STRATEGIC HIGHWAY RESEARCH PROGRAM 2
CAPACITY RESEARCH PLAN
Providing Highway Capacity in Support of the Nation’s Economic, Environmental, and Social Goals
March 2007

Executive Summary

The overall SHRP 2 Capacity program goal as stated in TRB Special Report 260 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 scope of the Capacity program, as defined by the SHRP 2 Oversight Committee, extends from the early stages of the transportation planning process when many potential alternatives are being considered through project development. When decisions include a major highway component, further development of the highway option is within the scope. When decisions are made that lead to non-highway options, further development of the non-highway component is outside the scope.

The Technical Coordinating Committee (TCC) for Capacity has met on June 26-27 and October 16, 2006. The TCC defined the overall Capacity research program, based on the Interim Plan completed in 2003 as subsequently constrained by SAFETEA-LU funding. The TCC concluded that the essence of delivering new highway capacity is an effective process for collaborative decision making, supported by better tools for analyzing impacts on the economy, environment, and communities. Accordingly, the TCC selected and combined projects from the Interim Plan and assigned budgets. The TCC selected seven projects that address the essence of the goal, reserving approximately $8 million to develop specific tools that will be selected based on the insights of the other projects. On July 17, 2006, the SHRP 2 Oversight Committee approved two Capacity projects for the fall of 2006: C01 and C02. On December 29, 2006, the Oversight Committee approved projects C03, C04, and C05 for calendar 2007.

The Capacity Research Plan consists of the following projects, which the TCC concludes will have the greatest positive impacts:

- C01: Improving collaborative decision making and the process for selecting solutions to capacity problems. One product of this effort will be recommendations for tools to be developed under Project C07 that will have maximum impact on practice.

- C02: Application of system-based performance measures to the decision making process. “System-based” includes measures pertaining to the economy, the transportation network, the human environment, and the natural environment.

- C03: Integrating the economic and land value benefits of adding highway capacity into the decision process and communicating these benefits to the public and elected officials in a convincing manner. Note: This project was re-scoped in March 2007 and the project description in this document has been revised.
• C04: Better understanding of how highway users react to congestion delays and road pricing

• C05: Broadening our definition of “adding highway capacity” to include the contribution of operational and design improvements.

• C07: Development of high-priority products to support collaborative decision making. (Topics to be generated by other SHRP 2 research.)

• C08: If funding permits, a project on watershed and habitat fragmentation will be conducted.

• Also contingent on funding, the scope of project C04 and C05 could be expanded.

All projects support the effort in project C01 to develop an improved collaborative decision making and solution selection process. Figure 1 shows the interrelationship of projects and Table 1 lists titles and funding levels.

Figure 1
Relationship of capacity Research Projects
TABLE 1
Capacity Projects: December 2006

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Title</th>
<th>Allocated by TCC</th>
<th>Budget Assigned by ETG</th>
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<tr>
<td></td>
<td><strong>2006 Funding</strong></td>
<td>($ Millions)</td>
<td>($ Millions)</td>
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<tr>
<td>C01</td>
<td>A Framework for Collaborative Decision Making on Additions to Highway Capacity (Includes concepts of watershed and habitat preservation and environmental stewardship)</td>
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<td>$2.6</td>
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<td>C02</td>
<td>Systems-Based Performance Measurement Framework for Highway Capacity Decision Making.</td>
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<td></td>
<td><strong>2007 Funding</strong></td>
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<td>C03</td>
<td>Interactions between Transportation Capacity, Economic Systems, and Land Use and Integrating Economic Considerations in Project Development</td>
<td>$4.0</td>
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<tr>
<td>C04</td>
<td>Improving Our Understanding of Highway Users and the Factors Affecting Travel Demand (Emphasis on pricing and congestion)</td>
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<td>C05</td>
<td>Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs</td>
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<td></td>
<td><strong>Future Funding</strong></td>
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<tr>
<td>C07</td>
<td>Development of high priority modules to support collaborative decision making</td>
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<td></td>
<td><strong>Capacity Program Total</strong></td>
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<td></td>
<td><strong>Recommendations if more funding becomes available</strong></td>
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<tr>
<td>C08</td>
<td>Improving our Understanding of Approaches to Integrate Watershed and Habit Fragmentation Considerations into Transportation Planning and Development, with an emphasis on Highways</td>
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<tr>
<td></td>
<td>Expand scope of fundamental research on travel demand under C04</td>
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<td></td>
<td>Add operations modeling component to C05</td>
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<tr>
<td></td>
<td><strong>Capacity Program total if more funding available</strong></td>
<td>$24.0</td>
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When Expert Task Groups (ETGs) meet to develop the actual request for proposal, they assign a budget appropriate for the scope of work. This may be less than the amount allocated by the TCC,
but not more. In the case of C01, the ETG did not feel that any tools could be developed without work to identify the most needed tools with more specificity. Accordingly, the ETG for project C01 included a task to recommend to the TCC the most needed tools. That recommendation will provide the basis for programming the remaining of funds allocated to C01 and the funds held in reserve as project C07.

At the October 16, 2006, meeting the TCC decided to merge the scopes and budgets for projects C03 and C06 relating to economic issues. A special task group will be convened to rework the scope, and the revised scope will be reviewed by the TCC in March 2007. An RFP is scheduled for July 2007.

Capacity Project C05, Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs, has much in common with Reliability Project L04, Incorporating Reliability Estimations into Planning and Operations Modeling Tools. The two responsible SHRP 2 staff officers will prepare a white paper recommending a course of action to the TCC. The Capacity TCC will review the white paper in March 2007.

2006 PROJECTS

C01: A Framework for Collaborative Decision Making on Additions to Highway Capacity

Budget: $2.6 million ($4.0 million allocated by TCC)

Objectives: (1) Develop a system-based, transparent, well-defined framework for consistently reaching collaborative decisions on transportation capacity enhancements and (2) identify a SHRP 2 research strategy for addressing gaps in supporting information systems.

Statement of the Problem: Transportation projects of all types involve decisions by a wide range of stakeholders, including transportation agencies, environmental and other resource agencies, tribal governments, elected officials, and the public. Large projects often span multiple jurisdictions and involve decisions by federal, state, and local governments. A broad array of information must be assembled and communicated to inform the decision makers and stakeholders. The stakes are high. The economic health, mobility, and safety of the nation depends on adequate transportation capacity, yet controversy over mode, alignment, environmental impacts, cultural impacts, and the fundamental value of the enterprise may delay major projects for decades.

One of the problems to be addressed by this research is how to consistently balance the many competing interests so that we can make better decisions on adding transportation capacity and make them in a timely manner. A collaborative decision framework is anticipated that includes at least these elements:

- Existing processes that influence or are influenced by transportation planning and project development (e.g., statewide and metropolitan planning, project development, project engineering, corridor planning, NEPA and permitting processes, economic development, and resource management.)
• Decision points in each process and connectivity across processes. The proposed framework should include decision points that may be external to transportation planning but can influence the outcome.
• the relationships among stakeholders – elected officials, agencies, businesses, interest groups, citizens
• strategies for interactive communication
• supporting information technology, analysis tools, and data

The second problem addressed by this research is provision of the necessary decision support for a truly systems based analysis of potential transportation solutions (alternatives). A systems-based approach must assess the transportation capacity problems, considering a range of solutions that include highway operational improvements, transit, demand management, non-highway freight options, and highway construction. In addition the economic justification for a project must be convincing, and the human and natural environment must be protected to everyone’s satisfaction. More than just mitigation is required. A culture of environmental stewardship is expected. Highway agencies must work early and jointly with resource agencies to proactively improve neighborhood quality of life, watersheds and wildlife habitats. This requires analysis tools, data, data integration, and effective communication to constituencies.

Delivering a set of tools to support system-based analysis in a collaborative decision-making environment is a prodigious task, because existing tools are at various stages of maturity, data are not necessarily available, they are not of the same degree of completeness and precision, measures of performance are not universally accepted, the scientific basis for analysis is not universally accepted, and the conflict issues vary from project to project. A systems-based solutions screening process is desired that uses performance measures to assess, for each alternative, the costs, economic justification, capacity added, and impact on the human and natural environmental.

Expected research products:

• Ten case studies selected to identify the decision-making elements common to successful delivery of additional highway capacity

• A state of the practice report on system-based solution screening – decision support tools.

• A recommended collaborative decision-making framework (or frameworks) and decision support system

• A special report to the Capacity TCC on the tools that could be developed under SHRP 2 that will have the greatest positive impact on collaborative decision making

• Dissemination materials and five outreach programs

C02: Systems-Based Performance Measurement Framework for Highway Capacity Decision Making

Budget: $ 825,000 (1.0 million allocated by TCC)
Objective: To develop a performance measurement framework that informs a collaborative decision making process. The measures should reflect mobility, accessibility, economic, safety, environmental, watershed, habitat, community, and social considerations. The framework will become and integral component of collaborative decision making and decision support tools.

Statement of the Problem: Transportation agencies recognize the value of measuring system-level performance as a way to achieve consensus on controversial additions to highway capacity. Performance measures are valuable because:

- Each constituency sees a measure that relates to its concern
- Each constituency can better see the concerns of others
- The decision process is more transparent
- A better collective understanding is achieved of the transportation problem being addressed

Despite the value, many methodological, data, and analytic challenges hinder application of system-level performance measures. The goal of this project is to help collaborative decision makers develop and utilize performance measures to make the “right” decisions in transportation planning, project selection, program delivery, and asset management.

To date, agencies have generally had greatest success with operations and maintenance-related measures, such as pavement quality, bridge deficiency, and safety; and capacity-related measures such as volume to capacity ratio, or level of service rating. Well established data collection and analysis techniques have reinforced the use of these and similar measures as tools for decision making.

Success has been more elusive in other areas of system performance such as environment, accessibility, quality of life, or economic benefits. This is partly attributable to the fact that in these areas transportation agencies can not directly achieve target levels of performance through their own actions. For instance, water quality is affected by farming, households, industry, soil type and highway runoff. A highway may have a measurable effect on an adjacent stream, but not on the watershed. There is a scale issue that measures must address. For that reason in this project, both measures and indicators will be addressed. A measure can be affected directly by the action of a transportation agency through the decision process and the results measured objectively. An indicator is important, but is affected by many additional factors. It can be measured, but the condition of the resource cannot be totally ascribed to a transportation project.

Tremendous opportunities exist to broaden system-level performance measurement to include non-traditional elements of system performance. Many transportation agencies, however, are struggling to develop system performance measures in these areas. Some of the challenges that must be overcome include performance measure design, data collection, target setting, and interpretation and use of results. Better approaches are needed for quantifying transportation system performance in non-traditional ways. The ability to better understand system-level performance in terms of economic, mobility, accessibility, safety, environmental, community, and social considerations may lead to more collaborative decision making during system planning and project development. Transportation solutions, programs and projects can be planned to optimize performance measures selected by transportation agencies and their stakeholders.

The intent of this project is to create flexible frameworks to support system performance measurement that individual agencies can tailor to meet their needs. The performance
measurement framework will be incorporated into the collaborative decision making products of the SHRP 2 Capacity program.

Expected Research Products:

- A system-based framework for transportation performance measures in a collaborative decision-making process
- An editable, knowledge-based template for a web resource for delivering the information to practitioners:
  - A performance measures library and classification system
  - Examples of best practice that can be augmented by users
  - A plan for short- and long-term location and maintenance

2007 PROJECTS

C03: Interactions between Highway Capacity, Economic Systems, and Land Use and Integrating Economic Considerations in Project Development

Budget: $4.0 million

Objectives: To better understand the contribution of highway capacity improvements to regional economic vitality and land value; to develop methods to convincingly describe the regional economic effects of additions to highway capacity; and to develop institutional mechanisms and frameworks for ensuring that capacity enhancement decisions reflect economic development considerations.

Statement of the Problem: Strengthening the economic vitality of a region is one of the primary reasons for investing in highway capacity. Elements of improving economic vitality include better access to markets and labor force, reduced cost of delay, reduced congestion, improved safety, reduced pollution, and a better quality of life. However, the ways in which new and improved highway capacity influences economic vitality are complex and often indirect.

History is clear that improving transportation alone will not improve the economic vitality of a region unless other positive factors are present. This implies that the impacts of capacity enhancement vary with the type of area, the major economic drivers, economic growth forces, the nature of capacity problems, and the solutions proposed. One size does not fit all. In addition to primary impacts, we must also consider secondary and cumulative economic impacts in order to address the overall impact on regional economic vitality. The ultimate question for governments and taxpayers is will a transportation investment achieve the desired economic effect?

Many analytical tools exist for estimating economic impacts, but there is a general sense of dissatisfaction among decision makers and the public with the results. There is also an impression that the public does not appreciate or understand the critical role of highway capacity in sustaining the economy, enabling economic growth, and improving economic efficiency. Finally, planning processes do not generally reflect the economic effects of highway capacity on land use, and the economic effects are not well integrated into the highway capacity decision making process.

This project will strive to resolve these issues. The products will support the collaborative decision making framework being developed in SHRP 2 Project C01. That collaborative
framework will provide the forum for balancing transportation, economic impact, and environmental concerns.

Expected Research Products

- A critique, from a decision maker point-of-view, of the methods and results of economic impact analysis for new highway capacity.
- A categorization (typology) of conditions affecting the economic impact of highway capacity, e.g., urban high growth, suburban, rural, very rural, transitional, port city.
- Improved methods and tools, including case-study-based tools, to better represent the primary, secondary, and cumulative contribution of highway capacity to the economic vitality of different types of regions, including the impact on land values.
- Guidelines for convincingly communicating economic impacts.
- Recommendations for better integrating economic development impacts into systems planning, project development and the collaborative decision making framework being developed under SHRP 2 Project C01.

C04: Improving Our Understanding of Highway Users and the Factors Affecting Travel Demand

Budget: $1.0 million

Objective: To fill information gaps on critical relationships defining the demand for passenger and freight travel, with particular emphasis on congestion and pricing, so that travel demand models can be further improved to reflect the system-wide effects of highway capacity expansion decisions.

Background: The interaction between the demand for highway travel and the carrying capacity of highway systems is complex. As congestion worsens, for example, the cost of highway travel can increase significantly, and the manner in which users respond is not fully understood. Depending on the availability and convenience of alternative modes, a region’s built environment and land development patterns, and similar factors, different users tend to react differently to increases in generalized transportation costs. In the case of freight transport, trade-offs among the components of logistics (transportation, warehousing, inventory) can come into play as the reliability and efficiency of the highway system changes. In general, the demand for travel on an enhanced facility increases precisely because costs have fallen. If everything else remains the same, then the capacity of the entire system is increased, and increases in demand on the improved facility are off-set by decreases on other facilities.

Yet, even a casual observer knows that hardly any of the factors affecting transportation demand (at a facility or system level) stay the same—the population of regions change; the size of economies and demographics change; the logistics of moving freight changes in response to competition; and the very presence of new facilities induces new demand. In the long run, housing and business location patterns change in ways that are affected by markets, transportation costs, and many other forces that affect the demand for and carrying capacity of highway systems.

Under such a dynamic and often unpredictable reality, it should not be surprising that accurately forecasting the demand for highway travel is a daunting task. However, such forecasts are often
the backbone around which highway investment decisions are made. We must forecast demand as reliably as possible.

The purpose of this project is to build on work, being conducted by programs such as the Travel Model Improvement Program, to increase our fundamental understanding of highway users and the factors and forces affecting the demand for highway travel with particular emphasis on the effects of congestion and pricing on passenger and freight demand for highways.

Note: The TCC recommends adding $2.0 million if additional funding becomes available to extend fundamental research on travel demand in areas recommended by the Expert Task Group. Forecasting is so critical to the transportation decision-making process that, even though it has been extensively studied over the last 50 years, the need for improvement is so great that this is an appropriate focus of SHRP 2 Capacity if additional funds become available.

Expected products: The product of this project will be documentation on how passenger and commercial travelers react to congestion delays and pricing. The documentation will be presented in a form that can be incorporated into travel demand models to better support decision making on highway capacity.


Budget: $1.0 million

Objective: To develop approaches for re-defining highway capacity given improvements in operations, vehicle technology, context sensitive design, and other developments, so highway capacity projects reflect transportation-as-a-system considerations.

Problem Statement: A wide range of developments affects the number of vehicles that can be accommodated by highway facilities. New approaches to traffic operations that improve traffic flow at intersections and interchanges, changes in highway configurations (such as roundabouts and other design features), freeway management technology (such as ramp metering systems), and the design of vehicles has important ramifications on how practitioners plan the capacity of new facilities. For example, in Maryland improved signalization has changed expectations about the number of vehicles that can be accommodated on arterial facilities—from 1,000 per hour per lane to 1,400. On freeways, lane volumes routinely exceed by 25% or more volumes formerly considered maximum capacity.

The development of an integrated, systems-oriented approach to planning and project development requires a comprehensive perspective on how to increase the capacity of highway systems. Developments such as the ones described above are changing expectations about the carrying capacity of facilities. The problem addressed by this project is how to ensure that the full range of capacity enhancement measures available to practitioners is considered in planning and designing new facilities. One of the key considerations in new highway capacity must be how to optimize that capacity via use of new technology and design options.

It should be noted that while measures to reduce the demand for highway travel (often called transportation demand management) are important for better utilizing the capacity of transportation infrastructure, they are not the focus of this research project. Given growth in travel demand that is expected to far outstrip supply, and expectations that other organizations will be
dedicating resources to demand management approaches (e.g., road pricing, land use measures, car sharing), it is recommended that the Capacity focus area of F-SHRP focus on operations, technology, and design measures that will increase the effective capacity of highway systems.

**Note:** If additional funding becomes available, the TCC recommends an additional $1.0 million to operationalize the findings of the primary research in software that can be incorporated into the collaborative decision making modules developed project C07.

**Expected Products:** Handbook on integrating effective capacity decisions into transportation systems planning

### FUTURE CAPACITY RESEARCH PROJECTS

**Project C07: Development of High-Priority Modules to Support Collaborative Decision Making**

**Budget:** $8 million

**Objective:** To develop products, based on the recommendations from project C01 and others, which will make the maximum possible contribution to the state of the practice in delivering highway capacity.

**Statement of the Problem:** To be determined.

**Expected Research Products:** Specific, tangible products requested by the Capacity TCC to support collaborative decision making.

**Project C08: (Contingent on additional funding) Improving our Understanding of Approaches to Integrate Watershed and Habit Fragmentation Considerations into Transportation Planning and Development, with an emphasis on Highways**

**Budget:** $2.0 million

**Objective:** To develop approaches for integrating watershed and habitat fragmentation considerations into transportation planning and development, with a focus on highways, so that environmental stewardship, enhancement, and impact mitigation can be improved at the systems level. The findings of the project would be incorporated into the collaborative decision making framework and decision support modules.

**Statement of the Problem:** This research project recognizes that while there are many fundamental research needs in regard to transportation and the environment, other research programs will address many of these issues. The Federal Highway Administration’s Environmental Research Program and Surface Transportation Environment and Planning Cooperative Research Program (STEP) plus on-going research by the U.S. Environmental Protection Agency will conduct research related to air quality, noise, hazardous materials, global warming, and human health. The Transportation Research Board’s Environmental Research Needs in Transportation Conference (2002) identified over a hundred high priority research projects that may be funded by NCHRP, FHWA, or other entities. As a result, this research project focuses on watershed and habitat fragmentation issues as the two most critical
environmental concerns affecting highway planning and development in order to meet a vision of environmental stewardship and enhancements to the natural environment.

Adding highway capacity to address mobility, safety, economic development, community, and social needs while protecting and enhancing the natural environment is challenging, and water resources and habitat are some of the most direct and challenging environmental issues facing transportation during project development. Particularly in urban areas where alternative alignments are limited, natural resources such as wetlands, open space, or ecosystems are at a premium. Traditionally, water quality and habitat considerations have focused narrowly on site-specific mitigation techniques, some of which may be of marginal benefit and low cost-effectiveness. A broader understanding of approaches to watersheds and habitat management is needed so that transportation projects can more cost-effectively minimize and mitigate against adverse impacts and in fact enhance water resources and ecosystems.

Conventional storm water management technologies involve ponds and wetlands, which are not practical in urban areas due to lack of space and high costs, or construction of separate facilities where runoff is diverted for treatment and control. A new set of storm water management principles, called Low Impact Development (LID), involves an array of structural and non-structural micro-scale best management practices that are integrated with landscaping and location feature to remove pollutants, particularly in retrofitting urban areas. Other new technologies have been developed for treating ultra urban runoff. Greater understanding is needed, however, of the tradeoffs associated with these practices in terms of safety, traffic serviceability, and community enhancement, so that storm water management can better be integrated into highway planning and design. Better understanding is also needed in regard to systems planning based approaches for the greatest benefit to watersheds, beyond a project specific focus.

Habitat fragmentation poses similar issues. States often are building costly structures for wildlife connectivity, wildlife mortality reduction, and motorist safety but additional research is needed on the most cost-effective long-term approaches. Most efforts to date have been short-term monitoring to see if the target species are using the structures but little consideration has been given to factors that would improve future efforts and to examine broader issues of fragmentation associated with multiple highway projects.

This research project will build on research grounded in environmental science to identify and evaluate approaches for improving water quality and watershed performance and to reduce habitat fragmentation and its effects on wildlife health and population. It will also explore the tradeoffs associated with these approaches and applicability in different environmental contexts. A necessary component of this research will be exploration of measures to reduce the secondary and cumulative impacts of transportation on wetlands, wildlife and ecosystems.

**Expected Products:** A guide for integrating habitat preservation and watershed management into the planning and project development process.

**SHRP 2 CAPACITY SCHEDULE**

Figure 2 shows an anticipated 5-year schedule for capacity projects. The schedule shows first round projects requests for proposal being issued in September 2006, with contracts starting in January 2007. Subsequent annual plans (calendar year) will be selected by the Capacity TCC and approved by the Oversight committee and FHWA. Projects will be released by SHRP 2 staff every six months, following the approved plan, until the end of the program.
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<tr>
<th>SHRP II Capacity Projects</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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