

February 2010

# HIGHWAY RESEARCH

## The Second Strategic Highway Research Program Addresses the Four Required Areas, but Some Anticipated Research Was Not Funded



GAO

Accountability \* Integrity \* Reliability



Highlights of [GAO-10-248](#), a report to congressional committees

## Why GAO Did This Study

The 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users authorized the Department of Transportation to establish a highway research program to address future challenges facing the U.S. highway system. In 2006, the Second Strategic Highway Research Program was established to conduct research in four areas—safety, renewal, reliability, and capacity. The Transportation Research Board manages this program in cooperation with the Federal Highway Administration and others.

The legislation also required GAO to review the program no later than 3 years after the first research contracts were awarded. This report provides information about the process for selecting the program's projects for funding, the projects' status, and what, if any, research was eliminated because of funding and time constraints. To address our objectives, GAO reviewed the program's authorizing legislation, analyzed studies and reports related to the program and its projects, and interviewed officials from relevant transportation agencies and organizations.

GAO is not making recommendations in this report. The Department of Transportation and the Transportation Research Board reviewed a draft of this report and provided technical clarifications, which we incorporated, as appropriate.

View [GAO-10-248](#) or [key components](#). For more information, contact David Wise at (202) 512-2834 or [wised@gao.gov](mailto:wised@gao.gov).

## HIGHWAY RESEARCH

### The Second Strategic Highway Research Program Addresses the Four Required Areas, but Some Anticipated Research Was Not Funded

#### What GAO Found

The program's oversight committee funded research projects based on the recommendations of its four technical coordinating committees of experts (one for each of the four research areas), which considered the input of other experts and factors, such as available program funds and time frames. Prior to the program's establishment, detailed research plans were developed by panels of experts in 2003 that identified 106 possible research projects. However, these research plans were significantly modified on two occasions—in 2006, when less funding and time were provided for completing the program than had been assumed in 2003, and in 2008, when about \$20 million in additional program funding became available. On both occasions, the program's oversight committee relied on experts to prioritize and recommend projects for funding. As a result of this process, 56 of the 106 projects either evolved into, or were partially merged with, one or more of the currently funded projects, while 50 projects were eliminated entirely.

As of December 31, 2009, the program's oversight committee had allocated about \$123 million of the approximately \$171 million available to fund 85 projects in the four research areas of highway safety (40 percent), renewal (26 percent), reliability (16 percent), and capacity (17 percent). These funding allocations closely followed the overall funding percentages recommended by the Transportation Research Board in 2001. Of the 85 funded projects, 11 were completed, 52 were ongoing, 22 were anticipated, and all of the projects were expected to be completed by 2013. The outcomes are expected to vary by research area, ranging from useful data sets and related analyses to improved technologies, guidelines, and techniques for advancing the goals of each research area. Among other outcomes, the program staff expects

- the safety research will produce the largest, most comprehensive database on driver behavior available to date and, thus, provide the foundation for significant improvements in highway safety;
- the renewal research will produce a variety of tools and techniques to promote rapid and durable highway renewal;
- the reliability research will develop methods to provide highway users with relatively more consistent travel times between locations; and
- the capacity research will provide strategies for better decision making in highway planning processes to increase the capacity of U.S. highways.

Because of funding and time constraints, 50 of the 106 research projects identified in 2003 were eliminated entirely from funding, while many of the remaining 56 projects had one or more portions of their planned research eliminated. Overall, most of the funded projects are for applied research, but many of the implementation-related activities identified in 2003 were eliminated. While activities to (1) translate research results into products, (2) train and disseminate research findings, and (3) provide technical support for implementing the research are often needed to widely implement research results, program staff are hopeful that other researchers will initiate some of the eliminated research activities after the program's completion.

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### **Abbreviations**

DOT	Department of Transportation
FHWA	Federal Highway Administration
TRB	Transportation Research Board
AASHTO	American Association of State Highway and Transportation Officials
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SHRP	Strategic Highway Research Program
SHRP 2	Second Strategic Highway Research Program
TCC	Technical Coordinating Committee

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United States Government Accountability Office  
Washington, DC 20548

February 5, 2010

## Congressional Committees

As the United States entered the 21st century, the nation's highway infrastructure and transportation system faced critical challenges that demanded practical solutions. The highway system is the backbone of the U.S. economy and provides passenger and freight links to all other modes of transportation. However, the network of U.S. roadways, bridges, and other related structures constituting the system has been in constant use for decades, often exceeding original design life and expected traffic volumes. As a result, the system is deteriorating and has become heavily congested. For example, the average age of a bridge in the inventory of bridges nationwide is 35 years, and about a quarter of them are considered either structurally deficient or functionally obsolete.<sup>1</sup> Also, increased traffic congestion causes travel disruptions and delays that, in 2007, cost travelers about \$87 billion and an estimated 4.2 billion additional travel hours.<sup>2</sup> Furthermore, the number of deaths and injuries each year from highway accidents—the leading cause of death in 2006 for all persons between 3 and 34 years of age—constitute a major public health concern.<sup>3</sup>

Research and innovation play an important role in addressing the challenges of managing and using the highway system. Research efforts generally focus on incremental improvements that address a wide range of highway challenges and lead to a variety of user benefits across the highway system, including (1) lower construction and maintenance costs, (2) better system performance, (3) added highway capacity, (4) reduced highway fatalities and injuries, and (5) reduced adverse environmental impacts. In contrast, strategic highway research programs are designed to focus on fewer highway challenges and typically result in more rapid and significant transportation-related improvements.

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<sup>1</sup>GAO, *Highway Bridge Program: Clearer Goals and Performance Measures Needed for a More Focused and Sustainable Program*, GAO-08-1043 (Washington, D.C.: Sept. 10, 2008). Structurally deficient bridges have a component, such as the bridge deck, in poor condition because of deterioration or damage, while functionally obsolete bridges are those with a poor configuration or a design that may no longer be adequate for the traffic they serve.

<sup>2</sup>Texas Transportation Institute, *2009 Urban Mobility Report* (College Station, 2009).

<sup>3</sup>National Highway Traffic Safety Administration, *2008 Traffic Safety Annual Assessment*, (Washington, D.C.: June 2009).

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To address challenges facing the nation's highway infrastructure and transportation system and develop potential solutions to those challenges, in 1998, Congress requested the Transportation Research Board (TRB), a unit of the National Research Council within the National Academy of Sciences, to conduct a study for creating a strategic highway research program.<sup>4</sup> TRB conducted the study and, in 2001, issued Special Report 260: *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life* (Special Report 260), which concluded that a large-scale, special-purpose, and limited-duration research program focused on four research areas—safety, renewal, reliability, and capacity—could help the highway system meet customer demands over the next several decades.<sup>5</sup> To advance such a program, in 2002, the Department of Transportation's (DOT) Federal Highway Administration (FHWA) and the states' departments of transportation funded work to develop detailed research plans and specific projects for carrying out each of the four areas outlined in Special Report 260.<sup>6</sup> The results of this effort were completed and published in 2003.<sup>7</sup> In addition, section 5210 of the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) authorized the creation of the Future Strategic Highway Research Program.<sup>8</sup> SAFETEA-LU required that the program focus on the four research and development areas specified in Special Report 260 (i.e., highway safety, renewal, reliability, and capacity) and tasked DOT with establishing and carrying out the program through

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<sup>4</sup>The National Research Council's mission is to improve government decision making and public policy, increase public education and understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health.

<sup>5</sup>TRB, Special Report 260: *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life*, (Washington, D.C.: November 2001). The report recommended that the program receive 0.25 percent of the federal-aid highway funds from the Highway Trust Fund. This fund is used to distribute highway funding to states based on a formula specified in statute.

<sup>6</sup>The work, conducted through the National Cooperative Highway Research Program, was performed to develop the detailed plans and projects needed to execute the framework for research outlined in Special Report 260.

<sup>7</sup>National Cooperative Highway Research Program Report 510: *Interim Planning for a Future Strategic Highway Research Program: Summary Report* (Washington, D.C.: October 2003).

<sup>8</sup>Pub. L. No. 109-59, 119 Stat. 1144 (August 10, 2005). This law also authorized funding for numerous programs, including highway safety, transit, transportation research, and federal-aid highways. The federal-aid highway program is a federally assisted, state-administered program.

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the National Research Council. The resulting program, initiated in 2006, is referred to as the Second Strategic Highway Research Program (SHRP 2). The program is managed by TRB in cooperation with FHWA, the National Highway Traffic Safety Administration, and the American Association of State Highway and Transportation Officials (AASHTO).<sup>9</sup>

SAFETEA-LU directed us to review SHRP 2 no later than 3 years after the first contracts for research projects were awarded. This occurred on February 5, 2007. This report provides information about (1) the process for selecting SHRP 2 projects for funding, (2) the status of these projects, and (3) what, if any, planned research was eliminated from the program because of funding and time constraints. To address these issues, we reviewed the program's authorizing legislation, requirements, goals, and objectives. We also reviewed and analyzed literature, studies, and reports related to SHRP 2, and available agency and program documentation on the SHRP 2 research projects that were funded or identified for funding in the 2003 detailed research plans, as well as the revised plans for reprioritizing project for funding. In addition, we compared the current SHRP 2 projects with the four research areas identified in Special Report 260 and the projects identified in the 2003 detailed research plans to identify projects that were partially or fully eliminated from program funding. Finally, we interviewed officials from DOT, FHWA, the National Highway Traffic Safety Administration, the National Research Council, TRB, and AASHTO.

We conducted this performance audit from June 2009 through February 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. See appendix I for more information about our scope and methodology.

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## Background

Research and innovation play an important role in addressing issues associated with building, maintaining, operating, and using the U.S. highway system. Highway research is an essential national investment

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<sup>9</sup>AASHTO is a nonprofit association that represents highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico.



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because it helps address broad issues related to highway planning, safety, traffic operations, pavement durability, maintenance, and the impact of the highway system on the environment. In addition, research helps transportation professionals to (1) understand how the highway transportation system functions and (2) anticipate future demands. Past research has yielded many advances and innovations that have saved money, improved performance, added capacity, reduced fatalities and injuries, and minimized the impact of the highway system on the environment.<sup>10</sup> For example, in the late 1950s, the American Association of State Highway Officials sponsored research, called the AASHO Road Test, to study how traffic contributes to the deterioration of highway pavements.<sup>11</sup> This research, which contributed to the creation of nationwide design standards for the new Interstate highway system, was designed to complement existing highway research programs and is credited with critical advances related to the structural design and performance of pavements, and to understanding the effects of various climates on pavements.

While highway research has resulted in transportation advances, implementing research results can be difficult because of the number of stakeholders involved. The network of highway transportation stakeholders is large and complex, consisting of federal and state transportation agencies, universities, industry associations, and private organizations. In total, more than 35,000 highly decentralized public agencies manage the U.S. highway system, and thousands of private contractors, materials suppliers, and other organizations provide support services. The federal government supports highway research through FHWA, whose mission, in part, is to deploy and implement technology and promote the use of innovative approaches to address highway challenges. For example, to enhance mobility on U.S. highways, FHWA conducts and funds research on current and emerging nationwide transportation issues to, among other matters, enhance the transportation system's overall performance; reduce traffic congestion; improve safety; and maintain infrastructure integrity. However, according to a report issued by TRB in 2001, the majority of FHWA's highway research focuses on short-term,

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<sup>10</sup>TRB, Special Report 261: *The Federal Role in Highway Research and Technology*, (Washington, D.C.: December 2001).

<sup>11</sup>The American Association of State Highway Officials, or AASHO, was renamed AASHTO in 1973.

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incremental transportation-related improvements.<sup>12</sup> Although transportation agencies are generally responsive to implementing small innovations with the promise of short-term benefits, according to this report, it takes considerably longer to implement changes that realize large, long-term benefits.

Although the establishment of a national strategic highway research program, like SHRP 2, has been rare, it is not unprecedented. Specifically, in 1987, Congress established the first Strategic Highway Research Program (SHRP) to achieve large-scale, accelerated, and innovative highway research on topics not adequately addressed by prior or existing research programs.<sup>13</sup> SHRP focused on a few critical infrastructure and operational problems faced by state transportation agencies, such as the quality of asphalt used in highway construction, the integrity and longevity of road pavements, and the deterioration of concrete bridge decks and other components. The program, concluded in 1991, was considered ambitious because of its limited duration and its concentration on previously neglected research areas related to asphalt pavements, structural concrete, and winter maintenance. Two of the better known and more widely implemented results of SHRP are (1) the Superpave materials selection and design system, which resulted in more durable asphalt pavements, and (2) a collection of methods and technologies that significantly improved approaches for controlling snow and ice on roadways.

The success of SHRP prompted Congress and others to take several key steps that, ultimately, led to the establishment of SHRP 2. Table 1 provides a timeline of key events related to SHRP 2.

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<sup>12</sup>TRB, Special Report 261.

<sup>13</sup>In 1984, TRB issued Special Report 202: *America's Highways: Accelerating the Search For Innovation*, which recommended the creation of a national research program to focus on unaddressed but high-priority research areas. In response, the Surface Transportation and Uniform Relocation Act, enacted in 1987, reauthorized the federal-aid highway program and authorized the National Research Council to implement SHRP. Congress initially provided approximately \$150 million over 5 years to conduct the research. However, after this research was completed, Congress provided an additional \$108 million to implement the research.

**Table 1: Timeline of Key Events Related to SHRP 2**

Date	Event
1998	The Transportation Equity Act for the 21st Century reauthorized the federal-aid highway program and requested TRB to study the feasibility of creating a new strategic highway research program.
2001	TRB issued Special Report 260.
2002	AASHTO's board of directors passed a resolution supporting a new national strategic highway research program and authorized funding for a project to develop detailed research plans and specific projects based on the goals of Special Report 260. FHWA provided matching funds to develop the plans, which was conducted under the National Cooperative Highway Research Program. <sup>a</sup>
2003	The National Cooperative Highway Research Program completed the detailed research plans. The plans, which included specific projects in each of the four research areas, were summarized in the National Cooperative Highway Research Program Report 510, <i>Interim Planning for a Future Strategic Highway Research Program</i> .
2005	SAFETEA-LU authorized, among other matters, the creation of a strategic highway research program to address challenges affecting the U.S. highway system and funding for that program. The law also required TRB to report on the strategies and administrative structure for implementing the results of SHRP 2 no later than February 1, 2009. In December, FHWA, AASHTO, and the National Research Council signed a memorandum of understanding that (1) established a partnership among the three organizations to carry out SHRP 2, (2) selected TRB to manage the program, and (3) described the program's governance structure.
2006	SHRP 2 was officially inaugurated in March when FHWA provided TRB with funding to initiate the program through a cooperative agreement with the National Research Council.
2007	TRB awarded the first SHRP 2 research contracts in February.
2008	The SAFETEA-LU Technical Corrections Act of 2008 provided additional obligation authority for SHRP 2. <sup>b</sup>
2009	As required by Congress in 2005, TRB issued Special Report 296: <i>Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life</i> in January 2009. <sup>c</sup>
2013	Planned completion of SHRP 2 research.

Source: GAO.

<sup>a</sup>AASHTO and FHWA funded work to develop the detailed research plans and specific projects for each of the four research areas identified in Special Report 260 through the National Cooperative Highway Research Program. These plans and projects, known as the National Cooperative Highway Research Program Project 20-58, are available at [www.TRB.org/SHRP2](http://www.TRB.org/SHRP2).

<sup>b</sup>Pub. L. No. 110-244, 122 Stat. 1572, 1604 (June 6, 2008).

<sup>c</sup>TRB, Special Report 296: *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life*, (Washington, D.C.: Jan. 2009).

Special Report 260 recommended that the program address the following four research goals:

- safety—to prevent or reduce the severity of highway crashes through more accurate knowledge of driver behavior and other crash factors;
- renewal—to develop a consistent and systematic approach to performing highway rehabilitation that is rapid, causes minimum disruption, and produces long-lived (durable) transportation facilities, such as roadways and bridges;

- 
- reliability—to provide highway users with improved travel time reliability (more consistent travel times between locations) by preventing and reducing the impact of relatively unpredictable events, such as traffic accidents, work zones, special events, and weather; and
  - capacity—to develop approaches and tools for systematically integrating environmental, economic, and community requirements into the decision-making processes for planning and designing projects to increase highway capacity.

While Special Report 260 provided strategic direction and a general framework for developing SHRP 2, additional planning had to be conducted before the research program could begin. Therefore, in January 2002, TRB assembled five panels—an oversight panel and four technical panels of experts—to provide leadership and technical guidance for the development of detailed research plans for each of the four research areas. The panels consisted of a wide range of highway transportation experts, including representatives from state departments of transportation, FHWA, the National Highway Traffic Safety Administration, universities, industry associations, and private companies.

The planning effort, completed in September 2003, resulted in detailed research plans for each of the four research areas, which identified, among other matters, the objectives, scope, and anticipated projects and budgets for each of the four areas. Each technical panel of experts prioritized the research projects identified in its area after considering, among other matters, the (1) probability of each project's success and (2) likelihood that each project would improve transportation practices. In total, the four plans identified 106 projects—15 for safety, 38 for renewal, 33 for reliability, and 20 for capacity projects—designed to achieve the overall research goals specified in Special Report 260.

SAFETEA-LU, enacted in 2005, established several requirements for carrying out SHRP 2. For example, Congress required that the program (1) address the four research areas described in Special Report 260 as well as the detailed research plans completed in 2003 and (2) involve state transportation officials and other stakeholders in the governance of the research program. SHRP 2 began in December 2005, when FHWA, AASHTO, and the National Research Council formed a partnership to carry out SHRP 2 through a memorandum of understanding. In doing so, these entities specified that TRB should manage the program's daily operations and budget and establish a structure for carrying out the program. Similar to the 2003 detailed planning effort, TRB established the

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following organizational structure, composed of experts at all levels, to carry out SHRP 2:

- an oversight committee to approve annual work plans, budgets, and contractor awards, among other activities;
- a technical coordinating committee (TCC) for each of the four research areas to develop annual research plans and monitor the progress of contracts, among other matters;<sup>14</sup> and
- numerous expert task groups, as needed, to provide technical input to each of the four research areas, develop the requests for project proposals, recommend contractor selections, and monitor research projects.<sup>15</sup>

According to SHRP 2 staff, the extensive involvement of experts to define, prioritize, and oversee research in each of the four areas was intended to maximize the usefulness of the research results.

Special Report 260, which was requested by Congress, recommended that SHRP 2 receive \$450 million over 6 fiscal years, with 9 years to complete the research.<sup>16</sup> In 2005, SAFETEA-LU authorized \$205 million for SHRP 2 over 4 fiscal years (fiscal years 2006 through 2009). SHRP 2 was officially inaugurated in March 2006, when FHWA provided about \$36 million to TRB to initiate the program and 7 years to complete the research (i.e., by 2013) through a cooperative agreement with the National Research

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<sup>14</sup>The memorandum of understanding also enabled the SHRP 2 oversight committee to create technical advisory committees to assist TRB in carrying out the research program. These committees were formed in 2006.

<sup>15</sup>As of early November 2009, 55 expert task groups had been formed. According to TRB's manual for conducting research and preparing proposals for SHRP 2, the task groups consider several factors in making their recommendations: the (1) applicant's demonstrated understanding of the problem; (2) merit of the proposed research approach and methodology; (3) experience, qualifications, and objectivity of the research team in the same or closely related problem areas; (4) applicant's plan for involving small firms owned and controlled by minorities or women; and (5) adequacy of the applicant's facilities and equipment.

<sup>16</sup>In forming its funding recommendations for Special Report 260, TRB assumed that the formula used to fund SHRP (i.e., 0.25 percent of the federal-aid highway funds from the Highway Trust Fund) would be used to fund SHRP 2. Thus, TRB recommended that SHRP 2 receive about \$450 million over 6 years.

Council.<sup>17</sup> However, the initial amount provided for fiscal year 2006 constituted less than one-half of the annual recommended amount in Special Report 260 (\$75 million) and about \$15 million less than the annual amount authorized in SAFETEA-LU (\$51.25 million). SAFETEA-LU contained other funding limitations, which ultimately reduced SHRP 2's funding below its authorized amount.<sup>18</sup> The 2008 SAFETEA-LU Technical Corrections Act provided additional obligation authority for the program, which resulted in about \$20 million in additional funds. TRB currently expects about \$171 million in total SHRP 2 funding. Table 2 provides a comparison of the (1) funding and duration for SHRP 2 as recommended in Special Report 260, (2) program funding authorized in SAFETEA-LU, and (3) amount actually funded.

**Table 2: Amount and Duration of SHRP 2 Funding, as of December 31, 2009**

(Dollars in millions)			
	<b>Recommended</b>	<b>Authorized</b>	<b>Actual funding</b>
Annual funding level	\$75.0	\$51.25 <sup>a</sup>	\$42.7 <sup>b</sup>
Years of funding	6	4	4
Years for program duration	9	7	
<b>Total funding</b>	<b>\$450</b>	<b>\$205</b>	<b>\$171</b>

Source: GAO analysis.

Note: All funding amounts are in nominal dollars.

<sup>a</sup>The SAFETEA-LU Technical Corrections Act changed the funding source for SHRP 2 and resulted in about \$20 million in additional funding for the program for fiscal years 2008 and 2009. Consistent with a recommendation in TRB's Special Report 260, this legislation authorized the funding to come from state federal-aid highway apportioned funds, rather than from FHWA's research program budget. The legislation authorized an amount not to exceed 0.205 percent from state federal-aid highway apportioned funds.

<sup>b</sup>The actual funding level represents the average amount of funds received by the program across the 4 fiscal years: \$36.2 million in 2006, \$39.7 million in 2007, \$46.8 million in 2008, and \$48.2 million in 2009.

<sup>17</sup>SAFETEA-LU authorized the Secretary of DOT to make grants and enter into cooperative agreements with AASHTO and the National Academy of Sciences to carry out activities needed to establish SHRP 2. (Sec. 510(b).)

<sup>18</sup>According to FHWA officials, the total cost of SHRP 2 and other research programs authorized in SAFETEA-LU exceeded the budget authority available for these programs. As a result, funding for all of the research programs had to be reduced.

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## SHRP 2 Research Projects Were Selected Based on Expert Input and Program Funding and Time Frames

The SHRP 2 oversight committee funded research projects for the program based on the recommendations of its TCCs, which considered the input of other experts and factors such as available program funds and time frames. These experts included highway transportation personnel from federal, state, and local government; private sector firms; academia; AASHTO liaisons; and other stakeholder organizations within the U.S. and international highway community. While the 2003 detailed research plans constituted the starting point for decisions about project selections, the 106 projects identified in these plans had to be significantly modified on two occasions because of program funding and time frames. The first major modification occurred in 2006, when, as discussed, considerably less funding and time were provided for the program's completion than had been assumed by the parties involved in the development of the detailed research plans in 2003. The second major modification occurred in 2008, when about \$20 million in additional program funding became available because of the passage of the SAFETEA-LU Technical Corrections Act.

On both occasions, the SHRP 2 oversight committee relied on the input of experts to select projects for funding. Given less funding and time than had been assumed for completing the program, in 2006, the oversight committee requested that the parties involved in the 2003 planning effort reevaluate these plans for the purpose of rescoping the program and prioritizing projects for funding. In doing so, these parties assigned lower priority to projects that (1) were duplicative or similar to other research efforts, (2) could not be accomplished within SHRP 2's budget or time frame, or (3) could be deferred. In addition, they rescoped other projects under consideration for funding. After the four TCCs were formed later in 2006, the oversight committee requested them to review the revised research plans. As a result of this effort, the TCCs developed recommendations for project funding in each of the four research areas, which were approved by the oversight committee in November 2006.

When more funds became available, in 2008, the oversight committee asked the TCCs to prepare prioritized lists of additional projects for funding. In doing so, the oversight committee requested the TCCs to assign higher funding priority to (1) ongoing projects that addressed gaps in existing research, (2) projects that were demonstrating the most promising results, and (3) potential projects that advanced SHRP 2's strategic goals. This effort resulted in project recommendations for several new projects and additional funding for some existing projects, which were approved by the oversight committee in November 2008.

As a result of the reprioritization process, 56 of the 106 projects identified in 2003 either evolved into, or were partially merged with, one or more of the currently funded SHRP 2 projects, while 50 of the projects were eliminated entirely. Table 3 provides information on the number of projects identified in the 2003 detailed research plans (1) for each research area; (2) that either evolved into, or were partially merged with, one or more SHRP 2 funded projects; and (3) that were eliminated entirely from funding. Appendixes II through V provide more detailed information, by research area, on how specific projects identified in 2003 were reprioritized for funding.

**Table 3: Information on the Number of Projects Identified in 2003 That Evolved or Merged to Form a SHRP 2 Project or Were Eliminated**

(Dollars in millions)

Research areas	Projects identified in 2003	Projects that evolved into SHRP 2 projects <sup>a</sup>	Projects that had elements merged with other SHRP 2 projects <sup>b</sup>	Projects that were eliminated entirely
Safety	15	5	4	6
Renewal	38	16	5	17
Reliability	33	12	1	20
Capacity	20	7	6	7
<b>Total</b>	<b>106</b>	<b>40</b>	<b>16</b>	<b>50</b>

Source: GAO presentation of SHRP 2 information.

<sup>a</sup>For the purposes of this report, projects that “evolved” are those that had their core research elements largely addressed in one or more funded SHRP 2 projects.

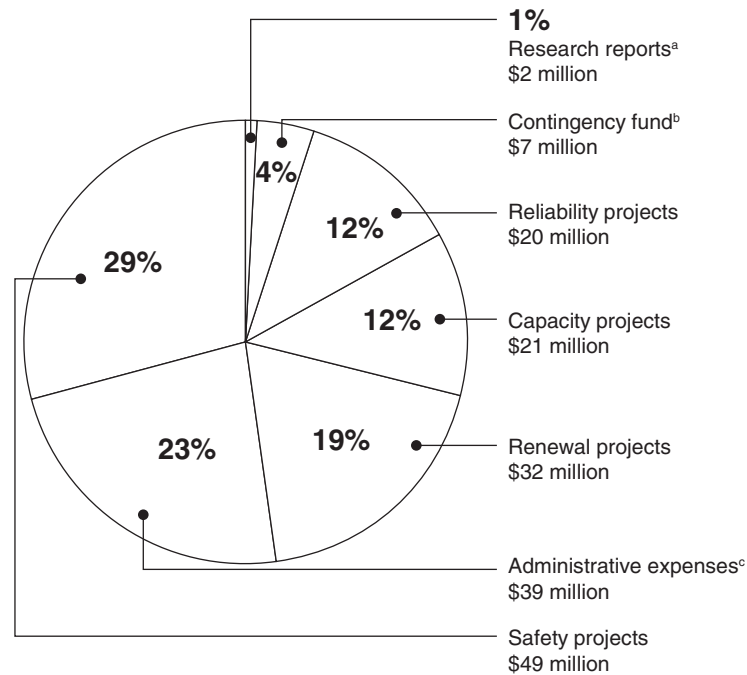
<sup>b</sup>Some portion or portions of these projects were merged to form one or more currently funded SHRP 2 projects.



## The SHRP 2 Oversight Committee Allocated about \$123 Million for 85 Projects: 63 Are Completed or Ongoing and 22 Are Planned

As of December 31, 2009, the SHRP 2 oversight committee had allocated approximately \$123 million (about 72 percent) of the roughly \$171 million available to fund projects related to highway safety, renewal, reliability, and capacity.<sup>19</sup> Of the 85 projects selected for funding, 11 were completed, 52 were ongoing, and 22 were expected to begin in the future. SHRP 2 staff expect all of the projects will be completed by 2013. The outcomes of the projects are expected to vary, ranging from the (1) production of data sets and related analyses to (2) development of improved technologies, procedures, guidelines, and techniques for advancing the goals of each of the four research areas. The oversight committee allocated the remaining \$48 million to fund administrative expenses, publication of research reports, and contingencies that may arise. Figure 1 illustrates how SHRP 2 funding was allocated as of December 31, 2009.

**Figure 1: Allocation for SHRP 2 Funding, as of December 31, 2009**



Source: GAO analysis of SHRP 2 data.

Note: Data do not add because of rounding.

<sup>19</sup>Each research project refers to an individual contract awarded, or expected to be awarded, to carry out specific research.

<sup>a</sup>The oversight committee allocated these funds (about 1 percent of total funding) to publish research reports. This includes the cost of all contractors' final project reports and TRB's January 2009 report to Congress on the strategies and administrative structure for implementing SHRP 2 research results.

<sup>b</sup>The oversight committee set aside these funds (about 4 percent of total funding) to meet future needs that may arise. According to SHRP 2 staff, this funding will likely be allocated to research, the production of research reports, and efforts to facilitate implementation of some SHRP 2 projects.

<sup>c</sup>The oversight committee allocated these funds (about 23 percent of total funding) for costs associated with travel for TCC and expert task group members, staff salaries, meetings, various publications other than research reports, and other administrative costs.

Special Report 260 recommended different percentages of funding for each of the four research areas, ranging from 15 percent to 40 percent of available funding.<sup>20</sup> As shown in table 4, the oversight committee closely followed the relative funding distributions recommended in this report. Table 4 compares the recommended funding levels and percentages in Special Report 260 with the actual funding levels and percentages.

**Table 4: Recommended and Actual Funding Levels and Percentages of Funding for the Four Research Areas, as of December 31, 2009**

(Dollars in millions)

Research area	Recommended funding distribution	Recommended funding level	Actual funding distribution	Actual funding level
Safety	40%	\$180	40%	\$49
Renewal	25	113	26	32
Reliability	20	90	16	20
Capacity	15	68	17	21
<b>Total</b>	<b>100%</b>	<b>\$450</b>	<b>100%</b>	<b>\$123</b>

Source: GAO presentation of Special Report 260 and SHRP 2 data.

Note: Some columns do not add because of rounding.

**About \$49 Million Has Been Allocated for 16 Safety Research Projects; 12 Are Completed or Ongoing and 4 Are Planned**

As of December 31, 2009, the SHRP 2 oversight committee had allocated about \$49 million to fund 5 completed, 7 ongoing, and 4 future safety projects, for a total of 16 projects. The goal of the safety research is “to prevent or reduce the severity of highway crashes through more accurate knowledge of crash factors and of the cost-effectiveness of selected countermeasures in addressing these factors.” The SHRP 2 safety TCC expects that the collection of safety research projects will (1) provide

<sup>20</sup>The recommended funding percentages in Special Report 260 were based, in part, on budget information from previous highway research studies.

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objective and reliable information on driver performance and behavior and (2) help assess the risks associated with related crash factors.

The 16 safety projects are part of two overall studies that are expected to produce a variety of data on driver behavior: the in-vehicle driving study and the site-based risk study. Most of these projects (15 of 16) and funding (\$48 million of \$49 million allocated) relate to the in-vehicle driving study, also referred to as the SHRP 2 naturalistic driving study. This study involves the use of cameras, radar, and other sensors installed in the vehicles of about 3,000 volunteer drivers in six locations for 1 to 2 years.<sup>21</sup> Collectively, the devices are expected to record (1) real-time video from multiple angles of each volunteer while driving (e.g., the driver's face and interior views of the vehicle) and the driving environment (e.g., road characteristics and traffic) and (2) information about the vehicle (e.g., the vehicle's speed and information on whether the seat belt is being used). In addition, researchers will record information on roadway conditions, as well as demographic data and data on other factors that may affect the drivers' behavior. Overall, SHRP 2 staff expect this study will result in objective information on driver behavior that, for the first time, will allow researchers to determine the relative risk associated with various factors and circumstances related to the analysis of accidents, near collisions, and uneventful driving experiences.<sup>22</sup>

The oversight committee allocated the remaining \$1 million for a project related to a site-based risk study. This project includes (1) a study to develop a portable, semi-automated video system and (2) a pilot field study, using multiple overhead video cameras, to record the relative position of traffic moving through selected locations to advance the understanding of driver behavior. While the intent of the naturalistic driving study is to passively observe individual drivers, the site-based study will allow researchers to observe multiple drivers at selected locations. SHRP 2 staff expect the project will allow researchers to observe how drivers resolve traffic conflicts; react to traffic controls, such as road signs and stoplights; and adjust to changing environmental

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<sup>21</sup>The naturalistic driving study will be conducted in six locations: Tampa, Florida; Bloomington, Indiana; Raleigh-Durham, North Carolina; Erie County, New York; central Pennsylvania; and Seattle, Washington. Data collection is expected to begin in the summer of 2010 and to continue until late 2012.

<sup>22</sup>Because near-collision events occur more frequently than actual accidents, data on these events are expected to offer valuable insights into factors leading to actual accidents.

conditions, such as light, weather, and pavement quality. Figure 2 provides the projected budget and timeline, by research category, for the SHRP 2 safety projects.

**Figure 2: Projected Budgets and Timelines for SHRP 2 Safety Projects**

Safety projects, by category	2007	2008	2009	2010	2011	2012
In-vehicle study or naturalistic driving study	← 15 projects, \$48.2 million →					
Site-based study	← 1 project; \$1.0 million →					
<b>Total</b>	<b>\$49.2 million</b>					

Source: GAO analysis of SHRP 2 data.

According to SHRP 2 staff, the naturalistic driving study is expected to produce the largest and most comprehensive database on driver behavior available to date because, unlike most previous studies that generally relied on simulations and subjective post accident observations, the naturalistic driving study is expected to provide objective information on driver behavior in real-world circumstances. These data are expected to help transportation officials (1) better understand risk factors, such as driver distractions, associated with different crash factors, and, ultimately, (2) develop practical measures to effectively reduce collisions or otherwise improve highway safety. SHRP 2 staff stated that while some data analysis is planned (about \$5 million), significantly more analytic work will be needed after the conclusion of SHRP 2 to fully realize the benefits of these data. According to these staff, future analyses of these data likely will lead to significant improvements in highway safety, particularly related to accidents that occur when vehicles run off the road—a major cause of highway fatalities.<sup>23</sup> In addition, the safety TCC expects the results of the site-based project likely will lead to similar future studies that may provide more comprehensive information on, for example, accidents resulting from collisions at intersections, where many accidents occur.<sup>24</sup> See appendix II for additional information on how these projects were reprioritized for funding and selected information about the currently funded safety projects.

<sup>23</sup>According to Special Report 260, such accidents account for one-third of highway fatalities.

<sup>24</sup>According to Special Report 296, such accidents account for 45 percent of all reported accidents.

**About \$32 Million Has Been Allocated for 28 Renewal Research Projects; 27 Are Completed or Ongoing and 1 Is Planned**

As of December 31, 2009, the SHRP 2 oversight committee had allocated about \$32 million to fund 3 completed and 24 ongoing projects, and 1 future project, for a total of 28 renewal projects. The goal of the renewal research is “to develop a consistent, systematic approach to performing highway renewal that is (1) rapid, (2) causes minimum disruption, and (3) produces long-lived facilities.” The SHRP 2 renewal TCC expects the collection of renewal projects will promote a systematic approach to highway rehabilitation and reconstruction (i.e., highway renewal) and result in quicker, more efficient, and improved repairs because the projects are designed to, among other matters, minimize travel disruptions and produce long-lived (i.e., more durable) facilities.

Nineteen of the 28 funded projects focus on developing rapid approaches to highway renewal and are expected to reduce the time involved in preparing and executing construction projects. In total, the oversight committee allocated about \$21.5 million (about 67 percent of total renewal funding) for these 19 projects. In addition, the oversight committee allocated about \$2.5 million to fund 4 projects to minimize disruptions to travelers, communities, or utilities while renewal construction is under way, and about \$8 million to fund 5 projects for producing more durable facilities needed to minimize the frequency of highway-related repairs. Figure 3 provides the projected budget and timeline, by research category, for the SHRP 2 renewal projects.

**Figure 3: Projected Budgets and Timelines for SHRP 2 Renewal Projects**

Renewal projects, by category	2007	2008	2009	2010	2011	2012
Rapid approaches	← 19 projects, \$21.5 million →					
Minimize disruption	← 4 projects, \$2.5 million →					
Long-lived/durable facilities	← 5 projects, \$8.2 million →					
<b>Total</b>	<b>\$32.2 million</b>					

Source: GAO analysis of SHRP 2 data.

The renewal TCC expects research in this area will promote rapid and durable highway rehabilitation and reconstruction and result in the production and implementation of various tools (i.e., hardware or technology) and techniques (i.e., strategies, procedures, recommendations, guidelines, or specifications). Overall, the renewal TCC expects 19 of the 28 projects will primarily develop tools, while the

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remaining 9 will primarily develop techniques for promoting rapid highway renewal. Specifically:

- To advance rapid approaches to highway renewal, 15 projects are expected to primarily develop tools, while 4 projects are expected to primarily develop techniques. For example, regarding tools, some of the 15 projects are expected to produce technologies for efficiently locating and characterizing underground utilities. This is necessary because studies show that locating utilities, such as water mains and electrical and gas lines, is the most significant source of delay in highway renewal work.<sup>25</sup> Regarding techniques, one of the 4 projects is expected to produce best practices and recommendations for addressing worker fatigue, which, according to SHRP 2 staff, can (1) negatively affect performance and the quality of work performed and (2) increase the potential for time-consuming and costly mistakes, accidents, and injuries among workers who often are required to work for extended periods of time.
- To minimize disruptions during renewal work, each of the 4 funded projects is expected to produce techniques for foreseeing and avoiding or mitigating travel disruptions. For example, 1 project is expected to establish cooperative strategies that help transportation agencies and utility companies effectively manage utilities throughout the renewal efforts, thereby minimizing disruptions to highway users and utility users in surrounding communities.
- To produce durable highway facilities, 4 of the 5 projects are expected to primarily develop tools, such as technologies for designing and constructing bridges to increase the service life of bridges, while the other is expected to primarily develop techniques for preserving pavements to promote a longer service life.

See appendix III for additional information on how these projects were reprioritized for funding and selected information about the currently funded renewal projects.

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<sup>25</sup>The SHRP 2 staff noted that accurately locating and characterizing underground utilities to protect or relocate utilities is a major, if not the primary, cause of delay in highway renewal projects. Such delays can extend the period of project development and delay the initiation of construction. In addition, damage to underground utilities can raise environmental, health, and safety concerns.

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About \$20 Million Has  
Been Allocated for 21  
Reliability Research  
Projects; 11 Are  
Completed or Ongoing and  
10 Are Planned

As of December 31, 2009, the SHRP 2 oversight committee had allocated about \$20 million to fund 1 completed, 10 ongoing, and 10 future projects, for a total of 21 reliability research projects. The goal of the reliability research is “to provide highway users with reliable travel times by preventing and reducing the impact of nonrecurring incidents.” Thus, projects in the reliability area are designed to address highway congestion caused by nonrecurring (i.e., relatively unpredictable) events—such as traffic accidents, work zones, special events, and weather. The SHRP 2 reliability TCC expects these research results will help transportation practitioners provide highway users with reliable travel times by, for example, helping to ensure that an individual’s commute to work is consistently the same and minimally affected by congestion caused by relatively unpredictable events.

The reliability TCC divided research in this area into four principal categories addressing different aspects of travel time reliability. The oversight committee allocated most of the funds, \$11.6 million (about 57 percent of total reliability funding), to 14 projects in two of the four reliability research categories—“data and analysis” and “institutional and human components.” Collectively, the 14 projects are expected to (1) develop data, analytical tools, and procedures for monitoring travel time reliability; (2) develop performance measures and models to evaluate the effectiveness of actions to control and mitigate the impact of relatively unpredictable events that cause congestion; and (3) identify how the institutional behaviors of transportation and public safety agencies and the human behaviors of travelers contribute to unpredictable events that affect congestion.

The oversight committee allocated the remaining funds—about \$8.6 million (or, approximately, 43 percent of total reliability funding)—for projects in the three remaining research categories. Specifically, the committee allocated about \$5.3 million to 4 projects for “incorporating reliability into planning, programming, and design” of highways. Further, the oversight committee allocated about \$1.5 million to 2 projects to encourage the development of innovative ideas related to “future needs and opportunities to improve travel time reliability.” Finally, in November 2008, the oversight committee allocated about \$1.8 million for a project to produce a framework for integrating the results of the reliability research, potentially providing transportation decision makers and practitioners with a guide to (1) understand travel time reliability and (2) incorporate reliability strategies into their project planning and design. Figure 4 provides the projected budget and timeline, by research category, for the SHRP 2 reliability projects.

**Figure 4: Projected Budgets and Timelines for SHRP 2 Reliability Projects**

Reliability projects, by category	2007	2008	2009	2010	2011	2012
Data and analysis component of reliability programs	← 6 projects, \$6.7 million →					
Institutional and human component of reliability programs	← 8 projects, \$4.9 million →					
Incorporating reliability into planning, programming, and design	← 4 projects, \$5.3 million →					
Future needs and opportunities to improve travel time reliability	← 2 projects, \$1.5 million →					
Framework integrating reliability results	← 1 project, \$1.8 million →					
<b>Total</b>	<b>\$20.1 million</b>					

Source: GAO analysis of SHRP 2 data.

Overall, the reliability TCC expects this research will develop and promote programs and strategies that monitor and improve travel time reliability. For example, one project focuses on developing guidance for establishing programs to monitor travel time reliability. Additionally, some projects are expected to use data collected from the SHRP 2 safety projects to understand how driver behavior is affected by relatively unpredictable events that cause congestion. Other projects are expected to develop measures for understanding the effectiveness of strategies used by transportation agencies, while some focus more on the managerial aspects of agencies, such as the identification of the optimal organizational structure to monitor travel time reliability. Moreover, the oversight committee funded 2 projects to incorporate some of the reliability research results into two widely used reference manuals for highway designers—TRB’s *Highway Capacity Manual* and AASHTO’s *Policy on Geometric Design for Highways and Streets*.<sup>26</sup> According to SHRP 2 staff, the inclusion of some of the research results into these reference manuals, such as research on cost-effective highway design features that can reduce the effects of relatively unpredictable events, represents a significant step toward the systematic implementation of the reliability research findings. SHRP 2 staff noted that the incorporation of travel time reliability into highway design, construction, and management is a relatively new concept for the transportation community. The staff said that they are hopeful that

<sup>26</sup>According to TRB, the *Highway Capacity Manual* is the principal reference used by highway designers in making decisions about highway construction and operational improvements. AASHTO’s *Policy on Geometric Design for Highways and Streets* provides guidance on appropriate dimensions for highway facilities and is used to develop design guidelines for freeways, conventional highways, and urban streets.



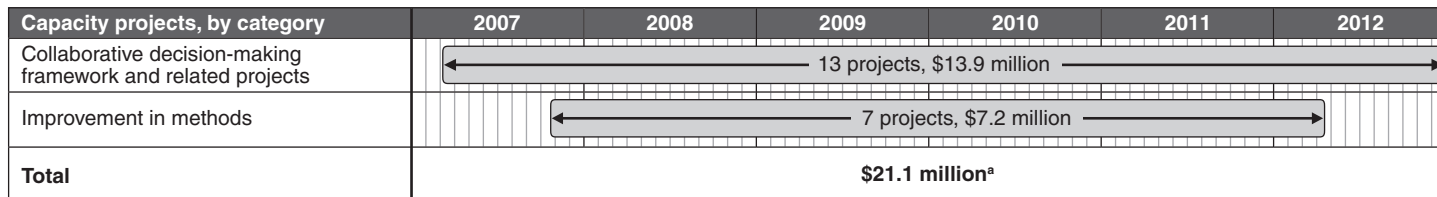
research in this area will result in innovative methods for reducing congestion. See appendix IV for additional information on how these projects were reprioritized for funding and selected information about the currently funded reliability projects.

**About \$21 Million Has Been Allocated for 20 Capacity Research Projects; 13 Are Completed or Ongoing and 7 Are Planned**

As of December 31, 2009, the SHRP 2 oversight committee had allocated about \$21 million to fund 2 completed, 11 ongoing, and 7 future projects, for a total of 20 capacity research projects. The goal of the capacity research is “to develop approaches and tools for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity.” The SHRP 2 capacity TCC expects this research will promote a holistic approach to addressing highway capacity issues.

The capacity TCC divided the capacity projects into two categories: the (1) development of a “collaborative decision-making framework,” to establish a decision-making process that includes environmental, economic, and social impacts of highway capacity efforts, and (2) “improvement in methods” to address common issues that arise during the design, planning, and execution of capacity-enhancing efforts. The oversight committee allocated most of the funds, \$13.9 million (about 66 percent of total capacity funding), for 13 projects related to the first category of projects and \$7.2 million for 7 projects in the second category. Figure 5 provides the projected budget and timeline, by research category, for the SHRP 2 capacity projects.

**Figure 5: Projected Budgets and Timelines for SHRP 2 Capacity Projects**



Source: GAO analysis of SHRP 2 data.

<sup>a</sup>The SHRP 2 oversight committee allocated \$0.25 million from reliability research to the capacity research area to incorporate strategies for improving travel time reliability into the decision-making process for highway capacity efforts.

The capacity TCC expects the outcomes of the 13 capacity projects to develop a framework for improving collaboration among transportation agencies, community and government stakeholders, and the general

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public, which could result in more comprehensive, efficient, and informed decision making. Specifically, the collaborative decision-making framework is expected to (1) provide guidance to agencies at key decision points and (2) help transportation stakeholders consider a variety of issues throughout the decision-making process. The following issues are included in the framework:

- community issues (e.g., comparative assessments of how alternative capacity efforts affect communities);
- environmental issues (e.g., analyses of how capacity-enhancing projects affect greenhouse emissions and the effective protection of wetlands);
- economic issues (e.g., assessments of matters, such as the expected increase in employment and tax revenue of highway capacity projects to the local economy); and
- travel time reliability issues (e.g., the effective loss of capacity because of relatively unpredictable events that cause congestion).

In addition, the capacity TCC expects the outcomes of the remaining seven projects will provide better methods for improving capacity efforts, such as models and analyses needed to assess the consequences of capacity-related enhancements. For example, one project is expected to establish partnerships with local transportation agencies and develop and operationalize an innovative travel demand model for analyzing the effects of capacity management strategies. The capacity TCC expects that this project will help transportation agencies better understand how their management strategies affect highway capacity, such as how their decisions about speed limits or the use of reversible travel lanes affect congestion. Another project in this category is expected to help transportation practitioners understand the impact of highway tolls and other pricing strategies on highway congestion. See appendix V for additional information on how these projects were reprioritized for funding and selected information about the currently funded capacity projects.

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**Because of Funding and Time Constraints, 50 of the 106 Projects Identified in 2003 Were Eliminated Entirely, while Many of the Remaining 56 Projects Had Portions of Their Planned Research Eliminated**

As a result of SHRP 2's reprioritization process, 50 of the 106 projects identified in 2003 were eliminated entirely, and many of the remaining 56 projects that either evolved into, or were merged with, one or more SHRP 2 projects had one or more aspects of their research eliminated from funding. As discussed, the reprioritization process was needed to adjust to funding and time constraints that had not been anticipated when the programs' detailed project plans were developed in 2003. According to SHRP 2 staff, in the end, the oversight committee typically funded applied research to develop products critical to transportation agencies and other stakeholders—rather than many of the implementation-related activities, such as testing the research results in real-world settings. Thus, the eliminated research typically was for, among other activities, (1) translating research results into products (i.e., research applications), (2) training and dissemination of the research findings (i.e., technology transfer), and (3) providing technical support for implementing research products and technologies and for demonstrating new technologies (i.e., research implementation).

According to DOT and AASHTO officials and SHRP 2 staff, early results of the SHRP 2 research have been promising but likely would be enhanced with additional funding to restore some of the eliminated research. DOT officials and SHRP 2 staff explained that initial research results often require additional research and development in real-world trials before a usable product is ready for implementation. Thus, in their collective view, to fully achieve the original expectations for SHRP 2, it will be important to eventually fund some of the research that had to be eliminated because of funding and time constraints. SHRP 2 staff further explained that the sooner new research findings are implemented, the earlier that the performance and economic benefits of the research will begin to accrue. Similarly, in June 2008, the Chief Deputy Director of the California Department of Transportation (and AASHTO representative) testified before the House Subcommittee on Technology and Innovation that the ultimate success of SHRP 2 research will depend on widespread deployment. According to SHRP 2 staff, they are hopeful that other researchers will develop projects for implementing some of SHRP 2's research after the program's completion.

The following sections provide information on some of the eliminated research.

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## Safety

Of the 15 safety projects identified in 2003, 6 projects were eliminated entirely, including 2 of the 3 projects related to the site-based risk study. As discussed, this study was expected to use multiple overhead video cameras to record the relative position and motion of each vehicle passing through selected locations under different traffic conditions or with different signal phases (e.g., left turns and yellow lights) to evaluate the effect on the traffic. To complete the study, the SHRP 2 safety TCC originally anticipated that 3 projects would be funded to (1) develop technology and methods for data collection and conduct a pilot test, (2) implement the study in field tests, and (3) analyze the resulting data and assess the implications of these data. However, because of funding and time constraints, the oversight committee funded only 1 of the 3 projects and, thus, SHRP 2 will not, according to the safety TCC, result in a comprehensive assessment of the risk of collision associated with driver behavior.

In addition, the 2 projects identified in 2003 for evaluating countermeasures were not funded.<sup>27</sup> Overall, this research was intended to (1) address the effectiveness of existing countermeasures through rigorous, retrospective studies of accidents under different conditions, and (2) support the development of new countermeasures. The first of the 2 eliminated projects was expected to identify and prioritize countermeasure issues for subsequent evaluations, while the second project would have evaluated the identified countermeasure issues to determine the associated benefits and costs based on retrospective crash data. A key requirement for both of these projects was the use of expected data from the site-based risk and naturalistic driving studies. However, because designing field studies requires substantial resources and time, neither of these projects was funded.

According to DOT officials and SHRP 2 staff, the 2 site-based and 2 countermeasures evaluation projects were dropped, in part because they expected more promising outcomes from the naturalistic driving study.<sup>28</sup> AASHTO representatives agreed and told us that it would not have been

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<sup>27</sup>Countermeasures include key roadway design characteristics, such as grade and curvature, and roadway treatments, such as rumble strips, signage, and markings.

<sup>28</sup>Additionally, according to SHRP 2 staff, the countermeasure projects were similar to other ongoing safety research.

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helpful to reduce funding for the naturalistic driving study to, instead, fund other projects because a larger, more comprehensive data set on driver behavior is needed for developing new and improved countermeasures. Thus, given limited funding, the SHRP 2 safety TCC decided to allocate most of the safety funding toward the development of this data set.

Finally, while the oversight committee funded all but 2 of the naturalistic driving study projects identified in 2003, that research also was affected by funding realities. Specifically, the study originally was intended to collect 3 years of data from about 4,000 volunteer drivers. However, 1 year and about 1,000 volunteers had to be eliminated from the planned study because of the shorter time frame for carrying out SHRP 2. According to SHRP 2 staff, an additional year of research would have yielded about 50 percent more data at little additional cost, since the equipment for the vehicles already would have been purchased. See appendix II for additional information on how the safety projects identified in 2003 were reprioritized for funding and the currently funded safety projects.

### **Renewal**

Of the 38 renewal projects identified in 2003, 17 projects were eliminated entirely. According to DOT and SHRP 2 staff, the renewal area probably was most affected by the reprioritization process because many of the projects identified in 2003 were daisy-chained together and thus dependent on the completion or initiation of other related projects. Many of the 17 projects were eliminated for this reason, while others were eliminated because they were similar to other recent, current, or planned research. Additionally, given less funding and time than originally anticipated, the SHRP 2 renewal TCC decided that many of the 17 projects, including several projects for developing technologies and techniques to (1) continuously monitor the health and performance of bridges and (2) improve their maintenance with minimum disruptions to users, should be eliminated from funding consideration because they were of lower priority than other research projects.

Further, while not entirely eliminated, some of the renewal projects selected for funding were reduced in scope, and implementation activities related to the research were not funded. For example, all of the renewal projects identified in 2003 that focused on innovative methods to locate and characterize underground utilities were scaled down because they depended on the outcomes of projects that had not been funded. In other cases, laboratory evaluations, field case studies, and demonstrations of proposed systems for improving pavements and bridges were eliminated

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because related pilot projects for implementing the research were not funded. See appendix III for additional information on how the renewal projects identified in 2003 were reprioritized for funding and the currently funded renewal projects.

### **Reliability**

Of the 33 reliability projects identified in 2003, 20 projects were eliminated entirely. As with the other areas, SHRP 2 staff told us that the reliability projects identified in 2003 needed to be reevaluated to fund as many high-priority projects as possible given available funding and time frames. According to the staff, the reprioritization of these projects was the most challenging area and, consequently, required the assistance of a facilitator to aid in the decision-making process. Because research for reducing the impact of relatively unpredictable causes of congestion and improving travel time reliability is new, the collection of SHRP 2 projects identified in 2003 was expected to provide a comprehensive approach to collecting real-time information for use in assessing travel time reliability. However, given less funding and time than had been expected, the SHRP 2 reliability TCC decided to focus on high-priority projects needed to collect and analyze fundamental data for improving travel times for travelers.

In addition, some of the 20 eliminated projects were designed to improve agencies' response to relatively unpredictable events through the use of new technologies to (1) monitor traffic and roadway conditions, (2) instantaneously communicate information about incidents and work zones to highway users, and (3) provide information about transporting hazardous materials to better prepare agencies that respond to accidents. Furthermore, several of the eliminated projects were designed to study the effect of various weather and pavement conditions on travel time reliability. According to SHRP 2 staff, these and other reliability projects identified in 2003 had to be eliminated because of funding and time constraints for conducting follow-on projects needed to apply the research results and transfer the technology developed to highway practitioners and other users. Thus, according to the staff, field tests to demonstrate the usefulness of the research to practitioners, provide additional insights into how the results can be implemented by agencies and other users, and create more usable future products will be needed following completion of SHRP 2. See appendix IV for additional information on how the reliability projects identified in 2003 were reprioritized for funding and the currently funded reliability projects.

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## Capacity

Of the 20 capacity projects identified in 2003, 7 projects were eliminated entirely. According to FHWA officials and SHRP 2 staff, the philosophy underlying this research area had to be completely reevaluated largely because the research planned in 2003 envisioned a much larger and broader scale of research. Specifically, many of the 2003 projects related to the development of a “virtual workspace” for highway planning and development intended to visually illustrate the effects of alternative planning approaches. According to SHRP 2 staff, the virtual workspace, once developed, would have facilitated simultaneous data transfer between highway practitioners at each step of the highway planning process. However, the SHRP 2 capacity TCC scaled down or eliminated most of the projects for advanced data gathering, access, and the computerized display elements that would be required for the virtual workspace, and, instead, decided to focus on research needed to produce the collaborative decision-making framework for highway planning and development.

SHRP 2 staff told us that most of the scaled-down or eliminated projects were for research application and implementation, such as technology transfer. Specifically, regarding the application of research results, many of the eliminated projects were expected to (1) enhance public and stakeholder support for capacity-enhancing projects and (2) develop partnerships to provide training and implement the research.<sup>29</sup> Collectively, these projects were intended to result in the systematic integration of environmental, economic, and community requirements into the analysis, planning, and design for enhancing highway capacity. In addition, while the currently funded capacity research projects are expected to result in the development of (1) a Web-based tool for using the collaborative decision-making framework and (2) manuals and tools to assist transportation agencies make more comprehensive and informed decisions, according to SHRP 2 staff, additional implementation, including technology transfer, will be needed to help ensure that the research results are widely implemented. See appendix V for additional information on

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<sup>29</sup>While many of the projects identified in 2003 involving partners, such as states and metropolitan planning organizations, were eliminated, according to FHWA officials and SHRP 2 staff, two of these projects were retained. The first of the retained projects involves field testing the collaborative decision-making framework, while the second involves field-testing approaches to mitigate environmental impacts.

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how the capacity projects identified in 2003 were reprioritized for funding and the currently funded capacity projects.

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## Agency Comments

We provided a draft of this report to DOT and TRB for review and comment. DOT and TRB provided technical clarifications, which we incorporated, as appropriate.

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We are sending copies of this report to other interested congressional committees and members, DOT, TRB, and others. The report also is available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or [wised@gao.gov](mailto:wised@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix VI.



David J. Wise  
Director, Physical Infrastructure Issues



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*List of Committees*

The Honorable Barbara Boxer  
Chairman  
The Honorable James M. Inhofe  
Ranking Member  
Committee on Environment and Public Works  
United States Senate

The Honorable John D. Rockefeller  
Chairman  
The Honorable Kay Bailey Hutchison  
Ranking Member  
Committee on Commerce, Science, and Transportation  
United States Senate

The Honorable James L. Oberstar  
Chairman  
The Honorable John L. Mica  
Ranking Member  
Committee on Transportation and Infrastructure  
House of Representatives

The Honorable Bart Gordon  
Chairman  
The Honorable Ralph M. Hall  
Ranking Member  
Committee on Science and Technology  
House of Representatives

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# Appendix I: Scope and Methodology

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To address our three reporting objectives, we reviewed the legislative requirements, goals, and objectives for the Second Strategic Highway Research Program (SHRP 2), including the Transportation Equity Act for the 21st Century; the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU); and the SAFETEA-LU Technical Corrections Act of 2008. We also reviewed the Department of Transportation's strategic plan for fiscal years 2006-2011, and the Federal Highway Administration's October 2008 Strategic Plan and its Corporate Master Plan for Research and Deployment of Technology and Innovation. In addition, we reviewed and analyzed literature, studies, and reports related to the research program. Our review included reports by GAO and the Congressional Research Service that provided background information on the first Strategic Highway Research Program, SHRP 2, and the Federal Highway Administration's research and technology program, including its federal-aid highway program. We also reviewed the Transportation Research Board's (TRB) Special Report 260: *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life*;<sup>1</sup> Special Report 261: *The Federal Role in Highway Research and Technology*;<sup>2</sup> Special Report 296: *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life*;<sup>3</sup> and the National Cooperative Highway Research Program's Report 510: *Interim Planning for a Future Strategic Highway Research Program*.<sup>4</sup> Finally, we reviewed quarterly, semiannual, and annual SHRP 2 reports; annual research plans for the four SHRP 2 research areas; and report summaries of the funded SHRP 2 projects.

To address our first two objectives (i.e., determining the process for selecting research projects for funding and the status of those projects), we reviewed the statutory requirements for SHRP 2 and reviewed available agency and program documentation. We also determined how the program

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<sup>1</sup>TRB, Special Report 260: *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life*, (Washington, D.C.: November 2001).

<sup>2</sup>TRB, Special Report 261: *The Federal Role in Highway Research and Technology*, (Washington, D.C.: December 2001).

<sup>3</sup>TRB, Special Report 296: *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life*, (Washington, D.C.: April 2009).

<sup>4</sup>National Cooperative Highway Research Program Report 510: *Interim Planning for a Future Strategic Highway Research Program: Summary Report*, (Washington, D.C.: October 2003).

is monitored and the program's reporting requirements. In addition, we obtained and analyzed agency and program documentation on projects that were either funded or identified for potential funding in the 2003 detailed research plans, as well as the revised plans for reprioritizing projects for funding. We also reviewed this documentation to identify how TRB plans to evaluate the research and how the outcomes of the research are expected to address highway challenges.

To address our third objective (i.e., determining what, if any, planned research was eliminated from the program), we compared program documentation related to the currently funded projects with the four research areas identified in Special Report 260 and the projects identified in the 2003 research plans. We also determined how actual funding for the four research areas compared with the funding levels recommended in Special Report 260. Because of time constraints, we did not assess the appropriateness of funding decisions or projects selected for SHRP 2 funding.

To address all three objectives, we also interviewed agency officials from the Department of Transportation (DOT), the Federal Highway Administration, and the National Highway Traffic Safety Administration, and representatives from the National Research Council, TRB, SHRP 2 staff, and the American Association of State Highway and Transportation Officials (AASHTO).

We conducted this performance audit from June 2009 through February 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

# Appendix II: Safety Research Projects

The SHRP 2 oversight committee funded many of the safety projects identified in the 2003 detailed research plans based on the recommendations of the SHRP 2 safety technical coordinating committee. As a result, 9 of the 15 safety projects identified in 2003 either evolved or were partially merged into the currently funded safety projects and 6 were eliminated. Table 6 provides information on the safety projects identified in 2003 and how they were reprioritized for funding. Table 7 provides information on the 16 currently funded SHRP 2 safety projects.

**Table 6: How Safety Projects Identified in 2003 Were Reprioritized for Funding**

Safety projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 2–1.1: Legal and Privacy Issues in Recruiting Volunteer Drivers and Vehicles for Field Studies of Driving Safety		✓	
Project 2–1.2: Development of Analysis Methods for Site-Based Risk Studies Using Recent Data			✓
Project 2–1.3: Development of Analysis Methods for Vehicle-Based Risk Studies Using Recent Data		✓	
Project 2–1.4: Development of Comprehensive Roadway Information in a Geographical Information System Database	✓		
Project 2–1.5: Application of Original Equipment Manufacturer Electronic Data Recorders for Risk Studies			✓
Project 2–2.1: Vehicle-Based Risk Study—Phase I: Study Design	✓		
Project 2–2.2: Vehicle-Based Risk Study—Phase II: Pilot Study		✓	
Project 2–2.3: Vehicle-Based Risk Study—Phase III: Field Study	✓		
Project 2–2.4: Vehicle-Based Risk Study—Phase IV: Intersection Analysis and Countermeasure Implications		✓	
Project 2–2.5: Vehicle-Based Risk Study—Phase IV: Road Departure Analysis and Countermeasure Implications	✓		
Project 2–2.6: Site-Based Risk Study—Phase I: Study Design and Pilot	✓		
Project 2–2.7: Site-Based Risk Study—Phase II: Field Study			✓
Project 2–2.8: Site-Based Risk Study—Phase III: Analysis and Countermeasure Implications			✓
Project 2–3.1: Identify Countermeasure Evaluation Topics			✓

**Appendix II: Safety Research Projects**

Safety projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 2-3.2: Retrospective Countermeasure Evaluation Projects			✓
<b>Total</b>	<b>5</b>	<b>4</b>	<b>6</b>

Source: GAO presentation of TRB and SHRP 2 information.

<sup>a</sup>For the purposes of this report, projects that “evolved” are those that had their core research elements largely addressed in one or more funded SHRP 2 projects.

<sup>b</sup>Some portion or portions of these projects were merged to form one or more currently funded SHRP 2 projects.

**Table 7: The 16 Currently Funded SHRP 2 Safety Projects, as of December 31, 2009**

Project number	Project title	Project cost	Start date (approx.)	Completion date (approx.)
S01A	Development of Analysis Methods Using Recent Data	\$300,000	2/05/2007	8/04/2009
S01B	Development of Analysis Methods Using Recent Data	300,000	3/19/2007	4/30/2010
S01C	Development of Analysis Methods Using Recent Data	300,000	2/05/2007	7/31/2009
S01D	Development of Analysis Methods Using Recent Data	100,000	3/01/2007	5/08/2008
S01E	Development of Analysis Methods Using Recent Data	300,000	3/02/2007	4/30/2010
S02	Integration of Analysis Methods	421,639	3/02/2007	1/31/2010
S03	Roadway Measurement System Evaluation	529,999	12/19/2007	12/31/2009
S04A	Roadway Information Database Development and Technical Coordination and Quality Assurance of the Mobile Data Collection Project (S04B)	1,000,000	3/01/2010	5/31/2012
S04B	Mobile Data Collection	3,500,000	10/01/2010	4/30/2012
S05	Design of the In-Vehicle Driving Behavior and Crash Risk Study	3,034,000	6/01/2007	10/31/2009
S06	Technical Coordination and Independent Quality Assurance for Field Study	6,200,003	11/01/2009	10/31/2012
S07	In-Vehicle Driving Behavior Field Study	16,489,644	4/01/2010	12/31/2012
S08	Analysis of In-Vehicle Field Study Data and Countermeasure Implications	5,527,953	9/01/2010	6/30/2012
S12	Data Acquisition System: Procurement quality assurance	154,864	10/01/2008	6/30/2010
S12A	Data Acquisition System: Equipment and Vendor	10,000,000	9/22/2009	7/31/2012

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Appendix II: Safety Research Projects

Project number	Project title	Project cost	Start date (approx.)	Completion date (approx.)
S09	Site-Based Video System Design and Development	1,041,898	2/28/2007	2/28/2010
16	<b>Total</b>	<b>\$49,200,000</b>		

Source: GAO presentation of SHRP 2 information.

# Appendix III: Renewal Research Projects

The SHRP 2 oversight committee funded many of the renewal projects identified in the 2003 detailed research plans based on the recommendations of the SHRP 2 renewal technical coordinating committee. As a result, 21 of the 38 renewal projects identified in 2003 either evolved or were partially merged into the currently funded renewal projects and 17 were eliminated. Table 8 provides information on the renewal projects identified in 2003 and how they were reprioritized for funding. Table 9 provides information on the 28 currently funded SHRP 2 renewal projects.

**Table 8: How Renewal Projects Identified in 2003 Were Reprioritized for Funding**

Renewal projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 1–1.1: Utilities Location Technology Advancements	✓		
Project 1–1.2: Geotechnical Solutions for Soil Improvement and Rapid Embankment Construction		✓	
Project 1–1.3: Replacement of Conventional Materials with High-Performance Materials in Bridge Applications			✓
Project 1–1.4: Rapid Rehabilitation Strategies of Specialty Structures			✓
Project 1–1.5: Micropiles for Renewal of Bridge Foundations			✓
Project 1–1.6: Needs Assessment and Implementation Plan for Developing a Comprehensive Intelligent Project Delivery System			✓
Project 1–1.7: Facilitating the Use of Recycled Aggregates			✓
Project 1–1.8: Identifying and Reducing Worker, Inspector, and Manager Fatigue in Rapid Renewal Environments	✓		
Project 1–2.1: Modular Bridge Systems			✓
Project 1–2.2: Develop Bridge Designs that Take Advantage of Innovative Construction Technology	✓		
Project 1–2.3: Modular Pavement Technology	✓		
Project 1–3.1: High-Speed, Nondestructive Testing Procedures for Both Design Evaluation and Construction Inspection	✓		
Project 1–4.1: Performance Specifications	✓		
Project 1–4.2: Alternate Contracting Strategies for Rapid Renewal		✓	
Project 1–4.3: Incentive-Based Specifications to Assure Meeting Rapid Renewal Project Goals		✓	
Project 1–4.4: Development and Evaluation of Performance-Based Warranties		✓	
Project 1–4.5: Risk Manual for Rapid Renewal Contracts	✓		

**Appendix III: Renewal Research Projects**

Renewal projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 1–4.6: Innovative Project Management Strategies for Large, Complex Projects	✓		
Project 1–5.1: Strategic Approaches at the Corridor and Network Level to Minimize Public Disruption from the Renewal Process	✓		
Project 1–5.2: Integrating the “Mix of Fixes” Strategy into Corridor Development			✓
Project 1–5.3: Strategic Approaches for Financing Large Renewal Projects			✓
Project 1–6.1: New Guidelines for Improving Public Involvement in Renewal Strategy Selection			✓
Project 1–6.2: New Guidelines for Improving Business Relationships and Emergency Response During Renewal Projects			✓
Project 1–6.3: Utilities–State Department of Transportation Institutional Mitigation Strategies	✓		
Project 1–6.4: Railroad–State Department of Transportation Institutional Mitigation Strategies	✓		
Project 1–6.5: Context-Sensitive Designs and Construction Operations to Minimize Impact on Adjacent Neighborhoods			✓
Project 1–7.1: Design, Installation, and Maintenance of Work Zones for High Consistency, Visibility, and Safety			✓
Project 1–8.1: Durable Bridge Subsystems	✓		
Project 1–8.2: Design for Desired Bridge Performance	✓		
Project 1–8.3: Composite Pavement Systems	✓		
Project 1–8.4: Stabilization of the Pavement Working Platform		✓	
Project 1–8.5: Using Existing Pavement in Place and Achieving Long Life	✓		
Project 1–9.1: Nondestructive Evaluation Methodology for Unknown Bridge Foundations			✓
Project 1–9.2: Development of Rapid Renewal Inputs to Bridge Management and Inspection Systems			✓
Project 1–9.3: Monitoring and Design of Structures for Improved Maintenance and Security			✓
Project 1–10.1: Preservation Approaches for High Traffic Volume Roadways	✓		
Project 1–10.2: Bridge Repair/Strengthening Systems			✓
Project 1–10.3: Techniques for Retrofitting Bridges with Non-redundant Structural Members			✓
<b>Total</b>	<b>16</b>	<b>5</b>	<b>17</b>

Source: GAO presentation of TRB and SHRP 2 information.



**Appendix III: Renewal Research Projects**

<sup>a</sup>For the purposes of this report, projects that “evolved” are those that had their core research elements largely addressed in one or more funded SHRP 2 projects.

<sup>b</sup>Some portion or portions of these projects were merged to form one or more currently funded SHRP 2 projects.

**Table 9: The 28 Currently Funded SHRP 2 Renewal Projects, as of December 31, 2009**

<b>Project number</b>	<b>Project title</b>	<b>Project cost</b>	<b>Start date (approx.)</b>	<b>Completion date (approx.)</b>
R01	Encouraging Innovation in Locating and Characterizing Underground Utilities	\$389,993	2/12/2007	12/10/2011
R01A	Technologies to Support Storage, Retrieval, and Utilization of 3-Dimensional Utility Location Data	1,000,000	9/01/2009	2/28/2012
R01B	Multi-sensor Platforms for Locating Underground Utilities	2,000,000	11/03/2009	5/02/2012
R01C	Innovation in Location of Deep Utilities	1,615,000	10/01/2009	3/31/2012
R02	Geotechnical Solutions for Soil Improvement, Rapid Embankment Construction, and Stabilization of the Pavement Working Platform	3,000,000	9/25/2007	9/24/2011
R03	Identifying and Reducing Worker, Inspector, and Manager Fatigue in Rapid Renewal Environments	1,000,000	10/01/2009	3/31/2012
R04	Innovative Bridge Designs for Rapid Renewal	1,999,052	10/08/2007	10/07/2011
R05	Modular Pavement Technology (Phase I: \$200,000 and Phase II: \$800,000)	1,000,000	2/11/2008	2/10/2011
R06	High Speed, Nondestructive Testing Procedures for Both Design Evaluation and Construction Inspection	350,000	3/16/2007	7/11/2008
R06A	Nondestructive Testing to Identify Concrete Bridge Deck Deterioration	750,000	3/13/2009	9/13/2011
R06B	Evaluating Applications of Field Spectroscopy Devices to Fingerprint Commonly Used Construction Materials	400,000	2/04/2009	2/03/2011
R06C	Using Both Infrared and High-Speed Ground Penetrating Radar for Uniformity Measurements on New HMA Layers	250,000	3/06/2009	3/05/2011
R06D	Nondestructive Testing to Identify Delaminations between HMA Layers	800,000	2/20/2009	8/19/2011
R06E	Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction	550,000	2/20/2009	8/19/2011
R06F	Development of Continuous Deflection Device	250,000	4/29/2009	4/28/2011
R06G	High-Speed Nondestructive Testing Methods for Mapping Voids, Debonding, Delaminations, Moisture, and Other Defects Behind or Within Tunnel Linings	1,650,000	9/08/2009	3/07/2012
R07	Performance Specifications for Rapid Renewal	2,999,984	2/27/2007	2/26/2012

**Appendix III: Renewal Research Projects**

<b>Project number</b>	<b>Project title</b>	<b>Project cost</b>	<b>Start date (approx.)</b>	<b>Completion date (approx.)</b>
R09	Risk Manual for Rapid Renewal Contracts	249,961	12/21/2007	6/20/2010
R10	Project Management Strategies for Complex Projects	1,250,000	9/01/2009	2/28/2012
R11	Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process	1,500,000	9/03/2009	3/02/2012
R15	Strategies for Integrating Utility and Transportation Agency Priorities in Highway Renewal Projects	250,000	2/05/2007	8/04/2008
R15B	Identification of Utility Conflicts and Solutions	300,000	3/04/2009	7/03/2011
R16	Railroad-DOT Institutional Mitigation Strategies	400,000	1/25/2008	10/30/2009
R19A	Bridges for Service Life beyond 100 Years: Innovative Systems, Subsystems, and Components	1,999,637	12/21/2007	12/20/2011
R19B	Bridges for Service Life beyond 100 Years: Service Limit State Design	999,990	9/03/2008	3/02/2012
R21	Composite Pavement Systems	3,999,999	9/04/2007	9/03/2011
R23	Using Existing Pavement in Place and Achieving Long Life	999,540	2/11/2008	2/10/2011
R26	Preservation Approaches for High Traffic Volumes Roadways	249,999	2/05/2008	4/04/2010
28	<b>Total</b>	<b>\$32,203,155</b>		

Source: GAO presentation of SHRP 2 information.

# Appendix IV: Reliability Research Projects

The SHRP 2 oversight committee funded many of the reliability projects identified in the 2003 detailed research plans based on the recommendations of the SHRP 2 reliability technical coordinating committee. As a result, 13 of the 33 reliability projects identified in 2003 either evolved or were partially merged into the currently funded reliability projects and 20 were eliminated. Table 10 provides information on the reliability projects identified in 2003 and how they were reprioritized for funding. In addition, 4 funded projects, which had not been identified in 2003, were developed to fill research gaps or provide more affordable research alternatives. Table 11 provides information on the 21 currently funded SHRP 2 reliability projects.

**Table 10: How Reliability Projects Identified in 2003 Were Reprioritized for Funding**

Reliability projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 3–1.1: National and International Scans of Best Practices in Traffic Incident, Weather, Work Zone, and Special Event Management	✓		
Project 3–1.2: National Outreach Program for Transportation Operations Practices			✓
Project 3–2.1: Data Requirements for Operations and Performance Monitoring		✓	
Project 3–2.2: Establishing National and Local Monitoring Programs for Mobility and Travel Time Reliability	✓		
Project 3–2.3: Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies	✓		
Project 3–2.4: Incorporating Reliability Estimation into Planning and Operations Modeling Tools	✓		
Project 3–2.5: Incorporating Mobility and Reliability Performance Metrics into the Transportation Programming Process	✓		
Project 3–2.6: Quantifying the Costs of Travel Time Reliability			✓
Project 3–3.1: Institutional Architectures for Implementation of Operational Strategies	✓		
Project 3–3.2: Public Official and Senior Management Education Program on the Benefits of Improved Transportation Operations			✓
Project 3–3.3: Highway Funding and Programming Structures to Promote Operations			✓
Project 3–3.4: Personnel Requirements for Conducting Effective Traffic Incident, Work Zone, and Special Event Management			✓
Project 3–4.1: Advanced Surveillance Technologies for Operations			✓

**Appendix IV: Reliability Research Projects**

	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
<b>Reliability projects identified in 2003</b>			
Project 3–4.2: Technologies to Communicate Traffic Control and Queue Propagation to Motorists			✓
Project 3–4.3: Systems for Tracking Hazardous Material Movements Nationwide			✓
Project 3–5.1: Improvement in Knowledge of Existing Weather and Pavement Conditions			✓
Project 3–5.2: Improved Forecasting of Near-Term Weather and Pavement Conditions			✓
Project 3–5.3: Using Road Weather, Safety, and Travel Reliability Data to Identify Ways to Improve Travel Time Reliability			✓
Project 3–5.4: Development of Better Mitigation Options for Weather Events			✓
Project 3–6.1: Identification and Evaluation of the Cost-Effectiveness of Highway Design Features to Reduce Nonrecurrent Congestion	✓		
Project 3–6.2: Incorporation of Nonrecurrent Congestion Factors into the Highway Capacity Manual	✓		
Project 3–6.3: Incorporation of Non-Recurrent Congestion Factors into the AASHTO Policy on Geometric Design	✓		
Project 3–6.4: The Relationship between Recurring and Nonrecurring Congestion			✓
Project 3–7.1: Quantification of the Causes and Effects of Inappropriate Driver Response to Adverse Weather, Roadside Distractions, Traffic Incident Scenes, and Queues			✓
Project 3–7.2: Measures for Reducing Inappropriate Driver Response to Adverse Weather, Roadside Distractions, Traffic Incident Scenes, and Queues			✓
Project 3–7.3: Improving Merging Behavior on Urban Freeways			✓
Project 3–8.1: Delay and Reliability Impacts of Traveler Information Systems			✓
Project 3–8.2: Increasing the Credibility of Travel Time Predictions with Travelers			✓
Project 3–8.3: Near-Term Analysis of Traveler Information Market and Its Impact on Public-Sector Operational Strategies			✓
Project 3–8.4: Real-Time Data Fusion to Support Traveler Information Systems			✓
Project 3–9.1: Implementation of Alternative Traffic Operation Strategies	✓		
Project 3–9.2: Advanced Queue and Traffic Incident Scene Management Techniques	✓		

**Appendix IV: Reliability Research Projects**

Reliability projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 3–9.3: Simulation and Gaming Tools for Traffic Incident Response	✓		
<b>Total</b>	<b>12</b>	<b>1</b>	<b>20</b>

Source: GAO presentation of TRB and SHRP 2 information.

<sup>a</sup>For the purposes of this report, projects that “evolved” are those that had their core research elements largely addressed in one or more funded SHRP 2 projects.

<sup>b</sup>Some portion or portions of these projects were merged to form one or more currently funded SHRP 2 projects.

**Table 11: The 21 Currently Funded SHRP 2 Reliability Projects, as of December 31, 2009**

Project number	Project title	Project cost	Start date (approx.)	Completion date (approx.)
L01	Integrating Business Processes to Improve Travel Time Reliability	\$397,789	2/25/2008	12/31/2009
L02	Establishing Monitoring Programs for Mobility and Travel Time Reliability	1,800,000	3/18/2009	3/17/2012
L03	Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies	1,749,998	2/27/2007	2/28/2010
L04	Incorporating Reliability Performance Measures in Operations and Planning Modeling Tools	1,250,000	2/06/2009	2/16/2012
L05	Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes	1,500,000	2/01/2010	1/31/2012
L06	Institutional Architectures to Advance Operational Strategies	1,000,000	2/28/2007	2/15/2010
L07	Evaluation of Cost-Effectiveness of Highway Design Features to Improve Travel Time Reliability	2,750,000	1/07/2008	1/06/2012
L08	Incorporating Non-Recurrent Congestion Factors into the Highway Capacity Manual Methods	500,000	1/03/2011	5/31/2012
L09	Incorporating Non-Recurrent Congestion Factors into the AASHTO Policy on Geometric Design	500,000	1/03/2011	5/31/2012
L10	Feasibility of Using In-Vehicle Video Data to Explore How to Modify Driver Behavior that Causes Non-Recurring Congestion	300,000	1/08/2009	4/30/2010
L10A, L10B, & L10C	Using In-Vehicle Data to Explore How to Modify Driver Behavior That Causes Non-Recurring Congestion	1,200,000	1/03/2011	5/31/2012
L11	Evaluating Alternative Operations Strategies to Improve Travel Time Reliability	1,000,000	9/03/2008	3/02/2010

**Appendix IV: Reliability Research Projects**

<b>Project number</b>	<b>Project title</b>	<b>Project cost</b>	<b>Start date (approx.)</b>	<b>Completion date (approx.)</b>
L12	Training and Certification of Traffic Incident Responders	999,942	3/19/2008	6/18/2010
L13	Requirements and Feasibility of a System for Archiving and Disseminating Data from SHRP 2 and Related Studies	374,919	9/24/2008	3/31/2010
L13A	Design and Implement a System for Archiving and Disseminating Data from SHRP 2 and Related Studies	1,135,000	2/01/2011	1/31/2012
L14	Effectiveness of Different Approaches: Traveler Information and Travel Time Reliability	1,000,000	9/01/2009	8/31/2011
L15	Reliability Innovations Deserving Exploratory Analysis	500,000	6/01/2010	2/28/2012
L16	Assistance to Contractors to Archive Their Data for Reliability and Related Projects	350,000	7/01/2010	2/28/2012
L17	A Framework for Improving Travel Time Reliability	1,800,000	9/01/2010	2/28/2012
<b>21</b>	<b>Total</b>	<b>\$20,107,648</b>		

Source: GAO presentation of SHRP 2 information.

# Appendix V: Capacity Research Projects

The SHRP 2 oversight committee funded many of the capacity projects identified in the 2003 detailed research plans based on the recommendations of the SHRP 2 capacity technical coordinating committee. As a result, 13 of the 20 capacity projects identified in 2003 either evolved or were partially merged into the currently funded capacity projects and 7 were eliminated. Table 12 provides information on the capacity projects identified in 2003 and how they were reprioritized for funding. In addition, 2 funded projects, which had not been identified in 2003, were developed to fill research gaps or provide more affordable research alternatives. Table 13 provides information on the 20 currently funded SHRP 2 capacity projects.

**Table 12: How Capacity Projects Identified in 2003 Were Reprioritized for Funding**

Capacity projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 4–1.1: Improving Our Understanding of Highway Users and the Factors Affecting Travel Demand	✓		
Project 4–1.2: Improving Our Understanding of Transportation System Performance	✓		
Project 4–1.3: Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs	✓		
Project 4–1.4: Improving Our Understanding of Approaches to Integrate Watershed and Habitat Fragmentation Considerations into Transportation Planning and Development, with an Emphasis on Highways		✓	
Project 4–1.5: Improving Our Understanding of Interactions between Transportation Capacity and Economic Systems	✓		
Project 4–1.6: Improving Our Understanding of the Relationship between Highway Capacity Projects and Land Use Patterns		✓	
Project 4–2.1: Applying Location- and Tracking-Based Technologies to Collect Data for Systems Planning and Project Development			✓
Project 4–2.2: Applying Remote Sensing Technologies to Collect Data for Transportation Systems Planning and Project Development			✓
Project 4–2.3: Facilitating Systems Planning and Project Development via an Integrated Environmental Resource Information System			✓
Project 4–2.4: Improving Public Participation by Enhancing Project Visualization Tools	✓		

**Appendix V: Capacity Research Projects**

Capacity projects identified in 2003	SHRP 2 funding decision		
	Project evolved into SHRP 2 projects <sup>a</sup>	Project had elements merged with other SHRP 2 projects <sup>b</sup>	Project was eliminated entirely
Project 4–2.5: Developing and Applying a Decision-Support Tool for Integrated Systems Planning and Project Development	✓		
Project 4–3.1: Integrating Environmental Stewardship and Enhancement into System Planning and Project Development	✓		
Project 4–3.2: Integrating Economic Considerations into Project Development		✓	
Project 4–3.3: Reducing Duplication and Process Delays in Planning and Project Development			✓
Project 4–3.4: Ensuring Support for Highway Capacity Projects by Improving Collaborative Decision Making		✓	
Project 4-3.5: Improving the Quality and Timeliness of Projects via Better Public Involvement			✓
Project 4–3.6: Screening Transportation Solutions in an Integrated Systems Planning and Project Development Process		✓	
Project 4–4.1: Improving Project Management during the Development and Delivery of Highway Projects			✓
Project 4–4.2: Improving Project Cost Estimates			✓
Project 4–4.3: Satisfying Commitments and Meeting Customer Expectations in Final Project Design and Construction		✓	
<b>Total</b>	<b>7</b>	<b>6</b>	<b>7</b>

Source: GAO presentation of TRB and SHRP 2 information.

<sup>a</sup>For the purposes of this report, projects that “evolved” are those that had their core research elements largely addressed in one or more funded SHRP 2 projects.

<sup>b</sup>Some portion or portions of these projects were merged to form one or more currently funded SHRP 2 projects.



Table 13: The 20 Currently Funded SHRP 2 Capacity Projects, as of December 31, 2009

Project number	Project title	Project cost	Start date (approx.)	Completion date (approx.)
C01	A Framework for Collaborative Decision-Making on Additions to Highway Capacity	4,249,994	2/09/2007	3/31/2012
C02	A Systems-Based Performance Measurement Framework for Highway Capacity Decision-Making	825,000	2/28/2007	10/30/2009
C03	Interactions Between Transportation Capacity, Economic Systems, and Land Use Merged with Integrating Economic Considerations Project Development	2,149,997	1/15/2008	12/31/2010
C04	Improving Our Understanding of Highway Users and the Factors Affecting Travel Demand	1,000,000	9/21/2007	6/10/2010
C05	Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs	1,000,000	1/07/2008	9/30/2009
C06A	Integration of Conservation, Highway Planning, and Environmental Permitting Using an Outcome-Based Ecosystem Approach	700,000	9/03/2008	3/02/2011
C06B	Development of an Ecological Assessment Process and Credits System for Enhancements to Highway Capacity	792,648	10/10/2008	10/11/2010
C08	Linking Community Visions and Highway Capacity Planning	800,000	2/04/2009	8/03/2010
C09	Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process	800,000	2/10/2009	8/09/2010
C10A	Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained, Time-Sensitive Network	1,400,000	8/13/2009	2/12/2012
C10B	Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained, Time-Sensitive Network	2,599,999	9/01/2009	2/28/2012
C11	Development of Improved Economic Analysis Tools Based on Recommendations from Project C03	200,000	9/01/2010	3/31/2012
C12	The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision-Making	300,000	9/01/2010	1/31/2012
C15	Integrating Freight Considerations into Collaborative Decision-Making for Additions to Highway Capacity	300,000	9/01/2010	1/31/2012
C16	The Effect of Smart Growth Policies on Travel Demand	425,000	1/03/2011	3/31/2012

**Appendix V: Capacity Research Projects**

<b>Project number</b>	<b>Project title</b>	<b>Project cost</b>	<b>Start date (approx.)</b>	<b>Completion date (approx.)</b>
C18	Pilot Test the Collaborative Decision-Making Framework with Three State Departments of Transportation, Including a Self-Assessment Method	1,250,000	9/01/2010	3/31/2012
C19	Add Expedited-Schedule Case Studies to the Collaborative Decision-Making Framework Data Base	300,000	9/01/2009	8/31/2010
C20	Freight Demand Modeling and Data Improvement Strategic Plan	550,000	9/01/2009	2/28/2011
C21	Pilot Test Approaches to Environmental Protection (using projects C06 A and C06 B)	1,250,000	1/03/2011	3/31/2012
C22	Prepare Decision Makers Guide to Collaborative Decision-Making Framework	200,000	1/03/2011	12/31/2012
<b>20</b>	<b>Total</b>	<b>\$21,092,638</b>		

Source: GAO presentation of SHRP 2 information.

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# Appendix VI: GAO Contact and Staff Acknowledgments

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## GAO Contact

David J. Wise, (202) 512-2834 or [wised@gao.gov](mailto:wised@gao.gov)

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## Staff Acknowledgments

In addition to the contact named above, Kathleen Turner, Assistant Director; Vashun Cole; Silvia Arbelaez-Ellis; Dana Hopings; and Amy Rosewarne made important contributions to this report.

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