identifies development of new tools to improve transportation infrastructure durability and resilience as a priority innovation area. Our proposed research for FY19 directly supports these objectives by developing and deploying tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs.

RD&T Critical Topics
Under Section 4.3, Improving Infrastructure, the RD&T Plan states that "development of advanced materials can enable new infrastructure designs, improve structural resilience to natural disasters." Our past work, which we propose to continue in FY20, is highlighted as examples of work to support this research area.

Additional information about the planned FY20 Resiliency R&T Program investments is presented below.

Activities	**Others Conducting Research in this Area**	**Findings from Past Investment**	**Projected Delivery Date for Tangible Outcomes**
Develop and deploy of tools, techniques, strategies and methodologies for assessing the sustainability and resiliency of transportation plans, projects and programs	N/A	Results documented in frameworks, engineering circulars, case studies documented,	FY21
Support expansion of alternative fuel corridors through technical assistance and training	USDOE	Designation criteria developed and applied, nominations analyzed and designated, maps of corridors developed and posted	FY21
Partner with State DOTs and others to improve tools and methods through demonstration projects and applied research	State DOT partners	Partnerships with DOTs and MPOs and others established for co-funded demonstration projects or pooled fund activities, results documented and distributed	FY21

Update training on engineering highways in coastal and riverine environments	USACE	Research results from past research will be in integrated into new and updated training and education materials	FY21
Explore flexibilities in right-of-way use when quantifying existing operational and safety concerns.	N/A	Best practices and examples developed and shared, workshops held to educate and empower states to utilize existing flexibilities	FY21

Multimodal Connectivity

Program Description/Activities:
In FY 2020, multimodal connectivity research build upon the FY 2019 research to study and foster the use and application of additional multimodal planning and design resources to improve safety and accelerate multimodal project development. Innovations will facilitate multimodal transportation projects that improve connectivity, safety, and convenience for all users. Research will include advancements in pedestrian and bicycle networks, public involvement, context sensitive solutions and design, and economic revitalization.

Planned 2020 FHWA Multimodal Connectivity R&T Program activities, and their relationship to FY19 activities are presented below.

Activity	Relationship to FY19 Activities
Identify, share, and promote effective and successful tools and information necessary to assess and bridge the gaps in multimodal transportation connectivity.	Activities build on FY 19 research to address identified gaps and feedback from early adopters to move research to full deployment and improve multimodal network connectivity.
Conduct R&T to support integrated surface transportation system for all users that is efficient, equitable, safe, environmentally sustainable, and supports economic revitalization	Activities build on FY 19 research to address identified gaps and feedback from early adopters to move research to full deployment and improve analysis and context sensitive solutions and design to accelerate project delivery.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure

Multimodal connectivity supports the Department's Safety and Infrastructure Goals, and contributes to all DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

> Safety/Promoting Safety: Multimodal connectivity research will study advanced technology, data collection and analysis techniques, and performance-based measures to promote transportation safety and efficiency for all users. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies in ensuring that multimodal transportation facilities are planned and designed to safely accommodate all users, including pedestrians and bicyclists.

Infrastructure/Improving Infrastructure: Multimodal connectivity research will study technologies, tools, analysis methods, and performance management approaches to promote the acceleration of multimodal transportation projects. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies to plan and prioritize multimodal investments, accelerate the delivery of multimodal infrastructure more efficiently and effectively, and improve connectivity, accessibility, safety, and convenience for all users, including those in rural areas.

Improving Mobility/Preserving the Environment: Multimodal connectivity research will study technologies, tools, analysis methods, and performance management approaches to promote to improve multimodal mobility for all users, while safeguarding our communities, maintaining a healthy environment, and stimulating economic growth. This research will provide tools, technologies, guidance, and training to support State departments of transportation, metropolitan planning organizations, and other transportation agencies to plan and develop multimodal infrastructure projects that improve multimodal mobility for all users, and to efficiently and effectively analyze the impacts of projects on the environment and communities (including rural communities).

Additional Information About Planned FY20 Multimodal Connectivity R&T Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Identify, share, and promote effective and successful tools and information necessary to assess and bridge the gaps in multimodal transportation connectivity.	AASHTO Center for Environmental Excellence University of North Carolina Highway Safety Research Center Portland State University's Transportation Research and Education Center State DOTs	Innovative methods for measuring multimodal network connectivity	Throughout FY 2020 and beyond
Conduct R&T to support integrated surface transportation system for all users that is efficient, equitable, safe, environmentally sustainable, and supports economic revitalization	AASHTO Center for Environmental Excellence	Innovative analysis techniques to accelerate project delivery	Throughout FY 2020 and beyond

Policy Analysis and Global Outreach

Program Description/Activities:
The domestic component of the Policy Analysis and Global Outreach program seeks to enhance FHWA's understanding how national transportation strategies and policies can improve the overall value of transportation investments to the American people. This research program supports the development and maintenance of a carefully-selected suite of tools and models to assess and forecast the factors shaping modal choice and travel behavior, system performance, highway construction costs, and user contributions to highway costs; identify cost-effective future highway investment levels and associated job/gross domestic product growth; and assess a range of revenue options. In 2020, this research program will continue to provide support to agency and Departmental leadership on emerging policy questions. The domestic component of this research program encompasses two broad lines of research which include eight main emphasis areas:

- *Transportation Investment*
    - Impacts of Investment on Conditions and Performance,
    - Macroeconomic Impacts
    - Benefit-Cost Analysis
    - Highway Costs and Funding Options.
- *Travel Behavior and Technology: Policies and Strategies for Future Transportation Markets*
    - Emerging Trends and Future Performance
    - Geo-Economics of Transportation
    - Strategic and Performance Management
    - Future Policy Symposia

The international component of the Policy Analysis and Global Outreach program seeks to gather, promote and disseminate global policy, best practices, and technical innovations to ensure a safe and efficient U.S. highway transportation infrastructure. Three main international program elements, Global Benchmarking, Multilateral, and Bilateral, facilitate the exchange of innovative ideas, best practices and technologies that can have a direct and practical impact on improving the high system. In 2020, through collaboration with international and domestic partners, this program will continue to work to address the Secretary's and FHWA's priorities.

Key FY20 FHWA Policy Analysis and Global Outreach Activities

Activity	Relationship to FY19 Activities
Impact of Investment on Conditions and Performance	Complete work on recoding HERS into a modern programing language. Begin implementing of recommendations from TRB Future of the Interstate Study, and FHWA Reinventing the C&P Report in a Performance Management-Based World Study. HERS: Begin development postprocessor to estimate distribution of truck cost savings by commodity category for potential integration with USAGE-Hwy; Begin developing new inter-temporal optimization tool; Enhance modeling of induced demand. NBIAS: Begin refining NBIAS to include evaluation and application of all costs related to the full or partial loss of use of a structure and risk analysis of full or partial loss of a structure.
Macroeconomic Impacts	USAGE-HWY model development and the development of analyses using the model will continue. Content will be driven based on feedback on products developed in 2018 and 2019. Initiate new study on global competitiveness, considering access to international markets and how highway investments benefit various industries.
Benefit-Cost Analysis	Continue regulatory analysis and economic support to facilitate discretionary grant BCA reviews. Initiate benefit-cost evaluation of highway speed limits and related enforcement measures, building off 2019 research on value of travel time savings and vehicle operating costs. Initiate research to estimate discomfort costs from rough pavements for benefit-cost analysis.
Highway Costs and Funding Options	Begin development of a single pavement distress analysis model for incorporation in multiple FHWA analytical software applications based on the framework and software requirements specification established during the first phase of the project in 2019. The model shall be available in a shared computer library. Begin development of a tool for estimating the impacts of toll and priced lanes on travel demand using framing paper results completed in 2019. The results of the analytical tool will be critical input for enhancing the existing FHWA Interstate Tolling Analysis Tool.
Emerging Trends and Future Performance	FY 20 work will build upon prior work to: 1) develop solutions to key challenges associated with use data fusion techniques; 2) advance understanding of AV future; 3) advance understanding of impacts of socioeconomic and demographic changes to transportation; and 4) assess methods and variables to develop performance measures to assess safety and mobility of roads

Geo-Economics of Transportation	FY20 work builds upon FY18-19 work to quantify trends and policy outcomes, providing subject matter expertise on current policy issues for FHWA/DOT leadership, with an increased emphasis on rural areas.
Strategic and Performance Management	FY20 work builds upon FY 19 work to develop a 'Reference Case' baseline for program strategy evaluation. Work may include updates to strategic performance measures, if needed.
Future Policy Symposia	FY20 work build upon FY18-19 work to provide subject matter expertise on current policy issues for FHWA/DOT leadership
Global Benchmarking Program	FY20 work will focus on coordinating two new studies as determined by FHWA leadership, as well as, follow up implementation activities related to FY18 and FY19 studies.
Multilateral Relations	The quadrennial World Roads Congress will take place in FY 2020, preparations for which take place in FY 18-19. It is also anticipated that Twinning projects with the EU/EC that take place in FY 2019 will continue or be completed in 2020, or possibly evolve into follow up projects.
Global Technology Exchange Program	The Netherlands partnership will continue the 2019-2020 work plan. The next US-Japan Bridge Workshop and US-Korea Roads Workshop will take place, following on the 2019 events.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The Policy Analysis and Global Outreach program supports all four Department Goals and contributes to all four DOT RD&T Critical Transportation Topics. Specific contributions are as follows.

Safety/Promoting Safety: This research program contributes to a systemic safety approach by developing data-driven baseline forecasts of crash and fatality rates reflecting changing economic and socio-demographic factors and travel behavior (including modal choices). This research provides a context for assessing the impacts of a range of broad policy options as well as specific safety options identified through participation in the USDOT Safety Data Initiative, which is supported by this research program. Socio-economic factors affecting rural travel safety are being explored.

International safety-related activities include supporting the development and dissemination of the Road Safety Manual for the World Road Association, collaboration with Japan and the Netherlands on bridge and tunnel safety, and road safety, respectively.

Infrastructure/Improving Infrastructure/Improving Mobility/Preserving the Environment: This research program supports the development of tools and techniques for evaluating tradeoffs across competing types of transportation investments, including specialized and priced lanes, and multimodal applications. This research includes tracking of highway construction costs, baseline forecasts of established system performance metrics, and estimates of cost-effective investment levels that can be used in setting performance targets intelligently. Transportation system investment, performance, and associated travel mobility is assessed for rural areas as well as for the country as a whole.

International infrastructure-related activities include supporting the development and dissemination of the Road Network Operations/ITS Manuals for the World Road Association, studies of infrastructure resiliency practices in Netherlands, Denmark, and Norway, exchanges with Korea on bridges and pavements, and collaboration with Japan on Intelligent Transportation Systems and environmental issues.

Innovation: This research program focuses heavily on the identification of emerging policy issues and support for the agency's development of strategies for addressing them. This includes extensive coordination among stakeholders, exploration of emerging data analytic and methodological approaches for assessing the impacts of policies and strategies, including FHWA's first use of Artificial Intelligence data fusion techniques to understand emerging travel behavior. This program takes innovative approaches to assessing the various ways in which transportation investments and economic development affect each other, including gross domestic product, employment, and land use. This research program is also exploring multi-modal geo-economic variations in transportation infrastructure costs, travel demand, and transportation services to better understand how technology and socio-economic changes may be reshaping future transportation system performance and policy opportunities. This geo-economic approach includes specific consideration of the differing travel needs of rural communities.

The Global Benchmarking Program (GBP) obtains and adapts foreign innovations that directly support DOT strategic goals and critical RD&T areas. Instead of re-creating advances already developed by other countries, the GBP facilitates the acquisition and adoption of technologies and best practices already available and used abroad. FHWA is supporting dissemination and implementation efforts of web-based versions of the Road Safety Manual and Road Network Operations /ITS Manuals. FHWA led the development of these products for the World Road Association. Bilateral program activities directly address agency priorities. The Office of International Programs works closely with FHWA Leadership, Program Offices, and the Office of the Secretary of Transportation to ensure that international topics and activities are geared to the Strategic Goals and topics. The specific areas addressed by each bilateral relationship depend on the expertise of the country involved and the interests of our partners, both internal and international. Two examples are Japan, with whom we have a long-standing collaboration on bridge and seismic issues that has been very beneficial, and the Netherlands, with whom we have collaborated on road safety, performance measurement, project acceleration, infrastructure resilience, emergency/crisis management, truck platooning and Smart Mobility.

Accountability: This program supports economic regulatory impact analyses conducted on behalf of the Office of Chief Counsel for all regulatory and deregulatory actions under consideration within FHWA. It enables more consistent and methodologically-sound application of lifecycle-cost, and related economic-impact strategic, programmatic, and project decision-making. This program's baseline forecasting also serves as an anchor for accountable strategic planning and development of measurable performance targets.

International activities in this area include collaboration with the Netherlands on emergency/crisis management.

Additional information about the planned FY20 Policy Analysis and Global Outreach R&T Program investments is presented below.

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Impact of Investment on Conditions and Performance:		Identification of cost-effective levels of investment used in legislative development. Development of performance targets for President's budget.	2020
Macroeconomic Impacts		Analysis of potential impacts of increased Federal funding consistent with the President's Infrastructure Initiative.	
Benefit-Cost Analysis	Academic and government researchers	Review of evidence from revealed preference studies of corridors with tolled express lanes showed some support for OST recommended values of travel time, but revealed need for evidence from stated preference studies to value reliability. TRB webinar presenting new fuel consumption equations generated considerable interest among attending transportation planners and modelers.	Benefit cost analysis of speed limits – 2020 Discomfort costs from rough pavement-2021

Highway Costs and Funding Options:		A framework and software requirements specification for pavement performance analysis at the national level has been established. Revenue forecasts for existing Highway Trust Fund taxes and alternative new revenue sources. Contribution to highway trust fund revenues by different vehicle classes and weight groups. The revised National Highway Construction Cost Index(NHCCI), shows a steady growth in highway construction costs over the last fifteen years, averaging 3.6% per year between 2003 and 2017.	Development of Pavement Distress Analysis and Prediction Modeling (2022) Development of a Tool for Estimating the Impacts of Toll and Priced Lanes on Travel Demand (2023)
Emerging Trends and Future Performance:	NHTSA, CDC, Office of Safety, Office of Operations (methods and variables to develop performance measures)	Researched millennial travel to assess long term effects of VMT decline for this age group. Analyzed relationship between transportation expenditures and student loan debt. Developed proof of concept for the integration/fusion of data and application of machine learning to improve key estimates of travel demand.	Spring 2019
Geo-Economics of Transportation	University research centers, national laboratories	Development of rural transportation access measures. Documentation of relationship between geography, mode choice, and travel volumes for millennials. Analysis of relationship between land use /built environment, transportation access and travel demand characteristics. Past investment has supported development of the agency's strategic planning documents and performance management tools.	August 2019

Future Policy Symposia	Similar events held by policy/research organizations and academia	Past symposia on connected communicates, smart cities, AV future scenarios, trends in industry and workers, and transportation data futures have facilitated leadership policy discussion, provided subject matter expertise on current policy issues, and supported engagement in an on-going dialogue with the transportation policy community.	White papers distributed 1-2 months after each symposium
Global Benchmarking	Other countries; the GBP benefits from the research investments of other countries	Innovative technologies and practices related to infrastructure resiliency, tunnel safety, shared mobility, and bicycle network planning	Study Reports (2019) Implementation actions (2020)
Multilateral Relations	Similar projects by other DOT modes, OST, USG agencies	Road Safety Manual, Road Network Operations/ITS Manuals, Unmanned Aircraft Systems study (to be completed), ongoing Twinning studies with EU/EC	2020, 2021 and beyond
Bilateral Relations	Similar projects by other DOT modes, OST, USG agencies	Extreme weather resilience adaptation tools, U.S.-Korea annual roads workshops, U.S.-Japan Bridge Workshops, webinars with Australia, most of them on freight-related topics, exchanges on ITS	2020, 2021 and beyond

Highway & Transportation Data

Program Description/Activities:
In 2020, the Highway & Transportation Data (H&TD) work will continue to serve as a comprehensive program of research, development, maintenance, and technology activities focused on supporting and advancing the current and future state of data collection, processing, analysis, modelling, dissemination, and visualization. The H&TD activities directly and indirectly support policy and program activities, and decisions across FHWA and the U.S. DOT, as well as data driven activities and research throughout state DOTs, MPOs, academic, the private sector, and the entire transportation community. The H&TD work also provides support to data providers at State DOTs and MPOs through policy and technical guidance development, training, and technical support. The H&TD program encompasses six key data areas covering 1) public roadway inventory, 2) travel condition including traffic volume, class, weight, speed and pavement, 3) travel behavior including why, how and when people travel, 4) fuel consumption including both gasoline and special fuels, 5) licensed drivers and registered vehicles, 6) highway financing data including local, state and Federal spending and revenue.

Statutory Requirements:
Is this program statutorily mandated (Y/N): Yes.

The highway and transportation data program are authorized by various statutes. The current FAST Act Section 6028 provides the most recent authorization to all the six areas.

In addition, The H&TD programs are directly and indirectly statutorily mandated by the following:

- 23 USC § 143 – Directly authorizes the Highway Use Tax Evasion Program, which is one of the H&TD programs.
- 23 USC § 315 - Authorizes the Secretary to prescribe and promulgate all needful rules and regulations for the carrying out of the provisions of title 23, which broadly covers the rules and regulations of the various data programs.
- 23 USC § 104 – Authorizes the apportionment factors. Several of the data programs, by their data being cited specifically as Apportionment factors, are authorized directly by this section.
- 23 USC § 503 – Directs FHWA to conduct the biennial Condition & Performance (C&P) Report to Congress. The Highway Performance Monitoring System (*HPMS*) is specifically cited in this section, and the remaining data programs are indirectly mandated since they provide needed data for the C&P Report.
- 23 USC § 103 – The HPMS is indirectly mandated, since it serves as the system of record for many of the national performance measures.
- 23 USC § 150 – The HPMS is indirectly mandated since it will soon serve as the system of record for the National Highway System.
- 23 USC § 167 – The HPMS is indirectly mandated since it will soon serve as the system of record for the National Highway Freight Network.
- 23 CFR § 420.105 (b) – Requires State DOTs to provide data that support FHWA's responsibilities to Congress and to the public.

Program Activities:

Planned 2020 program activities, and their relationship to FY19 activities are presented in the table below.

While FY20 will continue the annual cycle of data collection through improving and enhancing data collection, processing, and publishing methodologies, major emphasis will be devoted to a) piloting and deploying the outcome of the transportation finance data and information (500 Series of Data) program reassessment work and the highway performance and monitoring system (HPMS) reassessment work, b) implementing the new calendar year 2020 national household travel survey (NHTS) including the collection of passenger origin destination data, and c) complete the FHWA Policy Data Portal piloting with emergency relief program.

FY20 FHWA Highway and Transportation Data Activities

Activity	Relationship to FY19 Activities
Deliver the National Performance Management Research Dataset (NPMRDS) program	FY20 will start the new data collection cycle. The FY20 data format will be compatible with the FY19 data ensuring trending analysis can be carried out. The geospatial integration component will be built upon FY19 deliverables. Efforts on geospatial data integration will be significantly less.
Deliver the Highway Performance Monitoring System (HPMS) program	Continue to deploy the HPMS new data IT enhancements completed in FY19 with State DOTs. Start the 2020 HPMS data collection cycle.
Carry out the Traffic Monitoring and Traffic Data program	Start to process truck weight data for roadway loading tracking through the FY19 established weight data processing codes. Continue to generate the monthly TVT reports.
Implement the All Road Network of Linear Referenced Data – Infrastructure Inventory work	Continue the FY19 build up and complete all States and DC data and information. Deliver a national integrated network.
Carry out Other Section 6028 and Section 150 of USC 23 data program	Deploy the FY19 completed pilot on finance data collection with all state DOTs and other state agencies.
Conduct National Household Travel Survey	Deploy methods developed in FY19 to carry out actual data collection and processing
Collect Travel Behavior Data - a critical subset of the NHTS data	Deploy methods developed in FY19 to carry out actual data collection and processing
Develop and deploy Specialized Performance Management Data	Deploy methods developed in FY19 to carry out actual data collection and processing and piloting Policy Data Portal with emergency relief data program
Enhance and deploy the Integrated Transportation Analysis Platform (ITIP)	Deploy the ITIP with all FHWA division offices and continue to train Division offices for its application.

Improve Data Quality and Technical Guidance	Continue to improve and deploy new technologies, process and procedure oriented simplification for quality data and timely data.

Program Alignment with DOT Strategic Goals:

Safety: The H&TD program contributes directly to highway safety and the Department's Systematic Safety Approach by providing mission critical exposure data on: personal and commercial travel; highway system performance and use; traveler demographics and use; weigh-in-motion and vehicle classification; vehicle registrations; and licensed drivers. The H&TD program continues to enhance and employee innovative tools and techniques for analyzing, visualizing, and disseminating transportation data to support Department-wide Safety programs.

Infrastructure: The H&TD program provides mission critical data on the nation's infrastructure to support the delivery of the Federal-Aid program, Performance Management, and a number Agency-wide programmatic needs. These data include: highway system condition, performance, and use; personal and commercial travel; traveler demographics and use; weigh-in-motion and vehicle classification; and highway finances. The program continues to enhance training and support for data providers, while also expanding the tools and techniques used to quality check, analyze, visualize, and disseminate past, present and future data. Several of the data programs are undergoing reassessments to ensure their ability to meet current and future Department-wide needs.

Innovation: The H&TD program continues to be a hotbed for testing and deploying new technologies and techniques for data analysis and visualization. The program developed and deployed the first Agency-wide data warehouse, which is currently being moved to the cloud. The program also developed a generic data portal using commercial off the shelf software (COTS) for any program or office to use for collecting form based data, thus eliminating the need to build new systems every time an office or program wants to collect new data. The program manages the Data Visualization Center (DVC), which is an Agency-wide service providing: customized data visuals; assistance with existing data visualizations; and consulting services. Since its inception, the DVC has received over 135 requests for services from 29 Offices throughout FHWA and the U.S. DOT. In addition, on the data application front, significant effort has been devoted to cooperate and partner with private businesses on adopting and using private data.

Accountability: The H&TD program serves a critical role in implementing the Transportation Performance Management (TPM) requirements of MAP-21 and the FAST-Act which were codified in 23 USC § 103. The HPMS serves as the system of record for the travel, pavement, National Highway System (NHS), adjusted urbanized boundaries, and speed data. The Integrated Transportation Information Platform (ITIP), which is the name of the data warehouse, will serve as the central repository for all TPM data. The program also provides information on how much States and Locals spend annually on transportation, by various categories of improvements including but not limited to: capital improvements; restoration and rehabilitation; maintenance; and safety.

Additional Information About Planned FY20 FHWA Highway and Transportation Data Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
National Performance Management Research Dataset (NPMRDS)	State DOTs	The NPMRDS data developed are reliable and functional. All State DOTs except 6 rely fully on this data product delivered by FHWA's research effort. These 6 states may also switch back to the FHWA method and data later.	1/20/2021 Travel time data for all the NHS roadways for each of the 12 months in a calendar year.
Highway Performance Monitoring System (HPMS)	All State DOTs	A consistent national program of roadway inventory data and traffic data is critical to the success of State DOTs' and FHWA's highway program. The continued enhancement and deployment of new technology within HPMS is needed to ensure it continues to meet the needs of FHWA and the U.S. DOT.	8/15/2021 A set of quality highway performance data sets covering inventory, annualized traffic, and pavement condition data
Traffic Monitoring and Traffic Data	AASHTO State DOTs TRB	Updates to the Traffic Monitoring Guide in the era of rapid technology changes is critical. Private sourced data must be studied and evaluated for its potential to fundamentally change how traffic monitoring is carried out.	2/28/21 Monthly publication of the Traffic Volume Trend on highway usage

All Road Network of Linear Referenced Data – Infrastructure Inventory	State DOTs	The ARNOLD network is in high demand for a host of reasons including safety exposure analysis and performance management. The guidance must be updated and data collection must be continued to have a complete national inventory.	12/30/2020 A comprehensive and integrated highway system network data
Other Section 6028 and Section 150 of USC 23 data	State DOTs	Modern information technology tools must be used to process such data to improve efficiency. Also, data collected must be assessed for their adequacy and usefulness on a periodic basis.	8/20/2021 Annual licensed driver, registered vehicle, fuel consumption, state, local, and federal finance data
National Household Travel Survey	BTS MPOs, State DOTs, AASHTO TRB	The traditional Random Digit Dialing (RDD) method for the NHTS data collection does not work effectively any more given the rapid disappearance of landline phones. The address based sampling (ABS) method, with accompanying smart phone app, has proven to be reliable replacement to the traditional RDD method. Privacy protection, data aggregation, and reverse engineering are being researched.	4/20/2021 National travel behavior data on why, how and when people travel and trending information. State and local specific travel behavior data and information
Travel Behavior Data - a critical subset of the NHTS data	MPOs, State DOTs, AASHTO	The historical NHTS data lacks origin destination (OD) information. New data collection will include the OD data. The utilization of passively collected data (e.g., cellular, LBA based GPS and navigation based GPS) will be explored as an efficient method to collect OD data.	2/28/2021 National passenger origin destination data
Specialized Performance Management Data	State DOTs, AASHTO	Current research shows that crash data and FARS data can be analyzed along with the NHTS data to gain statistically valid VOF data (passenger household vehicle) at urban area level geography. However, methods for trucks and buses VOFs are still unclear.	12/30/2020 Vehicle occupancy data for every State and each of the urban areas identified by Census.

Enhance and deploy the Integrated Transportation Analysis Platform (ITIP)	NHTSA CDC	ITIP improves an analyst's ability to analyze data in a linked fashion. It reduces the time analysts may need to spent to link data and perform some of the analysis otherwise may not be possible.	12/30/2020 A functional and deployed on-line data analysis system for the entire agency
Improve Data Quality and Technical Guidance	State DOTs, MPOs, TRBs, AASHTO TRB	This area is the most productive given it is guidance and methods. New and improved methods and guidance often result more efficient program.	12/30/2020 Updated guidelines and methods as related to data collection

Every Day Counts (*On-Ramp to Innovation*) Program

Program Description/Activities:
The Every Day Counts (EDC) Program is a State-based program that identifies and rapidly deploys proven, yet underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce traffic congestion, and improve environmental sustainability. Proven innovations promoted through EDC facilitate greater efficiency at the State and local levels, saving time, money and resources that can be used to deliver more projects.

In FY 2020, FHWA will be advancing the fifth 2-year, round of the EDC program (EDC-5 calendar year 2019 to 2020). Also in FY 2020, FHWA will solicit Stakeholder and Public comments and suggestions on round six.
Key FY20 FHWA EDC Activities

Activity	Relationship to FY19 Activities
Deployment of EDC-5 Innovations	Continuation of activities started in FY19 (2nd year of two-year EDC deployment cycle)
Planning for EDC-6 roll-out	Selection of innovations for next two-year deployment cycle; some initiatives may be continued from EDC-5 or leverage ongoing efforts

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

The EDC Program accelerates the deployment of innovations that support all four goals of the DOT Strategic Plan. In addition, many of the innovations advanced under this program have had a significant positive impact on rural communities.

Additional Information About Planned FY20 EDC Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Deployment	N/A	Documentation and information sharing: best/noteworthy practices, lessons learned, and other information exchange with program stakeholders	Ongoing

State Transportation Innovation Council (STIC) Incentive Program

Program Description/Activities:
The FHWA State Transportation Innovation Council (STIC) Incentive program provides resources to help foster a culture for innovation and make innovations standard practice in their States. Through the program, funding up to $100,000 per State per Federal fiscal year is made available to support or offset the costs of standardizing innovative practices in a State transportation agency or other public sector STIC stakeholder.

In FY 2020, FHWA will continue the STIC Incentive program, providing additional grants to States to continue to foster a culture of innovation and make innovations standard practice.

Key FY20 FHWA STIC Activities

Activity	Relationship to FY19 Activities
Management of STIC Incentive Program	Continuation
National STIC Network Meetings	Continuation

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The STIC Incentive Program supports all four goals of the DOT Strategic Plan. In addition, many of the innovation advanced under this program have had a significant positive impact on rural communities.

Additional Information About Planned FY20 STIC Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Completion of STIC Incentive projects by funding recipients	N/A	Documentation and information sharing: best/noteworthy practices, lessons learned, and other information exchange with National STIC Network	Ongoing

Accelerated Innovation Deployment (AID) Demonstration Program

Program Description/Activities:
For FY 2020, the administration of the AID Demonstration Program will continue as in previous years. With a new series of innovations to be spotlighted in the fifth cycle of the Every Day Counts Program (Calendar Years 2019-2020), it is anticipated that transportation agencies will begin to apply for grants that incorporate these innovations into their projects.

Key FY20 FHWA AID Activities

Activity	Relationship to FY19 Activities
Management of AID Demonstration Program	Continuation
Preparation of new Notice of Funding Opportunity (NOFO)	Current NOFO for the program runs through FY 2020; new NOFO will re-establish parameters for program applicants beginning in FY 2021.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

In FY 2020, the AID Demonstration Program will continue to support the DOT's Strategic Goals and/or the Strategic Objectives under each of these goals. The sustained demand for AID Demonstration grant awards clearly shows the steady demand for adopting proven market-ready innovations into the way States and local transportation agencies do business and the need for the related technology transfer activities.

Additional Information About Planned FY20 AID Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Completion of AID Demonstration projects by awardees	N/A	Documentation and information sharing: best/noteworthy practices, lessons learned, and other information exchange with stakeholders	Ongoing

Accelerating Market Readiness (AMR) Program

Program Description/Activities:
The AMR Program in FY 2020 will continue to support promising new or underutilized innovations that have the potential to be considered for accelerated deployment. FHWA will track and monitor activities underway through the awards made under the first BAA. It is anticipated that FHWA will issue a second BAA to solicit innovations from transportation stakeholders to continue the successes being achieved with the first round of AMR awards. In addition, FHWA will continue to incorporate suggestions from within the agency for participation in AMR activities.

Key FY20 FHWA AID Activities

Activity	Relationship to FY19 Activities
Management of AMR Program	Continuation
Issue a 2nd Broad Agency Announcement	Continued solicitation of innovations from all transportation stakeholders

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

In FY 2020, The AMR Program will continue to support the Department's Safety, Infrastructure, Innovation and Accountability Strategic Goals, and contribute to all DOT RD&T Critical Transportation Topics.

With the anticipated issuance of a second BAA, FHWA may refine the scope to seek proposals that would better support topics that might have been underrepresented after the 2018 BAA.

Additional Information About Planned FY20 AMR Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Completion of activities funded from initial AMR Broad Agency Announcement and internal FHWA initiatives	TBD	Documentation of assessments of AMR funded innovations	Ongoing

Innovative Program Delivery

Program Description/Activities:
Innovative Program Delivery (IPD) provides tools, training and technical assistance that support the transportation community's use of cutting-edge financial and procurement strategies to deliver critical infrastructure projects. FHWA's efforts in this area are primarily led by the Center for Innovative Finance Support (CIFS), whose products are often marketed and deployed under the brand of the Secretary's Build America Bureau. These research and technology deployment efforts focus on revenue generation (tolling and value capture), procurement (public-private partnerships and other alternative contracting methods), and innovative finance (Federal project finance tools such as GARVEE Bonds and State Infrastructure Banks). Support for our partners include (1) technical resources, guidebooks and analytical tools, (2) capacity building and outreach, and (3) technical assistance for project implementation.
Technical resources:

- Public policy research into how transaction costs of P3s can be controlled for projects smaller than typically thought suitable for this delivery model. This would build on the growing recognition among public agencies that P3s – as a delivery mechanism instead of a funding solution – have potential for broad and creative application beyond the mega-project, but their high transaction costs (relative to other ACMs) may inhibit use.
- Refinements to FHWA's Value for Money educational tool, P3-VALUE, based on feedback from the community of users that have adopted the tool since its launch in 2015.
- A suite of best practice tools for public agencies to use when evaluating ACMs for project delivery.

Capacity building activities:

- Training for state and local partners on the appropriate use of Federal project finance tools, with an emphasis on opportunities for rural communities.
- Financial and organizational support for the Center for Excellence in Project Finance (CEPF) via a cooperative agreement to be awarded per a new competitive solicitation. The current CEPF, the BATIC Institute: An AASHTO Center for Excellence, offers a program of training, sharing of best practices, and technical assistance to all State Departments of Transportation and their local partner agencies.
- Intensive training for public project sponsors on critical aspects of public-private partnerships (P3s), including life-cycle cost comparisons between alternative delivery methods (Value for Money analysis), model contract provisions for long-term concession agreements, and best practices for competitive procurements. Each training course is based on material developed by the CIFS in recent years with research funding.
- Training for state and local partners on best practices for achieving efficiencies of scale on multiple small projects, such as bridges, via their "bundling" into consolidated design and construction packages. This training is based on research funded via FHWA's Accelerated Market Readiness program.
- Training for state and local partners on best practices for the successful implementation of "value capture" techniques to help finance transportation projects via the incremental property value generated by the project itself. This training would be based on research funded in FY 2019.

Technical assistance activities:

- Project-specific assistance to public sponsors assembling financial plans for Federal-aid projects. Building on research conducted in FY 2018, the CIFS will focus on opportunities for using SIBs to enable local and rural communities to finance the non-Federal share of project costs, which can present an inordinate challenge for small public budgets.
- Project-specific assistance to public sponsors implementing a P3 delivery method for a project seeking credit assistance via the TIFIA loan program and/or Private Activity Bonds (PABs). All such assistance would be coordinated through the Build America Bureau (see below) as established via the FAST Act.

Key FY20 FHWA Innovative Program Delivery Activities

Activity	Relationship to FY19 Activities
Discussion paper on the impact of P3 transaction costs for smaller projects.	This will build on FY 19 research on P3 office structures in State DOTs.
Refinements to P3-VALUE, based on feedback from user community.	P3-VALUE, the keynote of FHWA's P3 Toolkit, was developed in FY 14 and refined continually since.
Best practice tools for public agencies to use when evaluating ACMs for project delivery.	Synthesizes the findings from State research grants and technical assistance in FY 19.
Federal project finance tools training for State, local and rural communities.	This ongoing activity has been a responsibility of the OIPD since FY 09.
Center for Excellence in Project Finance (CEPF), Year 2 of 4.	First of three option years for cooperative agreement executed in FY 19
P3 intensive training for public sponsors.	This ongoing activity has been a responsibility of the OIPD since FY 15.
Project bundling training for state and local partners.	Second year of training effort begun in FY 19.
Training on best practices for successful implementation of value capture.	Second year of training effort begun in FY 19.
Project-specific financial assistance to State, local and rural communities.	This ongoing activity has been a responsibility of the OIPD since FY 09.
Project-specific assistance to P3s seeking TIFIA and/or PABs.	This ongoing activity has been a responsibility of the OIPD since FY 09.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure
Innovation	Improving mobility

Infrastructure: Construction and maintenance of critical national infrastructure lies at the core of the IPD mission. The condition and performance of our nation's roads, bridges and tunnels demand that State and local agencies spend more on infrastructure than their budgets allow. Scarce Federal funds, therefore, must be used efficiently to attract both public and private investors. In looking at rural communities, FHWA seeks to emulate Federal financing programs in sectors such as agriculture and housing, which play significant roles in rural development. Research into FHWA financing opportunities to leverage local participation in Federal-aid projects may open doors for this type of assistance.

Innovation: Regardless of how it is funded or financed, infrastructure will always require proficiency in project delivery. The IPD research on public agency best practices in evaluating innovative (alternative) contracting methods seeks to expand the range of appropriate delivery methods among all States. Alternative contracting methods typically are used less frequently in States with a higher proportion of rural communities, which could benefit from access to contracting approaches that enhance quality as well as cost and schedule reliability.

Additional Information About Planned Innovative Program Delivery Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Technical Resources	Universities (world-wide)	State and local agencies are more willing to employ innovative finance tools when appropriate resources are available.	Ongoing
Capacity Building	Non-profit and for-profit educational entities	State and local agencies turn over professional staff and expertise regularly. Agencies that have used innovative finance tools are always interested in training when new staff takes over responsibilities.	Ongoing
Technical Assistance	Private sector consultants	Complex projects typically require technical assistance from many sources. Federal assistance doesn't duplicate private sector consultants, who can effectively "socialize" Federal requirements among multiple clients.	Ongoing

Research Infrastructure, Technology Transfer and Partnerships

Program Description/Activities:
The FHWA Research Infrastructure Program supports the goals of the USDOT to invest strategically in transportation infrastructure, promote safe and secure transportation, enhance our environment, and create new alliances between the nation's transportation and technology industries. The program monitors legislative developments, helps to coordinate the R&T budget allocation, manages the research agenda development process, maintains the Turner Fairbank Highway Research Center, organizes strategic Research and Technology (R&T) investment, and provides marketing and outreach. The overarching role is to coordinate all elements that support and promote the highway R&T agenda to ensure the FHWA R&T program addresses national needs, meets future demands, and maximizes the strengths of all research entities. This R&T agenda is stakeholder driven, with partners engaged throughout the entire innovation lifecycle process, from agenda setting and planning, through the research, technology development, and innovation deployment phases, to the implementation and assessment stages. The Research Infrastructure, Technology Transfer, and Partnerships Program supports these coordinated efforts across all other Programs.

In addition to supporting R&T development and deployment activities, the Research Infrastructure, Technology Transfer, and Partnerships Program promotes communication, coordination, and collaboration with FHWA's partners, which are crucial to conducting the right research, doing it well, and delivering solutions when and where they are needed. Communication strategies address the needs of internal and external audiences and cover the depth and breadth of the federal effort for highway research and technology, displaying prudent use of government resources, advancing the state of the practice, and building a case for continued and future funding.

The Research Infrastructure, Technology Transfer, and Partnerships Program will build upon the activities in FY19 on multiple fronts. There will be continued work to identify opportunities to enhance communication, outreach, and sharing of information with our State, local, national, and international partners. The program will focus on strengthening the feedback loops in the Innovation Lifecycle and offering new services that move early-stage innovations from the laboratory to the field. The Research Infrastructure, Technology Transfer, and Partnerships Program will also implement elements of the new TFHRC master plan to enhance the research infrastructure in support of the Agency and Departmental goals. Additionally, the program will work with the Department to identify emerging priorities and resource needs in preparation for the next authorization bill.

Key FY20 FHWA Research Infrastructure, Technology Transfer, and Partnerships Program Activities

Activity	Relationship to FY19 Activities
Evaluate multi-level decision-making tools to support R&T investment opportunities	Build from the FY19 effort to prioritize, strategically plan, and allocate FHWA R&T resources.
Analyze FHWA project management system with USDOT Research Hub	Final analysis will inform decision making for future actions of the FHWA project management database

Analyze ROSA P database for potential enhancements that will improve customer searches and results.	Better search and results for FHWA customers using the ROSA P database.
Develop partnerships to access external research infrastructure	Continue efforts from FY19 to build partnerships that are beneficial to both sides

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

The FHWA Research Infrastructure, Technology Transfer, and Partnerships Program supports all DOT Strategic goals and Critical Transportation Topic Areas. This Program leads the development and coordination of a national highway research agenda to close critical knowledge gaps, identify collaboration opportunities, and accelerate innovations and technology deployment. To accomplish this, the Research Infrastructure, Technology Transfer, and Partnerships Program coordinates with and supports all other R&T programs, thereby aligning with the respective strategies of those Programs.

Additional Information About Planned FY20 Research Infrastructure, Technology Transfer, and Partnerships Investments is provided below. Note that no others are conducting research in these areas.

Activities	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Manage communications, publications, and web content	Supports technology transfer and information sharing with R&T partners	On-going
Manage FHWA-wide R&T corporate activities	Provides overall budget and legislation support to the FHWA R&T program and produces program evaluation and strategic planning opportunities	On-going
Laboratory and research infrastructure upgrades and maintenance.	Supports essential research needs including laboratory upgrades that supports research, which aligns with strategic needs. Maintains critical research infrastructure needs including laboratory space and IT needs.	On-Going
Knowledge Management	Provides collaboration opportunities that reduces cost associated with travel and	On-Going

	supports flexible information sharing with R&T partners	

Small Business and Innovation Research

Program Description/Activities:
The SBIR program is a highly competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT. The SBIR program favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, State DOTs, USDOT, or other federal agencies.

The program is administered by the Volpe Transportation Center. The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations, including the FHWA.

Planned 2020 FHWA SBIR Program activities, and their relationship to FY19 activities are presented in the table below.

Key FY20 FHWA SBIR Program Activities

Activity	Relationship to FY19 Activities
Review and prioritize funding for the most promising SBIR innovations	Projects funded in FY19 will be reviewed and considered for further funding in FY20 to advance the technology or innovation toward commercialization.
Implement a formalized TRL assessment program	Following a review of the FY19 TRL pilot program, a formalized, on-going program will be implemented.

Program Alignment with Strategic Goals:
The SBIR program solicits research and technology topics from all FHWA R&T offices annually, including the ITS Joint Program Office. Topics are selected based on the merit, suitability for the SBIR program, as well as consideration of alignment with Agency and Departmental goals. As a result, the SBIR program supports all of the FHWA R&T program offices and, by extension, all of the USDOT Strategic goals.

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility
Accountability	

Additional Information About Planned FY20 SBIR Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Review and prioritize funding for the most promising SBIR innovations	N/A	The phased approach for funding SBIR projects has been shown to be successful at moving technologies toward commercialization	On-Going
Implement a formalized TRL assessment program	N/A	Other programs, including the FHWA EAR program, have noted beneficial impacts on the development of technologies through an independent assessment of technological maturity.	On-Going

Exploratory Advanced Research

Program Description/Activities:
The EAR Program continuously considers new topics based on knowledge gained from current research investments, external technology scouting, and engagement with experts within and beyond the transportation community. The EAR Program generally does not invest in the same topic area from one year to the next but may return to a topic that continues to warrant additional exploratory research after a full cycle of investment, which generally is two to four years.

Key FY20 FHWA EAR Program Activities

Activity	Period of Performance	Partners/Notes
Initial Stage Investigations	FY 2020	Continue to engage partners broadly from within and outside the highway transportation industry to seek, screen, and scope for emerging, unexplored advances in science and technology
Sponsored Breakthrough Research	FY 2020-FY 2023	Continue to manage the existing portfolio and start research in new topics to provide a continued source of innovation into the highway research pipeline
Transition of Research Results	FY 2019- FY 2020	Continue to screen the Program portfolio of current projects to identify potential high impact results and focus transition of those results into applied research programs and demonstrations

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure Preserving the environment
Innovation	Improving mobility

Additional Information About Planned FY20 EAR Program Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
Connected Highway and Vehicle System Concepts —This focus area emphasizes the longer term needs to reach critical FHWA safety and mobility goals by developing the theory for and assessing the feasibility of systems that leapfrog current technological approaches for linking infrastructure with future vehicle and personal mobility technology.	Partner with NSF, Dept. of Energy, Dept. of Defense and industry	Leverage results from funded research ending in FY 2018 and FY 2019	Transition proof of concepts to applied research in government and industry in FY 2020 and FY 2021
Breakthrough Concepts in Material Science —This focus area leverages new approaches in materials science to produce innovative new highway materials with characteristics that enable enhanced functionality (including multi functionality), constructability, sustainability, cost effectiveness or operating characteristics of highway infrastructure and system monitoring sensors to enhance highway safety, reliability, and resilience.	Partner with NIST, Army Corps of Engineers and industry	Leverage results from funded research ending in FY 2018 and FY 2019	Translate new material models and characterization techniques from research to engineering tools in FY 2020 to FY 2022
Human Behavior and Travel Choices —This focus area leverages research concepts from the social sciences, including psychology and economics, along with more traditional research for improving safety, reducing congestion, and improving the livability of the Nation's communities.	Coordinate with NSF	Build on results from research ending in FY 2018 and FY 2019	Provide access to data and tools to other researchers in academia, industry, and government in FY 2020 and FY 2021. Support transition of tools to FHWA programs where appropriate in FY 2020 and FY 2021

Technology for Assessing Performance — This focus area seeks novel approaches and breakthrough technology that will revolutionize the use of performance management in the highway sector.	Coordinate with State DOTs and other asset owners	Build on results from research ending in FY 2018 and FY 2019	Work with State DOTs and industry to transition and scale results in FY 2020 and FY 2021.
New Technology and Advanced Processes for Energy and Resource Conservation —This focus area cuts across infrastructure, operations, and societal and complex natural systems that support innovative methods for reducing highway industry costs and provide alternative to virgin materials.	Coordinate with State DOTs and materials suppliers		

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)

Program Description/Activities:
The Advanced Transportation and Congestion Management Technologies Deployment Initiative (ATCMTD) Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. As the program is aimed at the rapid deployment of advanced technologies, limited expenditures for infrastructure construction is anticipated in grant application. The stated purpose is to reduce costs and improve return on investments; deliver environmental benefits through increased mobility; improve transportation system operations; improve safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and autonomous vehicle technologies. Successful proposals will contain quantifiable system performance objectives, use innovative technologies and strategies, and a plan for long term operation and maintenance of the deployed technologies. Partnering between the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders is encouraged.

Key FY20 FHWA ATCMTD Program Activities

Activity	Relationship to FY19 Activities
Selection of FY20 grant awards and timely implementation of projects	Continuation of the program with new funding opportunity
Continue award of FY 19 grants and manage FY16, FY17, FY18, and FY19 projects	Implementation of the ATCMTD program for FY16 – FY20

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety	Promoting safety
Infrastructure	Improving Infrastructure
Innovation	Improving mobility

Goals for the ATCMTD Program are directly linked to DOT's Strategic Goals and DOT RD&T Critical Transportation Topics and include:

- Reduced costs and improved return on investments, including through the enhanced use of existing transportation capacity (Infrastructure)
- Delivery of environmental benefits that alleviate congestion and streamline traffic flow Preserving the Environment)
- Measurement and improvement of the operational performance of the applicable transportation networks (Improving Mobility)
- Reduction in the number and severity of traffic crashes and an increase in driver, passenger, and pedestrian safety (Safety)

- Collection, dissemination, and use of real time transportation related information to improve mobility, reduce congestion, and provide for more efficient and accessible transportation, including access to safe, reliable, and affordable connections to employment, education, healthcare, freight facilities, and other services (Improving Mobility)
- Monitoring transportation assets to improve infrastructure management, reduce maintenance costs, prioritize investment decisions, and ensure a state of good repair (Improving Infrastructure)
- Delivery of economic benefits by reducing delays, improving system performance and throughput, and providing for the efficient and reliable movement of people, goods, and services (Improving Mobility)
- Accelerated deployment of vehicle-to-vehicle, vehicle-to-infrastructure, and automated vehicle applications, and autonomous vehicles and other advanced technologies (Innovation)
- Integration of advanced technologies into transportation system management and operations (Innovation)
- Demonstration, quantification, and evaluation of the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, and sustainable movement of people and goods (Safety, Improving Mobility)
- Reproducibility of successful systems and services for technology and knowledge transfer to other locations facing similar challenges (Innovation)

Per the FAST Act, awards have been made for FY 2016 and 2017 and grantees are just beginning to provide their quarterly reports (annual report deadlines have not yet occurred). The ATCMTD Program is funded for FY 2016 – 2020.

Additional Information About Planned FY20 Structures R&T Investments

Activities	Others Conducting Research in this Area	Findings from Past Investment	Projected Delivery Date for Tangible Outcomes
N/A	N/A	N/A	FAST Act requires the Secretary to post on the DOT website a report on the effectiveness of grant recipients in meeting their projected deployment plans by May 2020.

Surface Transportation System Funding Alternatives Program

Program Description/Activities:
Section 6020 of the Fixing America's Surface Transportation (FAST) Act, Pub. L. No. 114-94, authorizes the Secretary of Transportation to establish the Surface Transportation System Funding Alternatives (STSFA) Program. The STSFA Program purpose is to provide grants to States to demonstrate user based alternative revenue mechanisms that utilize a user fee structure to maintain the long-term solvency of the Highway Trust Fund. In Fiscal Year (FY) 2016, $15 million was available and $20 million annually from FY 2017 through 2020 will be made available for multiple demonstration projects. These grants will make up no more than 50 percent of total proposed project costs, with the remainder coming from non-Federal sources. Further, on August 1 of each year, if there are insufficient grant applications that meet program requirements, any excess funds must be transferred back to FHWA.

Key FY20 FHWA STSFA Program Activities

Activity	Relationship to FY19 Activities
Selection of FY20 grant awards and timely implementation of projects	Implementation of the STSFA program for FY16 – FY20
Publish NOFO to solicit for 2020 STSFA grants and review applications	Conduct outreach to attract potential applicants

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Innovation	Improving mobility

Goals for the STSFA Program are directly linked to DOT's Strategic Goals and DOT RD&T Critical Transportation Topics and include:

- Reduced costs and improved return on investments, through the identification of an alternative revenue source capable of funding costs of infrastructure improvements (Infrastructure);
- Charging by the mile reveals to users how much they drive which could impact driver behavior. Research suggests that it leads to some people driving less which is an environmental benefit that alleviates congestion and streamlines traffic flow (Preserving the Environment);
- The information collected from drivers provides them Collection, dissemination, and use of real time transportation related information to improve mobility, reduce congestion, and provide for more efficient and accessible transportation, including access to safe, reliable, and affordable connections to employment, education, healthcare, freight facilities, and other services (Improving Mobility);
- Integration of advanced technologies into transportation system management and operations (Innovation);

- Reproducibility of successful road user charge deployments including the services offered by vendors for technology and knowledge transfer to other locations facing similar challenges (Innovation).
- *What problem will be addressed?* The purpose of the program is to identify strategies that could supplement or replace the gas tax. Gas tax revenues are used to sustain the highway trust fund. The federal gas tax rate has not been raised in over a decade while vehicles have become more fuel-efficient and automakers have introduced electric vehicles. EVs do not pay a gas tax.
- *Why should we pursue (or invest in) this research?* STSFA is not a research program, rather it is a discretionary grant program, established in the FAST Act, that receives its funding through several FHWA research programs
- *Who else is researching this issue? N/A*
- *Have we invested in this topic in the past and what have we learned to date?* In accordance with the FAST Act, awards to date have been made for FY 2016 and 2017 and grantees are just beginning to provide their quarterly and annual reports.
- *What is the projected time of completion for a tangible outcome?* The STSFA Program funding is from FY 2016 – 2020.

Additional Information About Planned FY20 STSFA Investments

Activities	**Others Conducting Research in this Area**	**Findings from Past Investment**	**Projected Delivery Date for Tangible Outcomes**
Pilot deployments	N/A	N/A	Under the FAST Act, FHWA is also required to produce a biennial report on the demonstration activities carried out under the STSFA program, and to make that report publicly available on the Internet. The annual reports from States receiving funding under the program will provide the primary inputs for the biennial reports.