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Bumper to Bumper: The Need for a National Surface Transportation Research Agenda

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Written Testimony

*The Vital Federal Role in Meeting the Highway Innovation Imperative*

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Chairwoman Stevens and Ranking Member Baird. I'm honored to be invited to testify today on the critically important topic of this hearing. I am the Assistant Commissioner for Modal Planning and Program Management in the Minnesota Department of Transportation and also serve as chair of the Research and Technology Coordinating Committee (RTCC) of the Transportation Research Board of the National Academies of Sciences, Engineering, and Medicine. The National Academies has released a report this morning prepared by the RTCC and entitled *The Vital Federal Role in Meeting the Highway Innovation Imperative*. My testimony this afternoon is based on this report.

I understand from my invitation that “the purpose of today’s hearing is to review the Department of Transportation’s surface transportation research, development, and demonstration and technology transfer activities, examine research provisions of the FAST Act, and explore the need for a national surface transportation research agenda.” Our report covers four of the research, development, and technology transfer (RD&T) programs authorized in the FAST Act: the Federal Highway Administration (FHWA) RD&T program, the Intelligent Transportation Systems (ITS) program managed by the USDOT Joint Program Office, the State Planning and Research program, and University Transportation Centers Program.

The RTCC was established in 1992 to advise FHWA on its RD&T. Thus, our focus is on highway research, but, as described in my following testimony, our review of FHWA’s program would not be complete without also reviewing the other major federally funded RD&T programs addressing highway and highway-related R&D. Our report covers all three elements of the purpose for today’s hearing and I will comment on each of them after summarizing our report.

## **BACKGROUND AND CONTEXT**

To set the context for our report, we note that rapidly advancing technology, new mobility services, increased urbanization, and the growing frequency of severe weather events are changing highway transportation in fundamental ways. Coupled with rising travel demand, growing traffic congestion, more than 35,000 annual motor vehicle fatalities, and constrained highway funding, these developments are causing state and local governments to depend increasingly on innovations to maintain, repair, modernize, and operate their heavily used and aging highway assets. This report assesses whether the FHWA and ITS JPO programs are helping state and local governments meet this innovation imperative.

To make this assessment, our report focuses on whether FHWA and ITS JPO programs are responsive to key criteria for RD&T in support of innovation as set forth by Congress. The report documents how the two programs are meeting these criteria and fulfilling their roles in delivering critical innovations to state and local governments. However, the report also explains why even more capable, effective, and responsive RD&T programs are needed.

## KEY FINDINGS

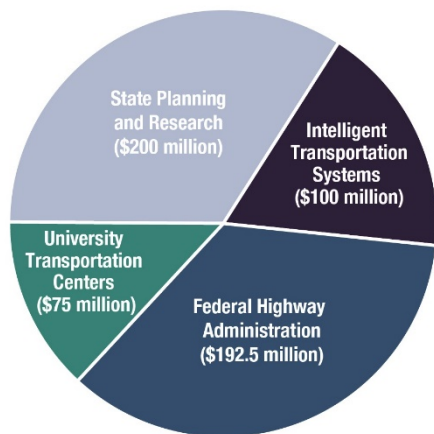
Our most important findings are that:

- 1. FHWA and ITS JPO RD&T programs are meeting the criteria established for them by Congress. They are effective, strategically organized programs that are helping states and local agencies meet the innovation imperative to improve highway system safety and performance.**
- 2. Addressing emerging and fast-changing critical issues in transportation is making RD&T even more vital than before, but the ability of FHWA and ITS JPO to fully respond is constrained by available resources for RD&T investments.**

Because they move the dominant share of freight and passengers, highways affect almost all aspects of the economy, society, and daily lives of Americans. These effects are highly beneficial but also involve costs. An ongoing stream of innovations is needed for the public-sector owners and operators of the nation's highways to maximize these benefits and minimize these costs. Because of the broad impacts of highways, the investments in innovation must likewise be broadly-based. The innovations must contribute to demands as diverse as increasing traffic safety, highway operating performance, environmental protection, resilience, asset management, technological advancement, materials durability, and sources of funding, among many others.

The federal government has a compelling interest in promoting innovation in highway transportation. FHWA and ITS JPO discharge this interest in highways, in part, by promoting innovation by the 50 states and nearly 40,000 local governments that own and operate highways. Private-sector innovation is also important, but it can be hindered by the many barriers to innovation in the public sector. These barriers include aversion to risk by asset owners, the "low bid" contracting process, limits on the use of proprietary and patented products, and others.

Annual federal investments in highway-related RD&T to foster public-sector innovation are spread across four major programs authorized by Congress: FHWA RD&T, ITS JPO, State Planning and Research (SP&R), and University Transportation Centers (UTCs) (see Figure 1). The annual level of RD&T funding represents 0.3 percent of annual expenditures across all levels of government on roads and highways. This level of investment is even more modest compared with the importance of highways to individuals, society, and the economy.



**FIGURE 1 Authorized federal highway-related RD&T by program (Fiscal Year 2017).**

## **RESPONSIVENESS TO CONGRESS**

In 23 USC 502(a), Congress has set forth several criteria that FHWA and ITS JPO RD&T must meet to foster innovation in highway transportation. Among these criteria, the committee focuses on allocating RD&T resources appropriately across the full innovation cycle, addressing gaps not covered by other programs, and conduct of research on nationally significant topics. In assessing whether the FHWA and ITS JPO programs are meeting these congressional criteria, the committee does so in the context of the two other federally funded, highway-related RD&T programs because of their interrelationships and the similarity of topics addressed.

### **Full Innovation Cycle**

Although innovation is often a non-linear, serendipitous process, innovation in the highway sector can be delineated in five stages: research, development, testing, technology transfer, and evaluation. These stages overlap and interrelate. Evaluation needs to apply to all of the stages in order for continuous improvement to occur in the fostering and delivery of innovation.

Consistent with the requirements of Congress, FHWA and ITS RD&T activities span the full innovation cycle. Almost 60 percent of FHWA's/ITS JPO's RD&T funding is allocated to applied research and development (R&D) according to FHWA and JPO estimates, although it appears that some of these funds could also be classified as pilot testing and technology transfer. FHWA and ITS JPO classify just more than 40 percent of their RD&T funding as technology transfer, although it appears that share could be even larger based on the how program areas are described by FHWA and ITS JPO. The committee's reading of the nature of the work funded in the R&D category suggests that the overall RD&T resource allocation is actually more heavily weighted toward technology transfer than R&D. Given that it generally costs more to promote innovation in the public highway sector than to develop it, such emphasis on technology transfer appears appropriate.

### *Fundamental Research*

Congress has also specified that FHWA's RD&T should include "fundamental, long-term research" to assist in the identification of promising future innovations. Investment in such high-risk research with its broad potential benefits is a clear federal responsibility. FHWA's Exploratory Advanced Research (EAR) program has this focus, but its annual funding (\$6 million) is modest and represents but 3 percent of FHWA RD&T. ITS JPO's \$18 million Emerging Technologies program is described as potentially supporting fundamental research, but much of the activity appears to be applied R&D, pilot tests, and demonstrations. Across all four of the federally funded highway-related RD&T programs reviewed in this report, almost all of the funding supports applied R&D, testing, demonstrations, and technology transfer. An emphasis on these stages of the innovation process is appropriate given the many practical problems state and local agencies face and their need to make ongoing incremental improvements across a range of challenging issues. However, based on the committee's estimate, the share of funding for these activities is disproportionately large. Inadequate investment in fundamental research risks missed opportunities for insights that might yield future transformative improvements in highway transportation. Universities may be more fertile areas for fundamental research than federal contract research programs, but the funding requirements and structure of the UTC program drives universities to focus on applied research. Congress may want to consider whether changes are needed to UTC program requirements to ensure adequate UTC investment in fundamental research.

### *Evaluation*

Congress has also specified evaluation requirements for RD&T. FHWA and ITS JPO have notable evaluation efforts, but even greater benefits are possible from expanded investment in this area. FHWA RD&T has an important initiative to conduct case-study evaluations of specific RD&T initiatives, but limited funding has constrained the number and extent of evaluations. The ITS program has an ongoing evaluation activity, including the independent evaluation component of its large-scale connected vehicle (CV) pilot projects. Regarding demonstration programs, as directed by Congress, FHWA is requiring annual reports of progress and documentation of lessons learned from grantees, but is relying on self-reports rather than independent evaluations. This raises questions about whether (a) there are better ways to fund and design demonstration programs around strategic objectives and reporting and (b) FHWA could rely on independent evaluation of a sample of demonstration projects rather than relying on self-reports from all of them.

The FHWA and ITS JPO research is spread across many different highway topics, allowing it to contribute positively to the many important aspects of highway transportation. Although the scope of the RD&T program is broad, the emphasis on being comprehensive can lead to resources being spread too thinly. Congress's direction in the Fixing America's Surface Transportation Act of 2015 stating that funding representing \$80 million annually in FHWA and ITS RD&T resources be transferred from existing RD&T for new pilot and demonstration programs has exacerbated this risk.

Understanding that deployment of innovation in the highway sector requires serving the states and local governments that own and operate highways, the FHWA and ITS JPO RD&T programs are explicitly designed for this purpose. More than 80 percent of FHWA's RD&T activities identify state DOTs as partners. ITS JPO's large-scale pilot programs and ITS demonstration projects conducted with state and local government partners represent 44 percent of ITS funding, and many of its other programs support state and local government initiatives as well.

### **Addressing Gaps in Research**

FHWA and ITS JPO RD&T programs, as required by Congress, are addressing a number of critical gaps not covered by other programs:

1. *Responsiveness to Congressional Direction.* FHWA RD&T is advancing congressional and federal policy direction in areas such as system performance, asset management, acceleration of project delivery, safety planning, and environmental compliance.
2. *RD&T Coordination.* FHWA provides the pooled-fund contracting mechanism for the dozens of ongoing collaborations in RD&T by states and by states with FHWA.
3. *Advancing City-, Regional-, and State-scale ITS Applications.* ITS JPO RD&T on cybersecurity, system integration, standards for interoperability, development of infrastructure-based sensing and communications systems, operational applications, and support for city-, regional-, and state-scale pilot tests is not being addressed in SP&R or UTC RD&T.
4. *Data Collection and Sharing.* FHWA develops and maintains invaluable, widely used national datasets (travel, safety, asset condition and performance, system extent, and funding among them).
5. *Broad Diffusion of RD&T Information.* FHWA funding and technology transfer activities support broad diffusion of information about ongoing and published transportation research from all sources to policy makers, practitioners, and researchers alike, and FHWA and ITS JPO websites provide extensive information about their RD&T activities.
6. *Support for Innovation from Discovery to Deployment.* FHWA and ITS JPO's stable resources and strategic approach enable them to make long-term commitments, often spanning more than a decade, to identify, develop, test, and demonstrate potentially promising innovations. FHWA and ITS JPO play a critical role in supporting state and local deployment through technology transfer programs that include funding, technical guidance and assistance, training and education, and professional capacity building.

### **Conduct of Nationally Significant R&D**

As described in Chapter 5 of our report, FHWA and ITS JPO RD&T is addressing most of the nationally significant topics identified in TRB's *Critical Issues in Transportation*. Illustrative examples of compelling policy and operational concerns that could drive sustained and additional RD&T include

Transformational Technologies—by (a) continuing to foster interoperability and cybersecurity of rapidly evolving connected and automated vehicle (CAV) technologies, (b) monitoring and forecasting how CAVs will affect highway performance and capacity, and (c) by collecting data about shared mobility travel and sponsoring research on the broad implications of this fast-growing trend.

Energy and Sustainability—by collaborating in R&D with other federal agencies and developing policies on how to best foster the recharging infrastructure needed for electric drive and low-GHG emission fuels for highway transportation.

Serving a Growing and Shifting Population—by addressing how to ensure that megaregions responsible for a growing share of national prosperity are well connected internally and with the rest of the nation and the world; developing funding strategies for highways supporting interstate passenger and freight travel in rural areas with declining populations; and improving the ability to estimate future Interstate highway travel at the network level, including accounting for the ability of passengers and freight to shift the time and routes of trips and to shift to other modes.

Resilience—by collaborating with other federal agencies conducting R&D addressing infrastructure vulnerability to natural and manmade disasters and by developing risk-management tools; incorporating the results from climate research into standards for resilient design; and developing policies and funding strategies regarding the rebuilding of more resilient infrastructure after it is damaged or destroyed.

Safety—by continuing to focus on the potentially transformative safety benefits of technology through ITS RD&T on systems integration; interoperability; sensing and communications to connect vehicles, infrastructure, and vulnerable road users; and continually updated guidance on the public role in development and deployment as private-sector CAV technologies evolve and find market acceptance.

Equity—by conducting R&D to (a) improve transportation access of disadvantaged populations and (b) conduct an updated study to assess whether all classes of vehicles are being charged their fair share of highway costs.

Governance—through (a) more expansive and in-depth policy research on the appropriate federal policy and funding role in interstate highway transportation and (b) research sorting out the trade-offs, responsibilities, and funding roles of the multiple levels of governments involved in highway transportation at the local level.

Asset Management and System Performance—by filling critical knowledge gaps about the structural condition of aged Interstate highway pavement foundations and the extent, condition, and performance of Interstate interchanges.

Funding and Finance—by supporting and managing a large-scale national pilot program to test (a) technologies and systems to allow for direct road user charges and (b) public and political acceptance of these alternatives.

Goods Movement—by conducting research and model development to understand the national policy trade-offs of shifting freight to other modes when considering expansion of Interstate highways. (FHWA RD&T is expanding its work in freight in response to congressional direction, but appears to lack the resources needed to make more substantive progress in this important and complex area.)

Research and Innovation—(a) to foster and support a culture of innovation by states, metropolitan planning organizations, and local highway agencies and (b) by conducting RD&T on ways to expand opportunities for private-sector innovation to occur in highway transportation.

## **PURPOSE OF TODAY’S HEARING**

Regarding the purpose of today’s hearing, our report leads to several observations I hope that the Subcommittee members will find helpful. I comment on each component of the purpose in turn.

### **RD&T Activities**

Regarding RD&T Activities, FHWA and ITS JPO programs cover the full innovation cycle in ways that both foster innovation and assist the states and local agencies that own highways in implementing them. FHWA’s technology transfer activities are particularly important to state and local agencies’ traditional missions because of the wide array of topics FHWA RD&T covers – including operations, safety, materials durability and performance, asset management, resilience, maintenance, environmental protection and many other challenging issues that states and local agencies must manage on a day-to-day basis. ITS JPO RD&T is laying the foundation for achieving the operational and safety benefits from advanced technologies being implemented in connected and automated vehicles. The overall allocation of RD&T resources between fostering innovations and the technology transfer programs that assist states and local agencies in implementing them appears appropriate.

Based on the committee’s review of the portfolios of all four federally-funded highway RD&T programs, however, we find them to be weak in two areas. First, we find inadequate investment in the fundamental research that is needed to identify future potentially transformative improvements in highway transportation. FHWA has a good exploratory advanced research (EAR) program but its funding level – just \$6 million annually – is rather low. Universities ought to be the best sources for carrying out fundamental research, but the UTC program matching requirements and program directives seeking near term solutions appear to be resulting in a preponderance of applied research that is crowding out fundamental research. We encourage Congress, USDOT, and the UTCs themselves to consider options for changing UTC program policies in ways that would allow for greater fundamental research by UTCs. Second,



despite some notable activities in FHWA and ITS JPO, we find little investment in evaluation research that can help program managers and policy makers understand how well RD&T programs are working at fostering innovation and how effective the innovations have been once implemented. If additional funding is not available for greater investment by FHWA and ITS JPO in fundamental research and evaluation, then these are subjects for reallocating resources within current budgets. We also encourage FHWA and Congress to consider how demonstration programs might be funded and organized differently to ensure clearer objectives and improved reporting. Demonstration programs can be very valuable ways to prove the benefits of innovations that agencies might be reluctant to adopt, but we need better proof of their effectiveness. We understand that gathering rigorous evidence from a large number of demonstration projects can be quite expensive. Evaluating a sample of demonstration projects rather than requiring reporting by all of them might be one way to gather the evidence that will motivate more agencies to risk adopting new innovations.

### **Research Provisions of the FAST Act**

From having reviewed the FHWA and ITS JPO modal research plans and programs in detail in carrying out our analysis, it is clear that the structure and focus of these programs are based on the authorizations of the FAST Act and congressionally-enacted legislation that precedes it. We observe in our report numerous examples of how FHWA and ITS JPO are following congressional direction and advancing congressional priorities. FHWA, for example, is carrying out R&D to help states implement the performance objectives Congress established in MAP-21 and the FAST Act for safety, congestion relief, freight movement, and asset management. It is carrying out FAST Act R&D authorizations to assist states and local agencies in implementing the latest pavement technologies and providing matching grants to states to explore the potential of road user charges to possibly replace our current heavy reliance on motor fuels taxes to pay for the highway programs of the states. The ITS JPO strategic plan and RD&T initiatives that flow from it are based on congressional direction, such as in enhancing (a) ITS architecture and standards for interoperability and (b) professional capacity building to assist states and local agencies in implementing ITS technologies.

### **Surface Transportation Research Agenda**

Regarding a surface transportation research agenda, I return to our recognition of the wide array of highway infrastructure and topics that states and local agencies need help with and the wide array of RD&T topics FHWA and ITS JPO are pursuing in this regard. Our review of some of the FHWA RD&T initiatives, including fundamental research, enhancing freight system performance, and essential areas of data collection, leads us to the conclusion that FHWA has a broad and strong portfolio, but aspects of it are spread quite thinly. There are more RD&T topics

that the committee would like to see FHWA address, but we're also aware of the resource constraints it faces. FHWA and ITS JPO are conducting nationally significant research, but there are compelling policy and operational issues such as the ones mentioned above that would justify greater levels of RD&T investment by the two programs if resources were available.

In closing, we note that the U.S. economy and citizenry depend on highways. In an environment in which transformative changes are occurring in technology, mobility services, climate and weather conditions, and the country's demographic landscape, innovations identified, in part through fundamental research, are desperately needed to harness technology to move highway traffic more quickly, safely, and with fewer adverse environmental impacts. Breakthroughs are needed in materials, construction, long-term asset condition and performance, and means to raise revenues to fund the maintenance and renewal of the highway network. The nation is fortunate to have effective highway RD&T programs at the federal level that are addressing these issues and more. With sustained and adequate funding and modest improvements in RD&T programs such as those suggested above, the programs will continue to serve and advance the national interest and international competitiveness well into the future.