Transportation and the Environment:
A Research Agenda for Oregon

Final Report

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August 2006

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List of Abbreviations

CTS	Center for Transportation Studies
FHWA	Federal Highway Administration
INR	Institute for Natural Resources
JPACT	Joint Policy Advisory Committee on Transportation
NRC	National Research Council
ODOT	Oregon Department of Transportation
OIT	Oregon Institute of Technology
OSU	Oregon State University
OUS	Oregon University System
PSU	Portland State University
RFP	Request for Proposal
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
UO	University of Oregon
USDOT	United States Department of Transportation
UTC	University Transportation Center

Executive Summary

The Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) has established two new research programs – the Surface Transportation Environment Planning (STEP) Cooperative Research Program and the Future Strategic Highway Research Program II (F-SHRP II). The creation of these new programs provides an opportunity for transportation professionals in government, education and industry to address research needs related to transportation and the environment.

In February 2006 Oregon State University hosted a workshop – *Transportation and the Environment: Linking Researchers, Transportation Providers and Industry* – attended by nearly 50 participants representing transportation providers, industry leaders, and academic researchers for the specific purpose of creating a transportation and the environment research agenda. The participants discussed needs and opportunities in the areas of ecology and natural systems, land-use, planning and performance measures, emerging technologies, and environmental and socioeconomic relationships. Key needs and opportunities were identified, and an attempt was made to categorize the needed research.

Among the needs and opportunities for transportation and the environment research, the following ideas rose to the top during the workshop:

- Developing integrated decision-support systems;
- Identifying, developing, and testing opportunities in green infrastructure (including the localization of industries, such as clustering transportation industries, construction material use, and use of recycled materials);
- Developing a process for systematically repairing or replacing culverts within watersheds or ecoregions; and
- Identifying opportunities to study the relationships between transportation and the environment within the context of the development of new cities and community developments in Central and Northern Oregon.

The authors recommend that the new Oregon University Transportation Center play a central role to continue and expand the momentum of this proposed research agenda, to help fulfill its potential, and to allow it to be refined and matured as collaborative partnerships grow and needs and opportunities present themselves.

1.0 Introduction

1.1 Overview

In conjunction with the 2006 Northwest Transportation Conference, a workshop – *Transportation and the Environment: Linking Researchers, Transportation Providers and Industry* – was convened in Corvallis, Oregon on 9 February 2006. The purpose of the workshop was to bring transportation industry leaders and academic researchers together to gain a broader understanding of, and to link, transportation industry needs and research capabilities in Oregon. The intent was to begin developing a research agenda that would position the State of Oregon to apply successfully for anticipated requests for proposals under two new research programs of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in FY2007 – as stated in House Bill 3 under Sections 5203 and 5209. Approximately 46 representatives from academia, government, and industry participated in this by-invitation-only workshop.

Numerous efforts around the state are bringing together people interested in transportation and the environment, but this was the first gathering of such a large and diverse group of Oregon-based academic researchers, transportation providers, and transportation industry leaders for the specific purpose of creating a transportation and the environment research agenda. The participants discussed needs and opportunities in the areas of ecology and natural systems, land-use, planning and performance measures, emerging technologies, and environmental and socioeconomic relationships. Key needs and opportunities were identified, and an attempt was made to categorize the needed research.

This document is a preliminary description of the landscape of transportation and environment research needs and opportunities for the State of Oregon. It should be regarded as a living document to refine and mature through the development of the new Oregon University Transportation Center (a partnership between Portland State University, the University of Oregon, the Oregon Institute of Technology, and Oregon State University). For example, some specific research areas, including human health, presently lack a defined or complete Oregon-specific research agenda.

1.2 Workshop Goals and Objectives

The purpose of the workshop was to bring transportation industry leaders and academic researchers together to gain a broader understanding of transportation industry needs and research capabilities in Oregon as they relate to transportation and the environment. The objectives of the workshop were:

- to inform Oregon transportation providers, industry and researchers about the research provisions of SAFETEA-LU;
- to identify Oregon needs and opportunities that could be met through research funded by these new programs; and
- to link researchers and transportation providers interested in pursuing new projects.

The participants represented many of the various disciplines that collectively define the field of transportation and the environment issues, including: transportation planning; civil, environmental, biological, forest, and transportation engineering; fish and wildlife; horticulture; landscape architecture and ecology; geography; and economics. These disciplines were represented by academics; consultants; industry clusters and associations; and local, regional, state, and federal representatives.

1.3 Workshop Agenda

The principal drivers for this workshop were new research funding opportunities in Sections 5203 and 5209 of SAFETEA-LU, conference reauthorization bill (HR 3), which created new cooperative research programs related to transportation and the environment. The key research areas mentioned in HR 3, Sections 5203 and 5209, are more fully addressed in two reports issued by the Transportation Research Board in Washington, D.C: *Surface Transportation Environmental Research: A Long-Term Strategy* (TRB Special Report 268, 2002); and *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life* (TRB Special Report 260, 2001). These research programs are also referred to as the Surface Transportation Environment Planning (STEP) Cooperative Research Program and the Future Strategic Highway Research Program II (F-SHRP II), respectively.

A few weeks before the workshop was to be held, a Transportation Research Board (TRB) and Federal Highway Administration (FHWA) meeting was held in Washington D.C. to address the implementation of the research programs. Though Institute for Natural Resources (INR) staff could not attend this meeting, through phone calls to the TRB and FHWA program coordinators and through Barnie Jones' (ODOT Research) attendance, INR staff learned that the initial funding opportunities for these collaborative research programs were going to be limited due to reduced funding, and that most of the expected programs were already designated (see Appendices 1 and 2).

The workshop was intended to address the following research areas as defined in HR 3 Sections 5203 and 5209 (see Appendix 3):

- human health
- ecology and natural systems
- environmental and social justice
- emerging technologies

- land use (planning and designing new road capacity to meet mobility, economic, environmental, and community needs)
- planning and performance measures

During the participation solicitation and planning stages and early in the workshop, it was recognized that there were not enough experts present to truly represent human health research issues. Thus, given the change of allocation and designation of funds for the programs, the workshop focused on developing a transportation and the environment research agenda that better reflected the needs and opportunities of those attending the workshop.

1.4 New Opportunity for Oregon Transportation and the Environment Research

Through the efforts of Congressman Peter DeFazio (D-Oregon), Congressman Earl Blumenauer (D-Oregon), and other members of the conference committee, $16 million was included in SAFETEA-LU for an Oregon University Transportation Center (UTC). Awarded to Portland State University's (PSU) Center for Transportation Studies (CTS), the $16 million is designated to support the collaborative and collective research efforts of several Oregon University System (OUS) institutions – PSU, the University of Oregon (UO), the Oregon Institute of Technology (OIT), and Oregon State University (OSU). Supported by the Joint Policy Advisory Committee on Transportation (JPACT) and the Oregon Department of Transportation (ODOT), the UTC will focus on Oregon's unique collaborative approach to the planning and implementation of transportation systems that emphasize the connections between land use, livability, and growth. A transportation and the environment research agenda can fit within two of the UTC goals (research selection and research performance) particularly as the UTC focuses on the U.S. Department of Transportation (USDOT) research priorities, as outlined in the USDOT 2003-2008 strategic plan – one of which is environmental stewardship (See Appendix 4).

2.0 Background

2.1 Status of Transportation and the Environment Research

The National Research Council (NRC) assembled the Committee on Ecological Impacts of Road Density to review the scientific information on the ecological effects of federally-funded, paved highways in urban and rural areas. This review included the impacts of roads and highway density on ecosystem structure and function and on the provision of ecosystem goods and services. The Committee did not focus on urban street networks, nor did it address the ecological effects of unpaved roads, or global or regional climate effects.

According to the Committee, current research in the area of transportation and the environment, particularly the environmental and ecological effects of roads, is not widely accessible as it is not in the academic, peer-reviewed literature (NRC, 2005). In a recent NRC report, the Committee stated:

> *For example, studies documenting the effects of roads on stream sedimentation have been reported in documents of state departments of transportation, the U.S. Army Corps of Engineers, and the World Bank. Although much of this literature is available through bibliographic databases, it is not included in scientific abstracting services and may not be accessible to a broader research community. Also, the data needed to evaluate regulatory programs are not easily accessible or amenable to synthesis. The data are typically contained in project-specific environmental impact statements, environmental assessments, records of decision, or permits (for example, wetlands permits), which are not easily available to the scientific community (NRC, 2005:224).*

The Committee also stated that while there have been studies on the local- and intermediate-scale ecological effects of roads, few have examined the complex nature of the environmental effects of roads. Though the appropriate spatial scale for ecological research is not always known beforehand, some ecological effects of roads may go undetected if an inappropriate scale is chosen (NRC, 2005). One of the Committee's nine conclusions (shown in Figure 1) speaks to this information gap by stating:

> *Ecological effects of roads at local scales (within a few kilometers of the roads) have been widely studied, documented, and understood, while effects at large scales are less documented and understood. More is known about the effects of bridges, overpasses, and culverts on flows of materials and organisms than about the effects of roads on larger patterns and processes, such as watersheds or migratory pathways (NRC, 2005:8).*

Most road projects today involve modifications to existing roadways, and the planning, operation, and maintenance of such projects often are opportunities for improving ecological conditions.

Planning boundaries for roads and assessing associated environmental effects are often based on socioeconomic considerations, resulting in a mismatch between planning scales and spatial scales at which ecological systems operate. Few studies have addressed the complex nature of the ecological effects of roads, and the studies that have done so were often based on small sampling periods and insufficient sampling of the range of variability in ecological systems.

The assessment of the cumulative impacts of road construction and use is seldom adequate... Impacts on certain resources are typically authorized through permits. Permitting programs usually consider only direct impacts of road construction and use on a protected resource, even though indirect or cumulative effects can be substantial.

The methods and data used for environmental assessment are insufficient to meet the objectives of rapid assessment, and there are no national standards for data collection.

With the exception of certain legally specified ecological resources, such as endangered or threatened species and protected wetlands, there is no social or scientific consensus on which ecological resources affected by roads should be given priority attention. In addition, current planning assessments that focus on transportation needs rarely integrate other land-management objectives in their assessments.

The state transportation project system offers the opportunity to consider ecological concerns at early planning stages.

Elements of the transportation system, including the types of vehicles and their fuels, will continue to evolve. Changes in traffic volume and road capacity, mostly through widening of roads rather than construction of new corridors, have smaller but nevertheless important ecological effects compared with the creation of new, paved roads.

Much useful information from research on the ecological effects of roads is not widely available because it is not in the peer-reviewed literature…Although much of this literature is available through bibliographic databases, it is not included in scientific abstracting services and may not be accessible to a broader research community.

Transportation agencies have been attempting to fill an institutional gap in ecological protection created by the multiple social and environmental issues that must be addressed at all phases of road development. The gaps often occur when problems arise that are not covered by agency mandates or when agencies need to interact with other organizations in new ways.

(NRC, 2005: 220-225)

Figure 1: Conclusions on the Review of Scientific Information on the Ecological Effects of Federally-funded, Paved Highways

Though there is a need for more and better information about cumulative, long-term, and large-scale effects of roads on the environment, a great deal is known about the ecological effects of roads on smaller scales. The report, which reviews, summarizes, and synthesizes much of the available scientific information on the ecological effects of federally-funded roads, can be read online at the National Academy Press site (http://www.nap.edu/catalog/11535.html).

2.2 ODOT Environmental Research Priorities

ODOT's Research Unit administers the state's federally-funded research, development and technology transfer program and emphasizes new technologies that aim to improve the performance of Oregon's transportation systems. Current research focuses on safety, infrastructure repair and preservation, maintenance practices, innovative contracting and project delivery, sustainable environmental practices, and the connection between land-use and transportation. The Research Unit categorizes research into eight areas, for which each area has an expert task group (ETG) that serves as an advisory committee:

- structures
- construction and maintenance
- traffic, safety, and ITS
- integrated multi-modal
- roadway design and human factors
- pavements and materials
- planning and economic analysis
- geotechnical, hydraulics, and environment

Those involved on the "Geotechnical, Hydraulics, and Environment" expert task group have identified nine research priorities (shown in Table 1) that serve as challenges to Oregon's transportation system.

Table 1: "Geotechnical, Hydraulics, and Environment" Expert Task Group Identified Research Priorities

Subject Area	Research Priority
Environmental	1. Plant Establishment 2. Habitat Connectivity 3. Human Environment
Hydraulics	1. Stormwater Management 2. Open-channel Hydraulics 3. Culverts
Geotechnical	1. Slopes 2. Walls 3. Foundations

Source: ODOT Strategic Research Priorities [online] http://www.oregon.gov/ODOT/TD/TP_RES/ResPriorities.shtml#Geotechnical__Hydraulics__Env

Research priorities are updated on an annual basis and go through a thorough reevaluation about every five years. With the determination of this year's research priorities the "Geotechnical, Hydraulics, and Environment" expert task group also provide a summary of issues that prompted these nine issues to surface as research priorities (Figure 2). For examples of ODOT environmental research see Appendix 5.

2.3 Developing an Oregon Transportation and the Environment Research Network

Across the nation, Oregon is distinguished for its reputation of environmental consciousness in both the public and private sectors. With Oregon's growing population and increased demand on both its transportation and natural systems, it was recognized that the State of Oregon has yet to develop a research agenda that will help address current needs and anticipated changes in the transportation and natural systems. Such an agenda would focus on developing and contributing to a knowledge base to support decision-making.

Though public-private research collaborations are taking place throughout Oregon, there is a need to conduct research that meets transportation provider and industry needs as well as to understand and formally evaluate the dynamics of transportation and the environment as they pertain to Oregon and the nation.

Many organizations and academic disciplines across the state are involved in either environmental or transportation research. However, with regard to the intersection of the two, there is not an agreed-upon set of priorities in Oregon; and, with the exception of certain partnerships and initiatives, little coordination exists across the state. Thus, there is no way to ensure that key gaps are addressed, that research results are fed into decision-making, government policies and programs, or that the research community is able to take advantage of funding and research opportunities.

The development of an Oregon-specific transportation and the environment research network would focus attention on priority needs and opportunities for research and form the basis of a strategy that would make a compelling case to support such research. With the opportunity presented by the establishment of the University Transportation Center (UTC), the UTC can provide a forum for a focused transportation and the environment research agenda, not only to assist in forming the connections to continue developing the agenda, but possibly as an investment strategy and the ability to undertake the proposed research in the most effective manner.

- **Plant Establishment**: The establishment of plants in an around Oregon's transportation system is important for easy maintenance, compliance with regulations and aesthetics. The establishment of desirable plants such as in landscaping and wetlands enhancement as well as the control of undesirable plants present significant problems that might benefit from research.
- **Habitat Connectivity**: The connected network of Oregon's transportation system is super imposed on natural and manmade environments. Consequently, this results in intersections and interactions of these environments. Some of the labels given to these interactions include fish passage, wildlife crossings, and context sensitive design. Minimizing the mutual impacts of these systems or seeking mutual enhancements might benefit from research
- **Human Environment**: Oregon's transportation system is an integral part of the human environment. To maximize its contribution to that environment issues such as hazardous materials, historical preservation, archeological investigation, and noise control need to be addressed efficiently and effectively. Research to enhance either efficiency or effectiveness could contribute to a better environment.
- **Storm Water Management**: Modern transportation systems create extensive areas of impervious surface. Handling of precipitation that falls on these surfaces is integral to the function of the system. Key issues relating to storm water management include water quality, UICs, and corridor master planning.
- **Open-Channel Hydraulics**: Oregon's transportation system crosses or parallels rivers, streams and channels throughout the state. Coexisting with these features requires that they be included in the design, construction, and maintenance of the system. Research regarding issues such as flood plains, bridge hydraulics and bank protection could result in better designs, easier construction and lower maintenance.
- **Culverts**: Culverts of many types and sizes are part of Oregon's transportation system. Being able to assess the condition of these culverts and replace them using "trenchless" techniques are important issues that need improved solutions. Tide gates and temporary water management are additional issues regarding culverts that could benefit from research.
- **Slopes**: Slopes are transient features on the earth. For an efficient transportation system changes in slopes need to be as slow and gradual as possible. Cut slopes, embankments and natural slopes all must be addressed to achieve slow gradual changes. Research into the methods to assure or reestablish optimally slow gradual change has the potential to both reduce maintenance costs and minimize disruptions of the system.
- **Walls**: Oregon's transportation system largely uses walls for two purposes. The first is as retaining walls. Innovations in retaining walls might result in lower construction or maintenance costs or improved performance. The second application of walls is for noise control. The economy, aesthetics, and effectiveness of these noise walls might be improved through research.
- **Foundations**: All of Oregon's transportation system rests on some sort of foundation. Optimizing the reliability of these foundations is essential to establishing the best system possible. Deep foundations are often necessary. These must perform their function while be affordable to construct. Materials and methods affect both the performance and the construction of these foundations. Shallow foundations are often sufficient but are equally important. Site conditions can often present unique challenges for both design and construction. Pavement subgrade is another type of foundation that can be challenging based on site conditions or unusual load demands. Research in these areas might improve ODOT's ability to build and maintain and efficient transportation system.

Source: ODOT Strategic Research Priorities [online]
http://www.oregon.gov/ODOT/TD/TP_RES/ResPriorities.shtml#Geotechnical__Hydraulics___Env

Figure 2: Issues Prompting ODOT Geotechnical, Hydraulic, and Environmental Identified Research Priorities

2.4 Existing Networks

Building a research agenda is not sufficient without knowing what is needed to fulfill it: what are Oregon's strengths and weaknesses? Building and acting upon such an agenda involves supporting existing and emerging networks and research collaborations. Understanding these existing networks will show the kind of support and connections that can be fostered more broadly.

Issue-based research collaborations are already taking place in areas such as wildlife, stormwater, and air quality, among others. For instance, the consulting firm GeoSyntec and faculty at OSU have a continuing collaboration in stormwater research. Another example is the collaboration between the trucking industry, the Oregon Department of Environmental Quality, and OSU in studying how to reduce air emissions from idling trucks. Some thematic research collaborations and networks are well-established, while others are in development (e.g., sustainable infrastructure, sustainable transportation indicators). Each of these collaborations can contribute to an overall research agenda and assist in communication among and between academics, transportation providers, industry, and policy-makers.

3.0 Organization of the Workshop

Principal steps in the organization of this workshop included the following: 1) organizing and designing the workshop; 2) identifying Oregon experts who should be invited to the workshop; 3) preparing a briefing document highlighting collaborative transportation and the environment research; 4) writing the workshop findings in the form of a report; and, 5) disseminating the findings to interested parties.

Staff from the Institute for Natural Resource (INR) at Oregon State University organized and facilitated the workshop. To get a range of representatives to invite to the workshop INR staff invited over 150 people representing the transportation industry (consultants, designers, contractors, and industry cluster representatives), transportation providers (city, county, state, and federal), and academics who are involved in transportation research and/or environmental research as it applies to transportation. Approximately 46 people participated in this workshop (see Appendix 6).

To prepare them for the workshop, participants were given a briefing document highlighting the intent and areas of research in HR 3 Sections 5203 and 5209. The purpose of the briefing document was to set some common ground by providing the details of each of the collaborative research programs including funding amounts and sources, program timelines, and the national research agenda (see Appendix 3).

The workshop agenda was designed to solicit the greatest amount of information in the shortest timeframe (see Appendix 7), while allowing time for discussion in both small and large groups. The workshop was intended to be flexible enough for it to take on a life of its own, following the direction developed by the interaction of the participants. With the exception of a brief opening presentation by Gail Achterman (see Appendix 8), the entire workshop allowed for "mixing" in small and large groups.

4.0 Oregon Research Agenda

The proposed research agenda that emerged from the workshop is categorized under five research area headings; ecology and natural systems; land use and planning; emerging technologies, socioeconomic relationships; and performance measures. Workshop participants saw some of the research items outlined in HR 3 Sections 5203 and 5209 as important for Oregon and included them in the proposed Oregon research agenda. In some cases, specific research items were elaborated on and in others they were not. In the categorization, some research issues were relevant to more than one area, and on occasion there was overlap between issues/items listed in the different research areas. This could not be avoided, as the field of transportation and the environment is multidisciplinary and the research areas are interconnected.

The research agenda presented here is a draft and is expected to be updated as issues, needs, opportunities, and collaborative partnerships evolve throughout Oregon. Although developed by a number of leading experts in Oregon, the agenda reflects an emerging and dynamic field. As such, this agenda is presented to provide direction for collaborative, public-private research partnerships and should be viewed as a living document.

Some of the opportunities to pursue the research outlined in the research agenda are described in Section 5, "Oregon Research Agenda – Opportunities." The agenda is presented according to five research areas.

Though the NRC report focused on paved, federal roads, it is noteworthy to consider the Oregon transportation and the environment research agenda in light of their research recommendations (Figure 3).

Research on the ecological effects of roads should be multi-scale and designed with reference to ecological conditions and appropriate levels of organization (such as genetics, species and populations, communities, and ecological systems.)

Additional research is needed on the long-term and large-scale ecological effects of roads (such as watersheds, ecoregions, and species' ranges). Research should focus on increasing the understanding of cross-scale interactions.

Ecological assessments for transportation projects should be conducted at different time scales to address impacts on key ecological system processes and structures. A broader set of robust ecological indicators should be developed to evaluate long-term and broad-scale changes in ecological conditions.

Monitoring systems should be developed for the evaluation and assessment of environmental effects resulting from changes in the road system — for example, traffic volume, vehicle mix, structure modifications, and network adjustments. Data from monitoring could then be used to evaluate previous assessments and, over the long term, improve understanding of ecological impacts.

A process should be established to identify and evaluate ecological assets that warrant greater protection. This process would require consideration not only of the scientific questions but also of the socioeconomic issues.

More attention should be devoted to predicting, planning, monitoring, and assessing the cumulative impacts of roads. In some cases, the appropriate spatial scale for the assessment will cross state boundaries, and especially in those cases, collaboration and cooperation among state agencies would be helpful.

Improvements are needed in assessment methods and data, including spatially explicit models. A checklist addressing potential impacts should be adapted that can be used for rapid assessment. Such a checklist would focus attention on places and issues of greatest concern. A national effort is needed to develop standards for data collection. A set of rapid screening and assessment methods for environmental impacts of transportation and a national ecological database based on the geographic information system (GIS) and supported by multiple agencies should be developed and maintained for ecological effects assessment and ecological system management across all local, state, and national transportation, regulatory, and resource agencies.

The committee recommends a new conceptual framework for improving integration of ecological considerations into transportation planning. A key element of this framework is the integration of ecological goals and performance indicators with transportation goals and performance indicators.

Improved models and modeling approaches should be developed not only to predict how roads will affect environmental conditions but also to improve communication in the technical community, to resolve alternative hypotheses, to highlight and evaluate data and environmental monitoring, and to provide guidance for future environmental management.

More opportunities should be created to integrate research on road ecology into long-term ecological studies by using long-term ecological research sites and considering the need for new ones.

(NRC, 2005: 220-225)

Figure 3: Research Recommendations by the NRC Committee on Ecological Impacts of Road Density on Paved Roads

4.1 Ecology and Natural Systems

Measure transportation's **short- and long-term impact on natural systems**

- Investigate landscape permeability effects of transportation system on environment
  - Habitat connectivity (connectors and corridors)
    i. Watershed scale
    ii. Cross-scale
  - Wildlife interactions
  - Species distribution

- Examine habitat value assessment and how it informs alternatives analysis
- Effects on habitat soils management
  - Stormwater
  - Invasive species

Develop **insight into both the spatial and temporal issues** associated with transportation and natural systems

Study the **relationship between highway density and ecosystem integrity**

- Impacts of highway density on habitat integrity and overall ecosystem health

Develop a **rapid assessment methodology** for use by transportation and regulatory agencies in determining the relationship between highway density and ecosystem integrity

- Tools to assess areas of high wildlife activity and primary corridors for purposes of planning transportation infrastructure

Expand research and thinking on the **uses for and vegetation of transportation corridors** in the United States

- Native roadside planting (What species? Where?)
  - Appropriate seed mixes
  - Appropriate right-of-way
  - Native plant systems for roadside stability
  - Native plant systems for safety
  - Identify species for erosion control
  - Control of invasive species
  - Roadside vegetation long-term maintenance reduction
    i. Mowing emission reduction
    ii. Cost-benefit analysis of installation of native plant systems
- Investigate the potential for and feasibility of creating greenhouse neutral roads (plant systems) along highway
  - Vegetative filter barrier for phytoremediation

Expand research efforts aimed at developing **efficient mitigation designs** for road crossing by animals

- Conduct rapid assessment of landscape "permeability" for wildlife
  - Wildlife primary corridors
  - Habitat fragmentation – species distribution and connectivity
  - Impact of transportation
- Assess and compare alternative median prescriptions to facilitate wildlife crossings

Catalyze research on the **effects of corridors and traffic** on adjoining land, including traffic disturbance and the spread of invasive species

Conduct further research on means of **restoring natural hydrologic and sediment flows** and distributions in the vicinity of roads

- Examine how roads can be rebuilt to allow for fluvial geomorphology (e.g., Stream Crossing/Floodplain (Hwy 35, John Day)
- Study sediment production from gravel roads

Expand research on transportation's **effects on water quality, aquatic ecosystems, and fish** in various bodies of water and on ecologically effective solutions

- Develop innovative riparian solutions near existing roadways for water quality and quantity issues
- Examine riparian solutions to water quality and quantity issues
- Examine water quality and stormwater management in a watershed context
- Effects of gravel roads and impervious surfaces on water quality
- Understand local and county water quality issues as they apply to surface transportation
- Impacts of stormwater from road systems
  - Cost and benefits
  - Quality and quantity
    i. Metals and polycyclic aromatic hydrocarbons (PAHs)
  - Culverts
    i. Water quality
    ii. Fish passage

Foster collaborative landscape-wide environmental analyses by engineers, ecologists, and planners, with an emphasis on combining ecological solutions with other societal objectives

- Research in design of green infrastructure
  - How do we quickly build dry, green bridges?
  - Explore and identify alternative designs (engineering specifications for alternative designs of infrastructure, e.g. green street technology)
  - Use of native vegetation
    i. Systems to identify native seed mixes for roadside vegetation
- Materials research for green infrastructure construction
  - Less expensive materials
  - Increase use of local materials (for sustainability/travel costs)
  - Improving "mix" of materials

  - Examine quality issues for the use of waste and recycled highway/road/bridge materials
- How do we systematically replace culvert infrastructure?
- How do we accelerate projects, decrease costs, and improve environmental results?

  Project Delivery
  - Impact of project delivery mechanism/bidding schedule on environmental impact
  - In terms of "construction windows"

  Design
  - Trends in bridge design and construction – "get in, get out, stay out," "build it dry, no wet feet."
  - Life-cycle cost of different materials
  - Performance results (comparative) of alternative versus "traditional" transportation treatments
  - Ways to provide mobility and air quality with existing infrastructure
  - Impact of seismic considerations

  Construction
  - Information on construction techniques, tools to minimize impacts

4.2 Land Use and Planning

Sustainable funding and strategic investments

- Develop strategic investment scenarios for mitigation funds
  - Investment
  - Criteria
  - Credit trading
  - Mitigation banking
- How can we link pollution credit trading with strategic mitigation investment
- How sustainability impacts all other choices (i.e., environmental, material, coordination on mitigation, etc.)

Identify the **costs and benefits of current development patterns and their transportation** implications

- Examine road construction life-cycle in context of land use planning system and/or sustainability
- Comparative impact of various development patterns on
  - Water quality (run-off)
  - Habitat
  - Sprawl
  - Density
  - Other?

Improve planning **methods for system analysis, forecasting, and decision-making**

- Population forecasts

  - Better understanding of utility needs
  - Better understanding of transportation needs
- Forecasting oil costs and different transportation needs

Develop tools **for measuring and forecasting complex transportation decisions** for all modes and users

- Better prescriptive tools
  - Population change
  - Transportation change
- 50-year transportation models (What is the future of transportation?)
  - Climate change
    i. Engineering choices (decommissioning, protecting, or building infrastructure)

Develop improved data, methods, and processes for considering land use, transportation, and the environment in an **integrated, systematic fashion**

- How do we integrate transportation and ecological systems in terms of decision-making, their interactions, and evolution (short- vs. long-term planning horizon)?
  - Collecting new data
  - Data integration
  - Modeling
    i. Long-term changes
    ii. Demand and supply side
    iii. Implementation
    iv. Performance measures
  - Implementation
  - Decision support (decision-making paradigm in a systems perspective)
    i. Boundaries
    ii. Time
    iii. Life-cycle integrated in land-use
- Need landscape scale data on environment and natural and cultural resources
  - What data is needed?
  - How can disparate data be combined?
  - How can data sets be standardized?

Continue and expand research on the **impacts of transportation facilities**

- Build flexibility for multiple uses/demands within existing transportation system
- Research into effective incentives for sustainable transportation modes, uses, and alternative infrastructure
- Examine how our street network can be designed to facilitate
  - Walking and cycling
  - Public health
  - Needs of an aging population
- Conduct comparative research with bicycle and pedestrian facilities

- Investigate how the design of the transportation system affects land use (within and outside of urban growth boundaries)

Assess and compare **alternative transportation and land use strategies**

- Models for regional cooperation

Develop a more effective understanding of the **nature of commercial travel and the freight industry**, as well as associated trends

Develop a more effective understanding of **the perceptions and priorities of the transportation system's customers** (users and taxpayers) decision processes, including key trends such as e-commerce and e-freight as associated trends and decision processes and develop a more effective understanding of the nature of personal travel, as well

Develop a more effective understanding of the **role of transportation services and facilities in the economy**

Develop **techniques for identifying community aspirations and crafting community and regional visions related to transportation planning**

Develop tools that incorporate the complex dynamics of travel behavior, and develop the reliable data sets needed for these models

Develop **methods and institutional structures for integrating transportation planning, programming, design, and operation**

- Research needs around integrated regulatory policy standards

4.3 Emerging Technologies

Assist in the **transition to environmentally benign fuels and vehicles** for passengers and freight

- Electrification of truck stops for diesel fuel mitigation
- Partnerships between agricultural industry (potential fuel crop producers) and transportation providers
- Lifecycle analysis – biofuels, (opportunity)
- Analyze potential for alternative sources for biofuels (i.e., wood, fuel crops)

Develop responses to and demand for new technologies that could offer improved environmental performance

Identify possible applications of intelligent transportation systems technologies for environmental benefit

- Intelligent multi-modal freight distribution

Respond to the impact of new technologies

- Risk Assessment
  - Highway associated risks with changes in fuel use (i.e. hydrogen)
  - Impacts of alternative fuels on air quality
  - Emissions
  - Water quality impacts
  - Heath impacts

Develop **policy instruments that would encourage the development of beneficial new technologies** in a cost-effective manner

Analyze user response to and future demand for environmentally beneficial vehicles, fuels, and mobility services, such as the demand for and use of new environmentally beneficial vehicles and fuels

- Transportation needs within the context of less oil
- Transportation – modes, reducing demands

4.4 Socioeconomic Relationships

Alternative transportation financing impact on environmental and socioeconomic relationships

Understand differences in mobility, access, travel behavior, and travel preferences across socioeconomic groups

- Aging population
- In context of emerging technologies (i.e., less oil, biofuels, alternative transportation, etc.)
- Understand the relationship between "green street" designs and public safety
  - Fire emergency needs
  - Americans with Disability Act requirements

Expand information on **consumer choice processes and travel and activity patterns** for both local and long-distance trips and both passenger and freight transportation analysis of social, environmental, and economic benefits and cost of various transport options

- Localization of industries
  - Clustering transportation industries
  - Construction-side materials
  - Recycled materials

Stimulate research on understanding public **preferences for improvements in natural systems** of both short- and long-term significance to society

- Better understanding of public perceptions about "ecosystem integrity" and "ecosystem health"
- Sociological studies on environmental vs. transportation/economic values
- Examine aesthetic roadside landscapes for purposes of
  - Public perceptions

- Sense of place
- Public health

Develop improved planning approaches that **better reflect and respond to community needs**

Improve **evaluation methods** for examining the **incidence of benefits and costs**

- Life-cycle cost evaluation for local communities
- Changing economic and policy models (short- and long-term)
  - Life-cycle analysis
  - Programmatic permits
- Transportation of goods – trucking vs. rail
- Alternative transportation
  - Link with economic development in rural areas
- Assessing real and total cost of sustaining transportation norms and weighing against values (environmental, social).

Understand the **socioeconomic implications of emerging land development patterns** and new transportation technologies

- Infrastructure changes (fuel, stations) based on needs
- Oregon's isolation from energy sources (fossil fuels) – impact on Oregon's alternative fuels

Develop cost-effective applications of technology that **improve the equity of the transport** system

Develop **improved methods for community involvement**, collaborative planning, and conflict resolution

- Institutional incentives for collaborative decision-making
- Information exchange – quality and quantity in light of changing science

Determine the effect of the built environment on **people's willingness to walk, drive, or** take public transportation

4.5 Performance Measures

Develop and test ecologically-based performance measures

- Monitoring
  - Post-construction
  - Environmental controls
  - Mitigation
  - Fish passage

Develop **ecologically-based performance techniques** to evaluate the success of highway project mitigation and enhancement measures

- Examine the integrity and feasibility of "many small" vs. "few large" mitigation sites
- Monitoring the effectiveness of mitigation sites on watershed or ecoregional scales

Develop **performance measures and policy analysis approaches** that can be used to determine effectiveness

- Identification of sustainability indicators, with attention to scale
  - Natural resource
  - Economic
  - Social
  - Transportation mobility
- How can sustainability indicators be integrated across institutions?

5.0 Research Agenda—Opportunities

5.1 Criteria for Opportunities

The greatest opportunities through which to implement the research agenda can be defined through three criteria. These opportunities would:

- have a national competitive advantage for Oregon;
- be completed within the time cycle of funding; and,
- focus on collaborative research.

5.2 Specific Opportunity Issues and Areas

Among the needs and opportunities for transportation and the environment research, the following ideas rose to the top during the workshop:

- Developing integrated decision-support systems;
- Identifying, developing, and testing opportunities in green infrastructure (including the localization of industries, such as clustering transportation industries, construction material use, and use of recycled materials);
- Developing a process for systematically repairing or replacing culverts within watersheds or ecoregions; and
- Identifying opportunities to study the relationships between transportation and the environment within the context of the development of new cities and community developments in Central and Northern Oregon.

Participants identified a number of opportunities (issues and areas) that can be readily taken advantage of with regard to transportation and the environment research.

- **Oregon Transportation Investment Act III (OTIA III State Bridge Delivery Program).** The impact of Oregon's aging transportation system was highlighted in a report on the disruption to Oregon's economy based on its deficient and failing bridges. The report led to the OTIA III State Bridge Delivery Program which streamlined the delivery of selected bridges. This program addresses the replacement of 350+ bridges with "green bridges" that are context-sensitive and meet various environmental performance standards. This streamlining effort required the cooperation and collaboration of 11 state and federal agencies. Opportunities abound for using this program as a springboard for various research projects.

- **Culverts.** A new forecast by ODOT on the mass deterioration and failure of Oregon's innumerable culverts has serious implications for our ability to meet

environmental needs, regulatory requirements and avoid economic disruptions. Salmonids ability to move throughout a watershed is vital their life cycles and needs. The predicted failure of culverts calls for a systematic and strategic watershed approach to assessing, prioritizing, and replacing (or retrofitting) these culverts while minimizing impact to fish passage and hydrologic and geomorphic processes. It would also call for investigating new materials and construction methods to extend the life of culverts or avoid them.

- **Wetland Issues.** Research opportunities lay in looking at wetlands in the landscape context, evaluating the advantages of larger systems and isolated wetlands (when considering mitigation banking systems), standardizing performance measures for wetland systems, and examining alternative benefits of wetland systems besides water quality. Participants also identified the opportunity to use ecoregion priorities and habitat assessment methods developed for ODOT's mitigation-conservation strategy to inform decision making (alternative analysis).

- **Green Infrastructure.** Participants noted an opportunity to conduct a case study of the Pioneer Mountain - Eddyville Project for green design and monitoring environmental impacts. This project is a 10 mile stretch on U.S. 20 in which the existing highway will be replaced with a new section built to modern safety and design standards. According to the record of decision, the new roadway will be reduced from 10 miles to seven, and will have two 12- foot travel lanes, a 14- to 16-foot median, where needed, and 12-foot climbing lanes in both directions approaching the highest elevation near Crystal Creek (FHWA, 2004). The Pioneer Mountain-Eddyville Project is expected to be completed in Oct. 2009. http://www.oregon.gov/ODOT/HWY/REGION2/PioneerMtnUS20.shtml.

  Other opportunities present themselves in:

  - Sustainable industries – products and services; emerging sustainability companies/groups
  - "Green tires" – impacts on noise, water quality
  - Engineering support for building green streets

- **New and Rapidly Developing Cities**. The cities of Prineville, Redmond, and Damascus are undergoing rapid development. (For example, in Damascus it is anticipated that this rural community will grow to accommodate 60,000 residents, 25,000 dwelling units, and 50,000 jobs in the next 20 years. Density will increase from 43,560 sq feet per person today to 8,712 sq feet per person in 2024.) It will be challenge to manage this dramatic growth and yet maintain the core values of the community. Since "new cities" are rarely being built, the opportunity is in getting better insight into how a whole new transportation

system would be developed for a new city and its environmental impacts. Could sustainability indices be developed?

- **Long-term Ecological Studies Sites (H.J. Andrews).** Opportunities could be created to integrate road ecology research into long-term ecological studies by using long-term ecological research sites such as H.J. Andrews Experimental Forest http://www.fsl.orst.edu/lter/research.cfm?topnav=9

6.0 Conclusions and Recommendations

With the news that the Oregon UTC will be receiving the first installment of a five-year National UTC designation ($1.56 million) to support transportation research and technology innovation, partner universities are gearing up to discuss the current strategic plans, solicit advice on additional advisory board members, and explore how each university can leverage their research capabilities within the new UTC.

The authors recommend that the UTC play a central role to continue and expand the momentum of this proposed research agenda, to help fulfill its potential, and to allow it to be refined and matured as collaborative partnerships grow and needs and opportunities present themselves. More specifically, the UTC can support the research agenda through:

- Aiding in the refinement of the proposed research agenda
- Continuing to network and link interested parties by
    - disseminating the proposed/refined research plan with UTC public relations information
    - hosting a transportation and the environment list serve and webpage on its website
    - conducting workshops and meetings
- Tracking requests for proposals (RFP) and general information relevant to transportation and the environment (Appendices 9 and 10) –
    - Government opportunities
    - Private foundations
    - Solicited and unsolicited proposals
- Continuing to network with and link interested parties
- Coordinating with others in advance of RFPs to help form project teams
- Getting representation on FHWA Advisory Boards
- Compiling existing efforts (projects, teams, etc.) and building on them
- Hosting a database of expertise for request for proposals and other activities

References

Federal Highway Administration. 2004. Record of Decision Final Environmental Impact Statement, FHWA-OR-EIS-04-2-F. Pioneer Mountain to Eddyville, US 20, Lincoln County, Oregon. [online] http://www.oregon.gov/ODOT/HWY/REGION2/docs/area4/PioneerMtn/ROD_finalFHWAsignoff.pdf

National Research Council. 2005. *Assessing and Managing the Ecological Impacts of Paved Roads.* National Academy Press, Washington, D.C.

Oregon Department of Transportation. 2006. Transportation Development Division, Research Unit. [online] http://www.oregon.gov/ODOT/TD/TP_RES/

Appendix 1: The Surface Transportation Environment Planning Cooperative Research Program (STEP) Implementation Strategy, Functions, and Emphasis Areas

http://www.fhwa.dot.gov/hep/step/strategy.htm

I. Purpose

The purpose of this document is to propose an implementation strategy for the Surface Transportation Environment and Planning Cooperative Research Program (STEP). The proposed strategy identifies functions, research emphasis areas, an implementation timeline, and a framework within which decisions will be made regarding project priorities and funding. The Federal Highway Administration (FHWA) is requesting comments on this document, and has established an FHWA Docket through which comments will be submitted. In addition, FHWA has established a website for STEP which it will use on a continuing basis as a major mechanism for informing the public regarding the status of the STEP, and to solicit input on the program governance. The website can be found at www.fhwa.dot.gov/hep/step/index.htm.

II. Description of STEP and Available Funding

Section 5207, Surface Transportation Environment and Planning Cooperative Research Program (STEP), of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) established a new cooperative research program for environment and planning research in section 507 of Title 23, United States Code, Highways (23 U.S.C. 507). The general objective of the STEP is to improve understanding of the complex relationship between surface transportation, planning and the environment.

The SAFETEA-LU authorized $16.875 million per year for FY2006-FY2009 to implement this new program. However, due to obligation limitations, rescissions and the over-designation of Title V Research in SAFETEA-LU, $11.914 million of the $16.875 million authorized is available in FY2006 with similar amounts anticipated in future years. STEP is also the sole source of funds to conduct all FHWA research on planning and environmental issues in FY2006. In addition, Congress mandated several special studies, and STEP will be the funding source for those projects as well.

The $11.9 million for STEP, in combination with other SAFETEA-LU research funding sources, is less than what was available to FHWA in prior years for planning and environmental research. On average, FHWA had $27.1 million available for planning and environmental research in FY2003-2005 (including earmarks and designations). Thus, funding in FY 2006 represents a 39.2% reduction in FHWA environmental and research funding (see Figure 1 and Table 1). This means FHWA will have to make

difficult choices among the many competing needs for planning and environmental research, and will not be able to fund all worthy research.

Figure 1: FHWA Research Funding for Planning and Environment, FY03-06

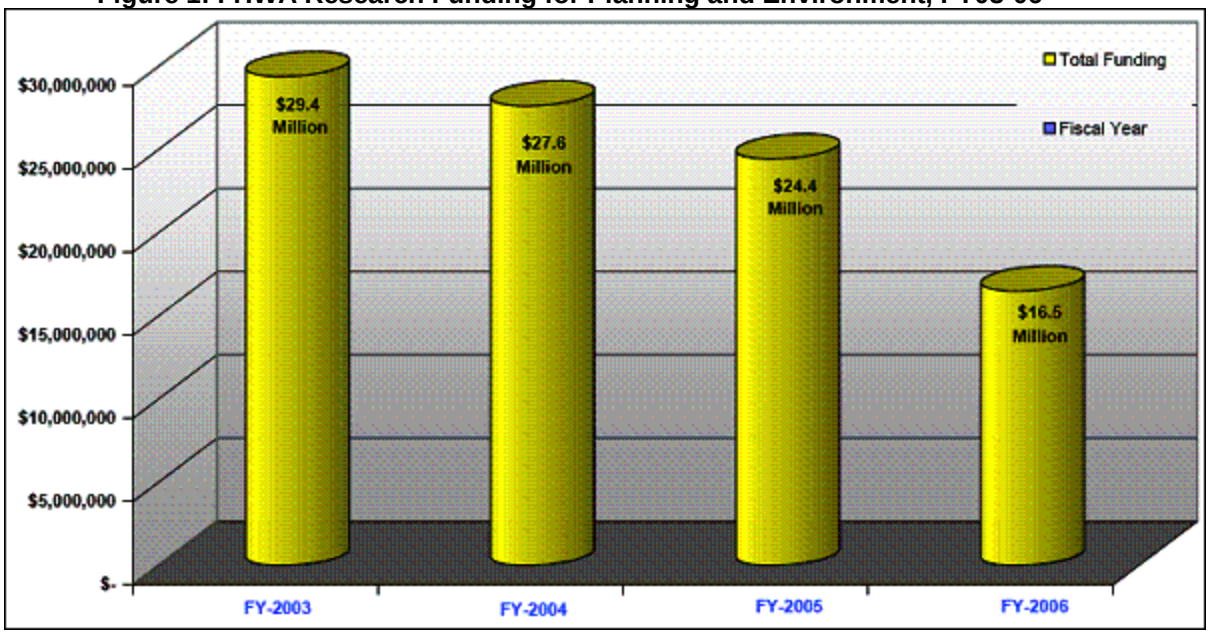


Table 1: FHWA Research Funding for Planning and Environment by Source, FY03-06 (minus obligation limitations, rescissions, etc.)

Funding Sources for HEP Research	2003	2004	2005	2006
Environmental Streamlining	$ 6,954,500.00	$ 6,557,237.00	$ 5,301,463.00	$ -
Surface Transportation Research	$ 15,082,000.00	$ 15,046,698.00	$ 13,863,981.00	$ -
Technology Deployment (TD) (excluding TELUS)	$ 4,229,000.00	$ 5,078,260.00	$ 4,446,144.00	$ -
TELUS (New Jersey Institute of Technology) *	$ 894,000.00	$ 940,419.00	$ 823,360.00	$ 706,022.00
Advanced Travel Forecasting Procedures (TRANSIMS)	$ 2,235,375.00	$ -	$ -	$ 1,853,308.00
Rural Transportation Research (New England Technology Institute)	$ -	$ -	$ -	$ 706,022.00
Center for Transportation Advancement and Regional Development	$ -	$ -	$ -	$ 441,264.00
Center for Environmental Excellence	$ -	$ -	$ -	$ 882,528.00
STEP	$ -	$ -	$ -	$ 11,914,125.00
Total Funds Available to HEP (2003 - 2006)	$ 29,394,875.00	$ 27,622,614.00	$ 24,434,948.00	$ 16,503,269.00

- TELUS is the Transportation, Economic and Land Use System. Funding was included in Technology Deployment for FY03-FY05

Congress mandated that the Federal share be 50% for research funded under Title V of SAFETEA-LU, including STEP. While this will not apply to contract funding, it will apply to STEP research funded through cooperative agreements and grants. Selective waivers of the non-Federal match may be possible, if justified, but USDOT has not determined the process, criteria, and authority for granting such waivers.

Section 507 of title 23 U.S.C. identifies certain characteristics of STEP regarding program content and administration. Regarding the program content, STEP may include research to:

- Develop more accurate models for evaluating transportation control measures and system designs for use by State and local governments to meet environmental requirements;
- Improve understanding of transportation demand factors;
- Develop indicators of economic, social, and environmental performance of transportation systems to facilitate alternatives analysis;
- Meet additional priorities determined through the transportation research and development strategic planning process identified in 23 U.S.C. 508; and
- Refine the scope and research emphases through outreach and in consultation with stakeholders.

In administering the program, USDOT and FHWA will ensure, to the maximum extent practicable, that:

- The best projects and researchers are selected based on merit, open solicitations, and selection by a panel of appropriate experts;
- Qualified, permanent core staff with ability to manage a large multiyear budget is used;
- Stakeholders are involved in governance of program; and
- There is no duplication with the Future Strategic Highway Research Program (SHRP II) (23 U.S.C. 510), which will be administered by the National Research Council of the National Academy of Sciences.

III. STEP Stakeholders

The number of stakeholders with an interest in environment and planning research is enormous and diverse, including these three tiers:

Tier 1 - Federal Agencies and Tribes: There are at least a score of Federal agencies with strong interest in transportation planning and environmental programs, including the Departments of Commerce, Defense, Homeland Security, Agriculture, Energy, Interior (DOI) and Housing and Urban Development, the Environmental Protection Agency (EPA), and the Centers for Disease Control and Prevention (CDC). Within each of these agencies, there are many discrete organizations/programs with an interest - e.g., National Park Service, US Forest Service, and Bureau of Land Management within the DOI. Within the US Department of Transportation (USDOT), FHWA partners with the Federal Transit Administration (FTA) on virtually all planning and environmental work, including research. FHWA also coordinates with the Federal Railroad, Aviation, Research and Innovative Technology, and Maritime Administrations, and with the Office of the Secretary of Transportation on Global Climate Change as well as other issues. Native American Tribes also have a major interest in research affecting their planning and environmental needs.

Tier II - State and Local Government: State Departments of Transportation (State DOTs) and Metropolitan Planning Organizations (MPOs) have a major interest in environment and planning research, as the research affects national policy and can also

provide important tools, information, and training to meet day-to-day needs of these agencies. In addition, local government transportation units (including transit operators as well as county public works departments and city transportation departments) depend on national environmental and planning research. State/local environmental and natural resource agencies and State Historic Preservation Officers also have a strong interest in planning and environmental research. There is also a growing interest by state/local health agencies in transportation planning and environmental research as it relates to "active living."

Tier III - Transportation and Environmental Stakeholders: Within the transportation and environment sector, there are hundreds and perhaps thousands of nongovernmental stakeholders, such as the American Automobile Association, American Road & Transportation Builders Association, American Highway Users Alliance, Surface Transportation Policy Project, Defenders of Wildlife, American Association of Retired People, Sierra Club, Conservation Law Foundation, American Council of Engineering Companies, American Planning Association, League of American Bicyclists, National Trust for Historic Preservation, and others too numerous to specify here.

The views and interests of the research community, including universities, consultants, and nonprofit research organizations are also important to consider, however it is probably appropriate to differentiate these views somewhat, based on their strong vested interest in receiving STEP funding to conduct research.

FHWA faces a great challenge to involve all of the above stakeholders in STEP, considering the large number of interested organizations and the dramatic differences in their views and interests. Nonetheless, FHWA will make a strong effort to seek out and consider the views of all of the above interests in shaping STEP and carrying out the STEP program. FHWA has already held initial meetings with some of these groups to begin receiving input on the governance and strategic direction of STEP, and will continue this outreach in the future.

IV. Relevant Past Work

FHWA's Office of Planning, Environment and Realty has undertaken several activities in past years that are pertinent to establishing STEP. These activities include research needs assessments, conferences, sponsoring multi-jurisdictional groups and panels focused on creating new research agendas for transportation planning, realty and environmental research. FHWA also relied on the following in creating the STEP Implementation Strategy, and will continue to use these as key resource documents in the continued implementation of STEP. The documents are listed in chronological order.

Refocusing Transportation Planning for the 21st Century (TRB Conference Proceedings 20, Washington, DC, February 7-10, 1999 and Irvine, CA, April 25-28, 1999).
Documenting the proceedings of a two-part conference, this report contains (1) the

recommendations of Conference I participants regarding a new vision for the transportation planning process and critical issues for research, and (2) specific research problem statements written as part of Conference II, building on the critical areas defined in Conference I.
(Not available in electronic form)

Environmental Research Needs in Transportation: Report of a Conference. Washington, DC, March 21-23, 2002.
This report contains the proceedings of a conference held in March 2002, which was intended to set an agenda for transportation/environmental research for a broad array of government and non-government entities with an interest in transportation planning and environment (not just for FHWA). In the proceedings are top research needs identified at the conference, along with background papers. These are organized into chapters for 15 topic areas.
http://trb.org/news/blurb_detail.asp?id=3958

Surface Transportation Environmental Research: A Long-Term Strategy (TRB Special Report 268), 2002.
This report defines a broad research program to address and inform major public policy debates about the effects of surface transportation facilities and operations on the human and natural environments. The committee that conducted the study identified major gaps in knowledge that could be filled through a cooperative program of research involving federal agencies, states, and environmental organizations. The committee recommended creation of a new cooperative research program to carry out its recommended research agenda.
http://trb.org/news/blurb_detail.asp?id=612

V. STEP Research Functions

In implementing STEP, it is important to establish the research functions for the program. The following STEP research functions are proposed for comment:

Outreach and Collaboration

As mandated in the legislation, and part of any well designed research program, FHWA will conduct outreach and solicit input on STEP program direction and governance, and will seek collaborative opportunities with other entities conducting research, including Federal partners. By seeking outreach at several different points in the decision-making process (see Section VII below), FHWA will attain a high degree of programmatic transparency. FHWA will work to develop measures of performance that will be assessed on a regular basis. FHWA will undertake outreach and collaboration in several different forms, including listening sessions, expert panels, peer exchanges, Federal Register notices, STEP email discussion groups, and domestic scans, among others. FHWA will also establish mechanisms for coordination with other entities conducting research (such as the National Cooperative Highway Research Program and the Transit

Cooperative Research Program (NCHRP, TCRP), SHRP II, EPA, CDC, DOI, FTA, other Federal agencies, State DOTs, and universities) to minimize duplication.

Conduct research

In implementing STEP, FHWA will conduct a needs-driven research program; building on past and future outreach to the research and user communities, and documented research needs assessments. FHWA will conduct research under STEP via competitive bids, grants, cooperative agreements, pooled funds, etc. FHWA will incorporate peer reviews into STEP research as much as possible. In addition, FHWA expects to share funding for various research activities with our partners and will use a variety of mechanisms to enable joint funding.

Deploy results and build capacity

For research to be meaningful to the practitioner communities, results of research must have a deployment component. Deployment and capacity building will be key aspects of the STEP program, being integrated into each emphasis area and project undertaken. Deployment and capacity building activities may take the form of information dissemination, training, peer-to-peer exchanges, domestic scans, workshops, technical assistance, presentations, web-conferences, etc.

VI. STEP Emphasis Areas

STEP will include the above functional goals within topical research emphasis areas. FHWA has identified proposed emphasis areas based on the SAFETEA-LU legislation, and by utilizing past research needs conferences and assessments, as discussed earlier. FHWA proposes 22 emphasis areas, which are listed in Table 2, first by major category, namely planning or environment, and second, in alphabetical order. There is no level of importance implied by the order.

VII. Implementation Framework for STEP *Incremental, Evolutionary Approach*

While FHWA is putting programmatic, contractual, outreach and collaborative mechanisms in place to implement STEP during FY 2006, initial portions of the FY 2006 STEP program will begin in Spring 2006. Some critical research needs in transportation planning and the environment and some FHWA legacy programs and Congressional mandates must be funded in the interim. FHWA intends to take an incremental and evolutionary approach to STEP implementation and will ultimately work under a more structured implementation strategy.

Proposed Framework

Figure 2 illustrates a proposed framework for STEP research. The framework corresponds to the implementation timeline found in the next section. Major products

for which FHWA will seek public and stakeholder feedback are bolded in the figure. The figure reads from top to bottom.

Table 2: Proposed STEP Emphasis Areas

STEP Emphasis Areas

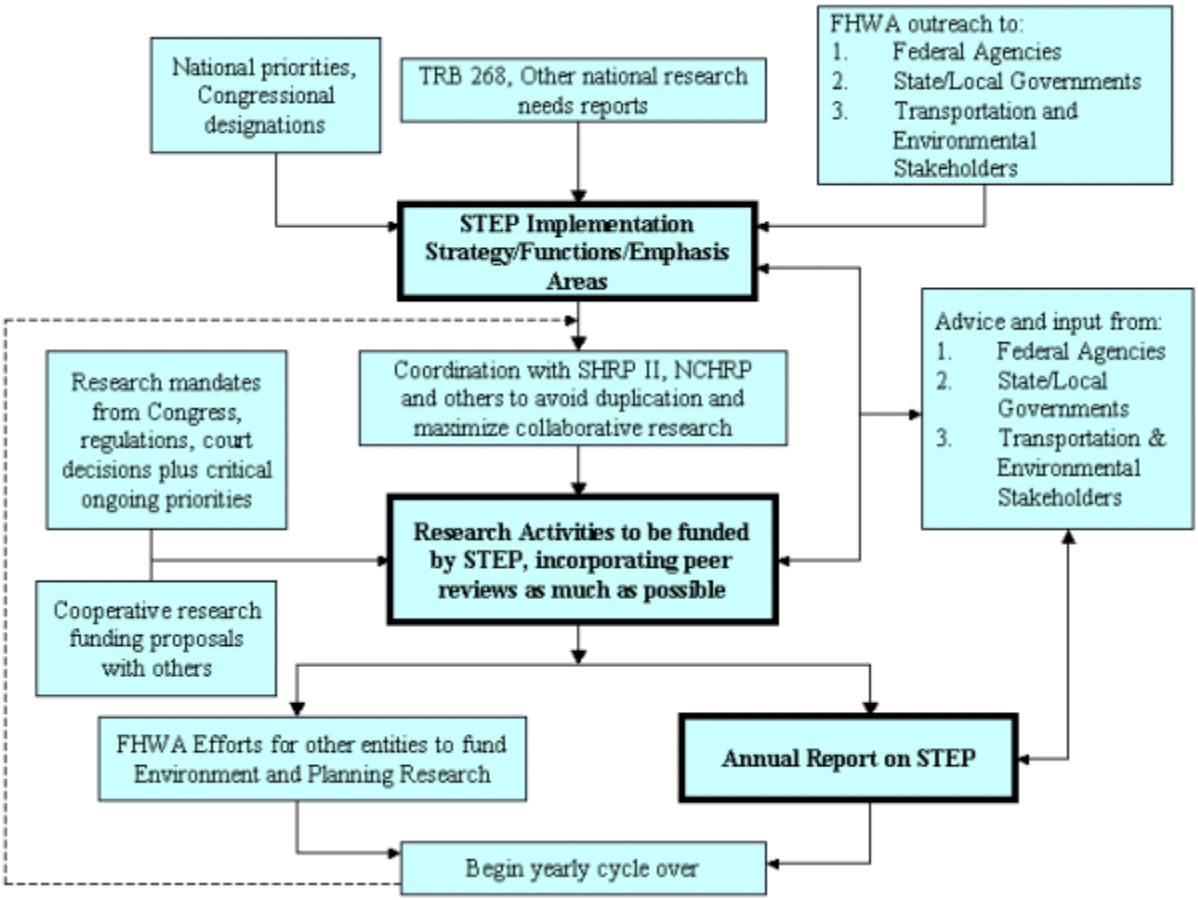
ENVIRONMENTAL

- Air Quality (including Climate Change and Air Toxics)
- Bicycle/Pedestrian/Non-motorized Travel
- Billboards/Right-of-Way Management
- Community/Neighborhood Impacts
- Context Sensitive Solutions
- Environmental Process Improvement
- Historic Preservation
- Human Health and Physical Activity
- Noise
- Water Quality and Wetlands
- Wildlife, Vegetation, and Habitat

PLANNING

- Freight Planning
- Geographic Information Systems and Spatial Information
- International Border Planning with Mexico and Canada
- Land Use and Transportation
- Operations Planning
- Planning for National Security, Defense, and Interstate needs
- Public Involvement (including Visualization)
- Safety Planning
- Scenario Planning
- Statewide and Metropolitan Planning Process Improvement (including Planning Capacity Building)
- Travel Modeling

Figure 2: Proposed STEP framework



1. ***Initial Round of Input on Research Needs and Priorities***: In formulating a proposed STEP framework, FHWA is relying on three major sources initially:
   - National priorities as reflected in legislation enacted by Congress and Executive Branch policies;
   - Research needs recommendations reflected in TRB reports and national conferences (e.g., those cited in IV. Relevant Past Work); and
   - FHWA's initial meetings and STEP outreach with (a) Federal agencies; (b) State/local governments; and (c) transportation and environmental stakeholders.

2. ***Proposed STEP Implementation Strategy, Functions, and Emphasis Areas:*** Based on the initial input, FHWA is formulating and proposing (in this document) a STEP implementation strategy, functions, and emphasis areas.

3. ***Second Round of Input***: FHWA will consider the advice and input received from #2 above, together with any cooperative research funding proposals we receive from others and also any legally binding research mandates in SAFETEA-LU, regulations, and court decisions, as well as critical ongoing collaborative research priorities, such as the Transportation Planning Capacity Building Program,

supported by FHWA, FTA, the American Association of State Highway and Transportation Officials (AASHTO), the Association of Metropolitan Planning Organizations (AMPO), the American Public Transportation Association (APTA), and the National Association of Regional Councils (NARC). Special priority will be given to cooperative research proposals, where other entities are willing to provide meaningful funding for STEP research needs.

4. ***Coordination with SHRP II, NCHRP and Other Relevant Research Programs***: As FHWA considers the Second Round of Input, we will coordinate with SHRP II, NCHRP, and other relevant research programs to avoid duplication and maximize collaborative research opportunities.

5. ***Proposed STEP Research Activities***: Based on the above, FHWA will develop a set of research activities to be funded by STEP each year. The research activities will be done jointly in FY2006 and FY 2007, and then yearly in FY 2008 and FY 2009. Generally, the proposed STEP Research Activities will be made available for comment, then finalized and implemented. FHWA will incorporate peer reviews as much as possible and involve other Federal agencies, state/local government staff, and transportation and environmental stakeholders in the review, dissemination, and evaluation of the research results.

6. ***Annual Report***: FHWA will produce an annual report on the use of STEP funds and make it available on the STEP website and through other means.

7. ***Ongoing Participation of Federal Agencies, state/local governments, and transportation and environmental stakeholders***: FHWA will provide ongoing outreach and opportunities for stakeholders to participate in STEP, through shaping research priorities, providing funding for collaborative research, shaping specific research activities, and evaluating the results of STEP-funded research. As needed, we will revise the STEP framework and mechanisms to facilitate the ongoing involvement of stakeholders in STEP.

8. ***Influencing Other Research Programs:*** The research needs for environment and planning far exceed the funding available through STEP. Other Federal agencies, other organizations, and research programs bear a responsibility and provide opportunities to help meet environment and planning research needs. FHWA will seek to influence these other research programs to help meet the research needs identified through our STEP outreach.

VIII. STEP Implementation Timeline

The following is a proposed timeline for the implementation of STEP.

December 2005

Conduct initial meetings with other Federal agencies, state/local transportation partners, and stakeholder groups (an initial round of meetings has occurred, and more will be conducted if desired by stakeholders)

January 2006

Present overview of STEP at TRB Annual Meeting (completed)

February 2006

Develop STEP Implementation Strategy/Goals/Emphasis Areas
Publish Federal Register Notice soliciting feedback on STEP Implementation Strategy/Goals/Emphasis Areas

Spring 2006

Conduct outreach for STEP by emphasis area, review research needs, and identify gaps
Coordinate with SHRP II, NCHRP and others to avoid duplication
Develop priorities for and fund critical, short-term research funding
Develop Draft FY 2006/07 Research for comment (yearly)

Summer 2006

Conduct outreach, listening sessions at TRB Mid-year conference on Draft FY 2006/07 Research Activities (yearly)
Conduct continued outreach by FHWA HEP Offices by STEP emphasis area (ongoing)

Fall 2006

Announce Final FY 2006/07 Research Activities (yearly)

Winter 2006/07

Implement 2006/07 Research Activities, through appropriate procurement methods, agreements and partnerships

January 2007

Solicit comment on FY 2006 STEP Annual Report (yearly)
Hold meetings and discussions on STEP at the TRB Annual Meeting

Spring-Winter 2007

Repeat process to identify FY 2008 Research Activities

IX. Opportunities for Stakeholder Involvement

Several stakeholders have expressed an interest in the ways in which they can provide input. Within the proposed framework for implementing STEP, FHWA envisions several key points in the process where various forms of stakeholder input will be needed. These will likely include, but not be limited to:

- Input and feedback on STEP programmatic structure, governance, implementation strategy, goals, and emphasis areas;
- Input from potential funding partners on collaborative research opportunities;
- Input, advice, and feedback on yearly-proposed Research Activities (both programmatically and by emphasis area);
- Input and advice during listening and outreach sessions at the TRB Annual Meeting, and other venues; and
- Input and feedback on the STEP Annual Report.

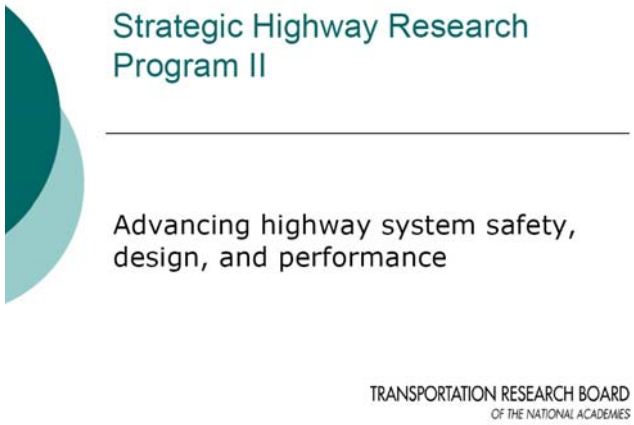
A variety of opportunities for stakeholder feedback, input and advice for STEP will occur. This will be done to get input on the overall approach to shaping and implementing the STEP as well as to further define needed research emphasis areas and set priorities for the program. Once STEP emphasis areas are finalized (after considering stakeholder input), they will be posted on the website. FHWA then envisions a variety of stakeholder input opportunities that will vary by emphasis area. After STEP emphasis areas are finalized, FHWA intends to identify specific points of contact within the Office of Planning, Environment and Realty for each emphasis area and will post them on the STEP website.

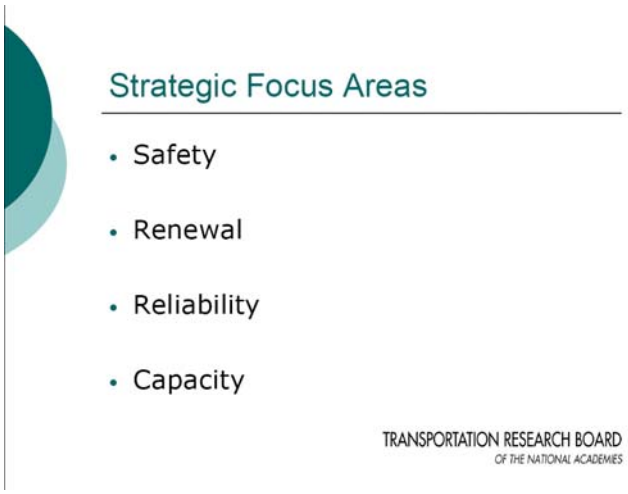
Within STEP, FHWA anticipates that requests for proposals or other competitive contracting mechanisms to conduct research will be developed to address emphasis areas. Work under STEP will be consistent with the legislative requirements and FHWA intends to encourage development of proposals for potential cooperative and jointly funded projects using a variety of competitive arrangements. Therefore, unsolicited proposals will not be the likely mechanism for receiving funding under the STEP. However, as with any research envisioned by external parties, FHWA receives unsolicited proposals through an existing, formal FHWA process (see "A Guide to Federal Highway Administration Policies and Procedures for Submitting Unsolicited Proposals", http://www.fhwa.dot.gov/aaa/gtup.htm).

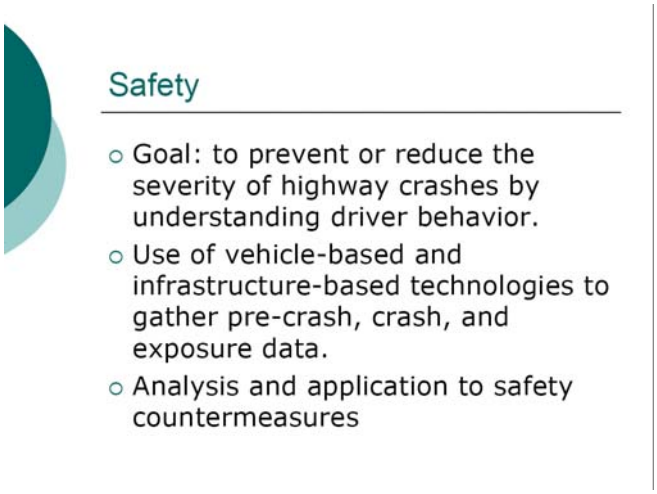
As the STEP evolves, FHWA expects to follow the same, or a very similar, timeline as that described in section VIII above. The timeline, and any updates or revisions, will also be posted on the STEP website to aid stakeholders in understanding key points in time when they can provide input.

Official comments regarding the Draft Implementation Strategy should be submitted via instructions included in the Federal Register Notice dated March 1, 2006. Comments should be submitted by April 17, 2006.

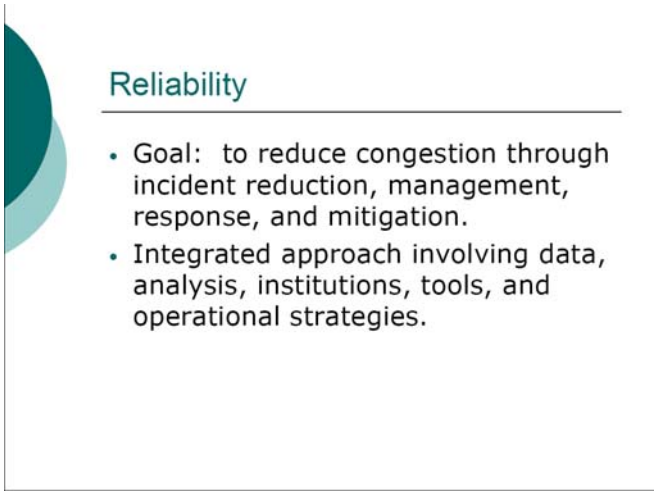
Appendix 2: Future Strategic Highway Research Program II (F-SHARP II)



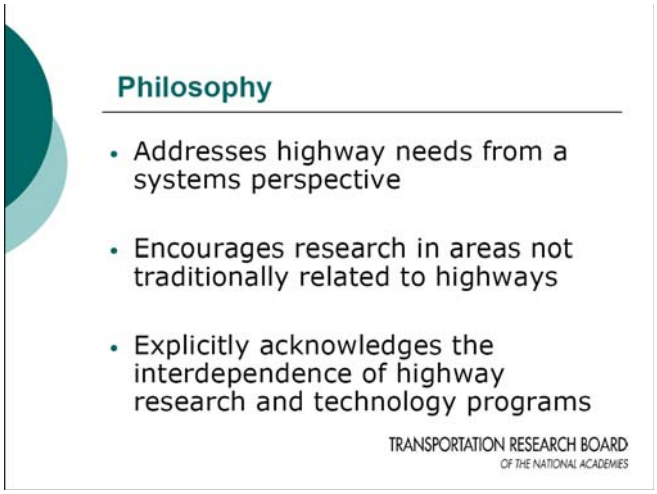


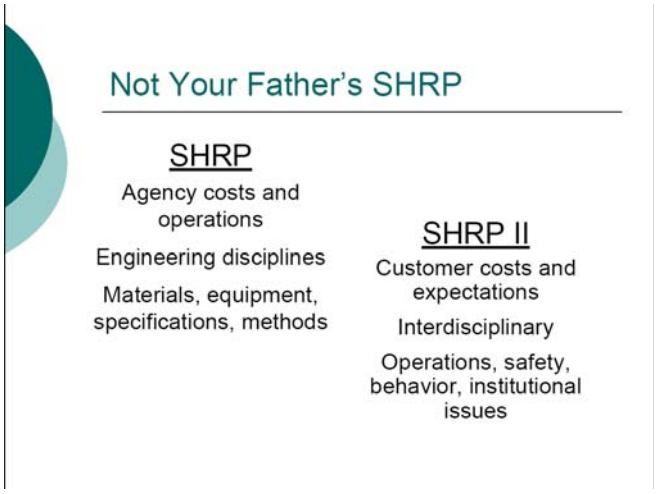

Safety
Goal: to prevent or reduce the severity of highway crashes by understanding driver behavior.
Use of vehicle-based and infrastructure-based technologies to gather pre-crash, crash, and exposure data.
Analysis and application to safety countermeasures

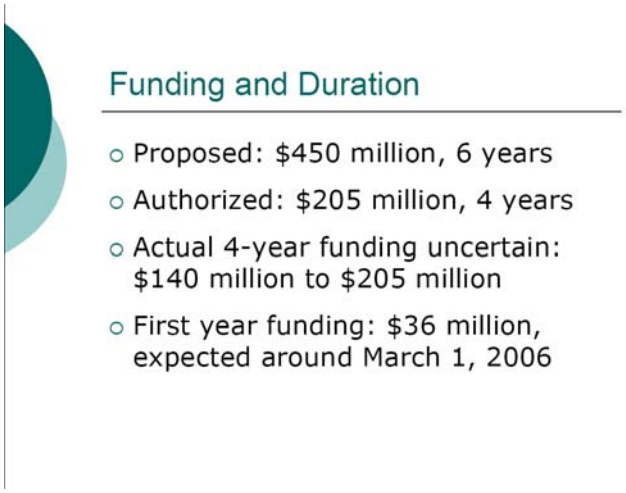

Renewal
Goal: to renew aging infrastructure through rapid design and construction methods that cause minimal disruption and produce long-lived facilities.
Integrated approach involving engineering, finance, contracting, planning, safety, maintenance, customer relations.


Reliability
Goal: to reduce congestion through incident reduction, management, response, and mitigation.
Integrated approach involving data, analysis, institutions, tools, and operational strategies.


Capacity
• Goals: to integrate mobility, economic, environmental, and community needs in planning and designing new transportation capacity.
• Systems approach involving fundamental knowledge, data, tools, institutional issues.


Philosophy
• Addresses highway needs from a systems perspective
• Encourages research in areas not traditionally related to highways
• Explicitly acknowledges the interdependence of highway research and technology programs
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

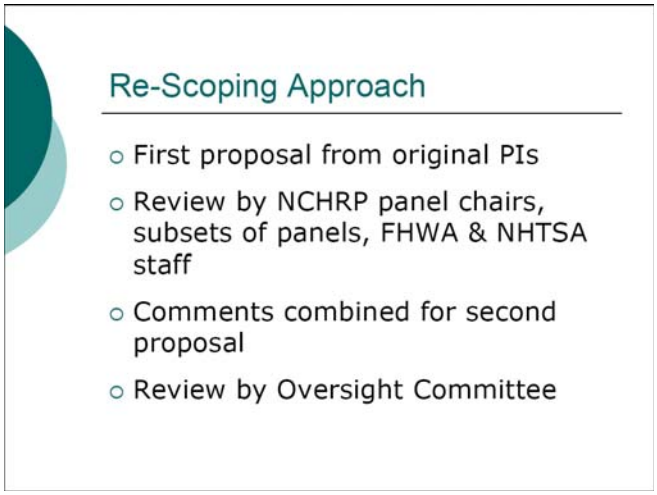

Not Your Father's SHRP
SHRP
Agency costs and operations
Engineering disciplines
Materials, equipment, specifications, methods
SHRP II
Customer costs and expectations
Interdisciplinary
Operations, safety, behavior, institutional issues

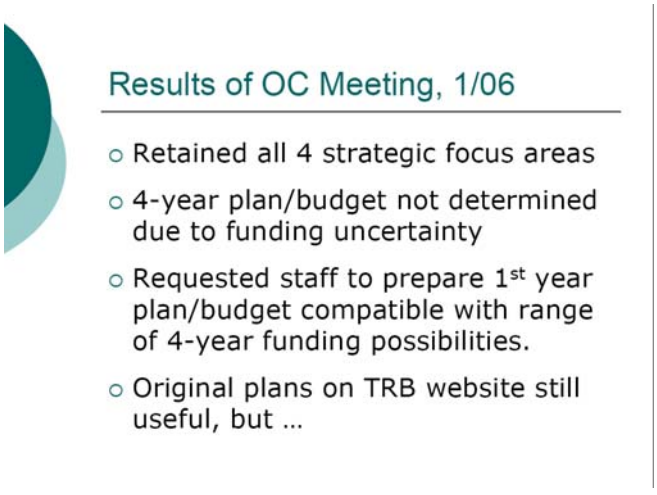

Funding and Duration
Proposed: $450 million, 6 years
Authorized: $205 million, 4 years
Actual 4-year funding uncertain: $140 million to $205 million
First year funding: $36 million, expected around March 1, 2006


Governance
Oversight Committee
Established, met 1/06
Technical Advisory Committees
One for each strategic focus area
To be established and meet by 4/06
Expert Task Groups
One for each group of related contracts
To be established as needed


Oversight Committee
Allen Biehler, PennDOT, *chair*
Norm Abramson, Southwest Research
Anne Canby, STPP
Rick Capka, FHWA
Frank Danchetz, Arcadis
Nick Garber, UVA
Jacqueline Glassman, NHTSA
Andrew Horosko, Manitoba Transpo
John Horsley, AASHTO
Ron Kirby, Metro Washington COG
Harold Linnenkohl, Georgia DOT
Susan Martinovich, Nevada DOT
John Njord, Utah DOT
Ananth Prasad, Florida DOT
Pete Rahn, Missouri DOT
James D. Staley, YRC Regional Transpo
Kirk Steudle, Michigan DOT
Richard Wagman, Wagman, Inc.,
Paul Wells, New York State DOT


Administration
National Research Council/TRB
In partnership with AASHTO, FHWA
Neil Hawks, Director
Ann Brach, Deputy Director
Eventual staff of about 20
First 4 positions being advertised now


Re-Scoping Approach
First proposal from original PIs
Review by NCHRP panel chairs, subsets of panels, FHWA & NHTSA staff
Comments combined for second proposal
Review by Oversight Committee


Results of OC Meeting, 1/06
Retained all 4 strategic focus areas
4-year plan/budget not determined due to funding uncertainty
Requested staff to prepare 1st year plan/budget compatible with range of 4-year funding possibilities.
Original plans on TRB website still useful, but …

Major Research Areas Removed

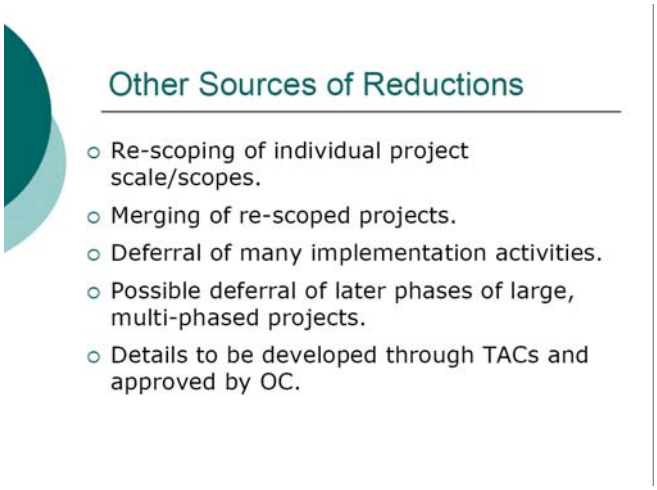
- Safety:
  - Countermeasure evaluation (2-3.1, 2-3.2)
  - Use of OEM data recorders (2-1.5)
- Renewal:
  - High performance materials (1-1.3)
  - Recycled aggregates (1-1.7)
  - Modular bridge systems (1-2.1)

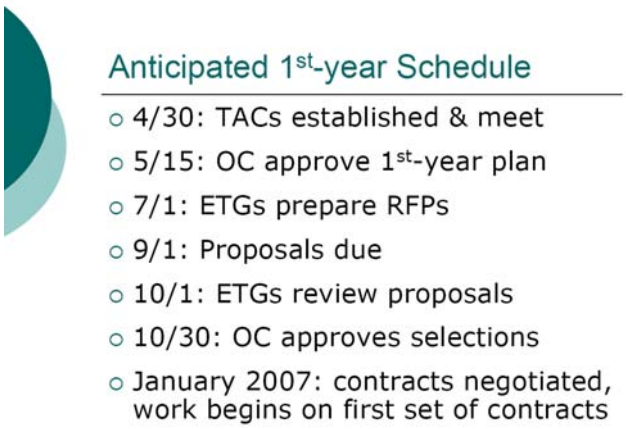
Major Research Areas Removed, cont.

- Reliability:
  - Costs of travel time reliability (3-2.6)
  - Advanced technologies (3-4.1, 3-4.2, 3-4.3)
  - Weather information (3-5.1, 3-5.2, 3-5.3, 3-5.4)
  - Traveler information (3-8.1, 3-8.2, 3-8.3)
  - Simulation and gaming tools (3-9.3)

Major Research Areas Removed, cont.

- Capacity:
  - Watershed & habitat fragmentation (4-1.4)
  - Highway capacity & land use (4-1.6)
  - Remote sensing (4-2.2)
  - Reducing duplication/process delay (4-3.3)
  - Project delivery (4-4.1, 4-4.2, 4-4.3)


Other Sources of Reductions
Re-scoping of individual project scale/scopes.
Merging of re-scoped projects.
Deferral of many implementation activities.
Possible deferral of later phases of large, multi-phased projects.
Details to be developed through TACs and approved by OC.


Anticipated 1st-year Schedule
4/30: TACs established & meet
5/15: OC approve 1st-year plan
7/1: ETGs prepare RFPs
9/1: Proposals due
10/1: ETGs review proposals
10/30: OC approves selections
January 2007: contracts negotiated, work begins on first set of contracts


Contact SHRP II
By email SHRPII@nas.edu
By telephone at 202-334-1430
Visit www.TRB.org/SHRPII
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Appendix 3: Workshop Briefing Document

Briefing Document

Transportation and the Environment: Linking Researchers, Transportation Providers, and Industry

Background

Sections 5203 and 5209 of HR 3, the new transportation reauthorization bill, create new cooperative research programs related to key areas addressed in the *Surface Transportation Environmental Research: A Long-Term Strategy* (TRB Special Report 268, 2002) and the *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life* (TRB Special Report 260, 2001) reports, respectively.

1. The six areas of research in HR3, Section 5203 – human health, ecology and natural systems, environmental and socioeconomic relationships, emerging technologies, land use, and planning and performance measures; and,
2. Four areas of research set out in HR3, Section 5209 with our efforts focusing specifically on the area of planning and designing new road capacity to meet mobility, economic, environmental, and community needs.

Purpose

The purpose of this project is to develop a research agenda that will strategically position the State of Oregon to propose innovative and relevant research targeted toward the research agendas set out in HR3 Sections 5203 and 5209. This will be done by:

- Informing Oregon transportation providers, industry, and researchers about the research provisions of HR 3;
- Identifying Oregon needs and opportunities that could be met through research funded by these new programs; and,
- Linking researchers and transportation providers interested in pursuing new projects through a facilitated workshop that will be held on 9 February 2006, the last day of the 2006 Northwest Transportation Conference at Oregon State University.

Workshop – 9 February 2006, 12:00-4:30PM
CH2M HILL Alumni Center, Room 111A/B
Oregon State University

This workshop aims to link researchers, transportation providers, and industry interested in pursuing new research projects. Workshop goals include:

- Sharing knowledge concerning the present status of transportation industry needs and research capabilities in the area of road ecology for the state of Oregon;

- Identifying and prioritizing transportation/road ecology research capabilities as they correspond to transportation industry and regulatory needs; and,
- Identifying participants able and willing to participate in various aspects of proposal development when funding opportunities occur.

Benefits

Expected benefits of this project, include:

- A broader understanding of the landscape of transportation industry needs and research capabilities in Oregon;
- The development of a private-public network of transportation professionals, OUS academics, and ODOT personnel interested in cooperative research in the State of Oregon; and,
- The development of a road research agenda that will strategically position ODOT and the State of Oregon to readily apply for anticipated requests for proposal from the Transportation Research Board in FY2007 through two research programs stated in House Bill 3 under Sections 5203 and 5209.

For More Information

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Institute for Natural Resources
Oregon State University
210 Strand Agricultural Hall
Corvallis, Oregon 97331
Telephone: 541.737.1976
Fax: 541.737.1887
E-mail: lisa.gaines@oregonstate.edu

HR3, Section 5203: Surface Transportation Environment and Planning Cooperative Research Program

The advisory committee, in consultation with interested parties, shall carry out and periodically update research and development called for in the Transportation Research Board Special Report 268, entitled *Surface Transportation Environmental Research: A Long-Term Strategy* and published in 2002, as described in subsection (e). The national research agenda shall include a multiyear strategic plan.

Administration:	National Academy of Sciences
Funding Source:	Federal government share of costs is up to 100% Funds shall remain available until expended
Funds Available:	The fiscal year in which such funds are made available and the 3 succeeding fiscal years
Funding Amount:	$5,000,000 for fiscal year 2004 $15,000,000 for each of fiscal years 2005 through 2009

National Research Agenda

Human Health

- establish the links between transportation activities and human health
- substantiate the linkages between exposure to concentration levels, emissions, and health impacts
- examine the potential health impacts from the implementation and operation of transportation infrastructure and services
- develop strategies for avoidance and reduction of these impacts
- develop strategies to understand the economic value of health improvements and for incorporating health considerations into valuation methods

Emerging Technologies

- assist in the transition to environmentally benign fuels and vehicles for passengers and freight
- develop responses to and demand for new technologies that could offer improved environmental performance
- identify possible applications of intelligent transportation systems technologies for environmental benefit
- respond to the impact of new technologies
- develop policy instruments that would encourage the development of beneficial new technologies in a cost-effective manner
- analyze user response to and future demand for environmentally beneficial vehicles, fuels, and mobility services, such as the demand for and use of new environmentally beneficial vehicles and fuels

Ecology and Natural Systems

- measure transportation's short- and long-term impact on natural systems
- develop ecologically based performance measures
- develop insight into both the spatial and temporal issues associated with transportation and natural systems
- study the relationship between highway density and ecosystem integrity, including the impacts of highway density on habitat integrity and overall ecosystem health
- develop a rapid assessment methodology for use by transportation and regulatory agencies in determining the relationship between highway density and ecosystem integrity
- develop ecologically-based performance techniques to evaluate the success of highway project mitigation and enhancement measures
- expand research and thinking on the uses for and vegetation of transportation corridors in the United States
- expand research efforts aimed at understanding wildlife movement near corridors, roadkill rates, and road-barrier effects and at developing efficient mitigation designs for road crossing by animals
- catalyze research on the effects of corridors and traffic on adjoining land, including traffic disturbance and the spread of invasive species
- conduct further research on means of restoring natural hydrologic and sediment flows and distributions in the vicinity of roads
- expand research on transportation's effects on water quality, aquatic ecosystems, and fish in various bodies of water and on ecologically effective solutions
- support, expand, and initiate research on the ecological effects of air pollutants from roads and vehicles at the roadside, neighborhood, regional, and global levels
- develop road-network models and approaches for reducing habitat fragmentation, population extinction, wildlife-corridor, and remote-area impacts
- foster collaborative landscape-wide environmental analyses by engineers, ecologists, and planners, with an emphasis on combining ecological solutions with other societal objectives
- stimulate research on understanding public preferences for improvements in natural systems of both short- and long-term significance to society

Environmental and Socioeconomic Relationships

- understand differences in mobility, access, travel behavior, and travel preferences across socioeconomic groups
- develop improved planning approaches that better reflect and respond to community needs
- improve evaluation methods for examining the incidence of benefits and costs
- examine the differential impacts of current methods of finance and explore alternatives
- understand the socioeconomic implications of emerging land development patterns and new transportation technologies
- develop cost-effective applications of technology that improve the equity of the transport system
- develop improved methods for community involvement, collaborative planning, and conflict resolution
- develop operational definitions and indicators for environmental justice and social equity as the concepts pertain to transportation
- develop and demonstrate methods that can be used to display the incidence of transportation project and program effects, both beneficial and adverse, and develop improved methods for evaluating costs and benefits when they are not evenly distributed, including environmental and social justice impact criteria in system performance measures used in transportation planning and investment decisions
- continue and expand studies on the comparative costs of transportation and the effects of different development patterns, particularly for economically disadvantaged communities
- develop and test new methods for integrating public involvement into transportation analysis and decision-making, and examine the implications of emerging citizen coalitions for environmental and social justice

Land Use

- assess land consumption trends and contributing factors of transportation investment, housing policies, school quality, and consumer preferences
- incorporate impacts of transportation investments on location decision and land use
- identify the costs and benefits of current development patterns and their transportation implications
- determine the effect of the built environment on people's willingness to walk, drive, or take public transportation
- determine the roles of public policy and institutional arrangements in current and prospective land use and transportation choices
- develop improved data, methods, and processes for considering land use, transportation, and the environment in an integrated, systematic fashion
- continue and expand research on the impacts of transportation facilities
- assess and compare alternative transportation and land use strategies, such as models for regional cooperation

Planning and Performance Measures

- improve understanding of travel needs and preferences
- improve planning methods for system analysis, forecasting, and decision-making
- expand information on consumer choice processes and travel and activity patterns for both local and long-distance trips and both passenger and freight transportation analysis of social, environmental, and economic benefits and cost of various transport options
- develop tools for measuring and forecasting complex transportation decisions for all modes and users
- develop performance measures and policy analysis approaches that can be used to determine effectiveness
- develop a more effective understanding of the nature of commercial travel and the freight industry, as well as associated trends
- develop a more effective understanding of the perceptions and priorities of the transportation system's customers (users and taxpayers) decision processes, including key trends such as e-commerce and e-freight as associated trends and decision processes and develop a more effective understanding of the nature of personal travel, as well
- develop a more effective understanding of the role of transportation services and facilities in the economy
- develop techniques for identifying community aspirations and crafting community and regional visions related to transportation planning
- develop tools that incorporate the complex dynamics of travel behavior, and develop the reliable data sets needed for these models
- develop methods and institutional structures for integrating transportation planning, programming, design, and operation

Other Research Areas

Other research areas to identify and address the emerging and future surface transportation research needs related to planning and environment

HR3, Section 5209: Future Strategic Highway Research Program

The program established under this section shall be based on the National Research Council Special Report 260, entitled *Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life* and the results of the detailed planning work subsequently carried out in 2002 and 2003 to identify the research areas through National Cooperative Research Program Project 20-58.

Administration:	National Research Council of the National Academy of Sciences
Funding Source:	Federal government share of costs is 100%
	Funds shall remain available until expended
Funds Available:	the fiscal year in which such funds are made available and the 3 succeeding fiscal years
Funding Amount:	$17,000,000 for fiscal year 2004
	$60,000,000 for fiscal year 2005
	$63,000,000 for each of fiscal years 2006 through 2009

Research Program

A. Renewal of aging highway infrastructure with minimal impact to users of the facilities

- To achieve renewal, that is performed rapidly, causes minimum disruption, and produces long-lived facilities.
- To achieve such renewal, not just on isolated, high-profile projects, but consistently throughout the highway system.

B. Driving behavior and likely crash causal factors to support improved countermeasures

- To identify more accurately the contributions of various factors to highway crashes, fatalities, and injuries; and
- To determine the cost-effectiveness of selected countermeasures in preventing or reducing the severity of highway crashes.

C. Reducing highway congestion due to nonrecurring congestion

- To characterize the chosen incident types in terms of likelihood of occurrence, impacts on users, and customer expectations for management and response; and
- To develop integrated strategies or approaches that effectively apply the many tools and technologies available for managing and responding to the chosen incident types.

D. Planning and designing new road capacity to meet mobility, economic, environmental, and community needs.

- To develop an integrated, systems-oriented approach to meeting this multifaceted challenge(meeting mobility, economic, environmental, and community needs);
- To use the many potential tools and technologies for applying this approach in a systematic way throughout the highway development process; and
- To address the institutional issues surrounding highway development.

Dissemination of Results

The research results of the program, expressed in terms of technologies, methodologies, and other appropriate categorizations, shall be disseminated to practicing engineers for their use, as soon as practicable.

Appendix 4: Presentation by Chris Higgins (OSU) for the 17 May 2006 Meeting about the University Transportation Center

Status and Planning of Oregon's University Transportation Center

Chris Higgins

Kiewit Center for Infrastructure & Transportation

Oregon State University

Background

- University Transportation Center awarded
  - Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) enacted Aug. 10, 2005
  - Oregon UTC written into legislation by Rep. Peter DeFazio
  - OSU, PSU, UO, OIT named
- Grant Announced April 26, 2006 (budget redacted)
- Up to $16M total over 5 years (~$3M per year)
- First year funds: $1.6M
  - Post-date to Aug. 2005
- Managed by Research and Innovative Technology Administration (RITA) within USDOT

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Status

- VP's meetings – Governance Issues
- Meeting with Rep. DeFazio
- Executive Committee
  - PSU Rob Bertini
  - OSU Chris Higgins
  - UO Marc Schlossberg
  - OIT Roger Lindgren
  - ODOT Barney Jones
  - Oregon-FHWA Nathaniel Price
- Advisory Board membership yet to be determined

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General Grant Parameters

- Lead designated as PSU
- Lead gets 50% of grant funds
- Matching requirements
  - Need dollar for dollar match
  - Non-federal dollars required, SPR money ok
  - NCHRP can't be used
- Competitive peer review process for projects
- Nationally important topics

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National Research Agenda

Heavy focus on USDOT research priorities

- **Safety:** Enhance public health and safety by working toward the elimination of transportation-related deaths and injuries.
- **Mobility:** Advance accessible, efficient, intermodal transportation for the movement of people and goods.
- **Global Connectivity:** Facilitate a more efficient domestic and global transportation system that enables economic growth and development.
- **Environmental Stewardship:** Promote transportation solutions that enhance communities and protect the natural and built environment.
- **Security:** Balance homeland and national security transportation requirements with the mobility needs of the Nation for personal travel and commerce.
  - *DOT Strategic Plan 2003-2008*

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Strategic Plans

- **3 Months to Develop**
- **Approved by RITA**
- **Project Selection Process Begins**

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Strategic Plans

UTC Mission

Advance U.S. technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research and technology transfer at university-based centers

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Strategic Plans

UTC GOALS

- **Research Selection**: an objective process for selecting and reviewing research that balances multiple objectives of the program.
- **Research Performance**: an ongoing program of basic and applied research, the products of which are judged by peers or other experts in the field to advance the body of knowledge in transportation.
- **Education**: a multidisciplinary program of course work and experiential learning that reinforces the transportation theme of the Center.
- **Human Resources**: an increased number of students, faculty and staff who are attracted to and substantively involved in the undergraduate, graduate and professional programs of the Center.
- **Diversity**: students, faculty and staff who reflect the growing diversity of the U.S. workforce and are substantively involved in the undergraduate, graduate and professional programs of the Center.
- **Technology Transfer**: availability of research results to potential users in a form that can be directly implemented, utilized or otherwise applied.

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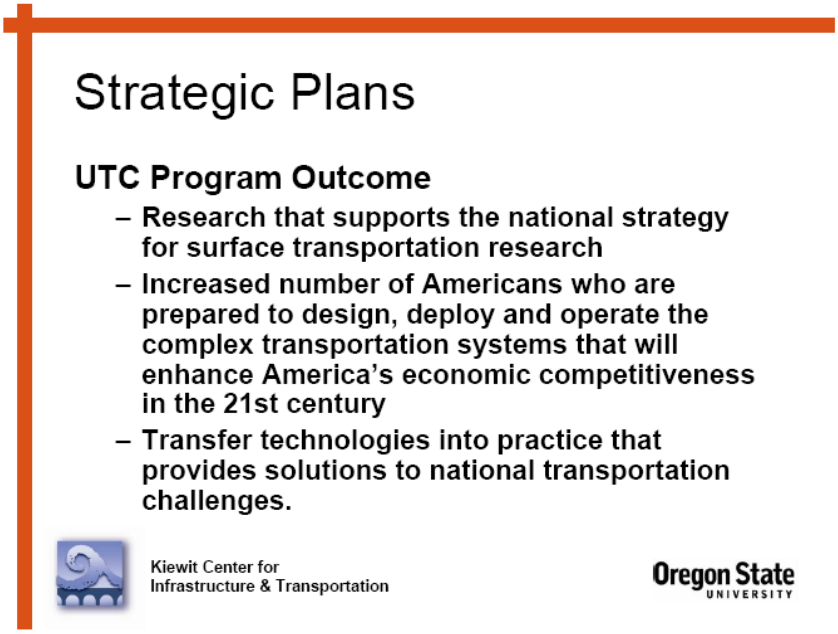
Strategic Plans
UTC Program Outcome
– Research that supports the national strategy for surface transportation research
– Increased number of Americans who are prepared to design, deploy and operate the complex transportation systems that will enhance America's economic competitiveness in the 21st century
– Transfer technologies into practice that provides solutions to national transportation challenges.
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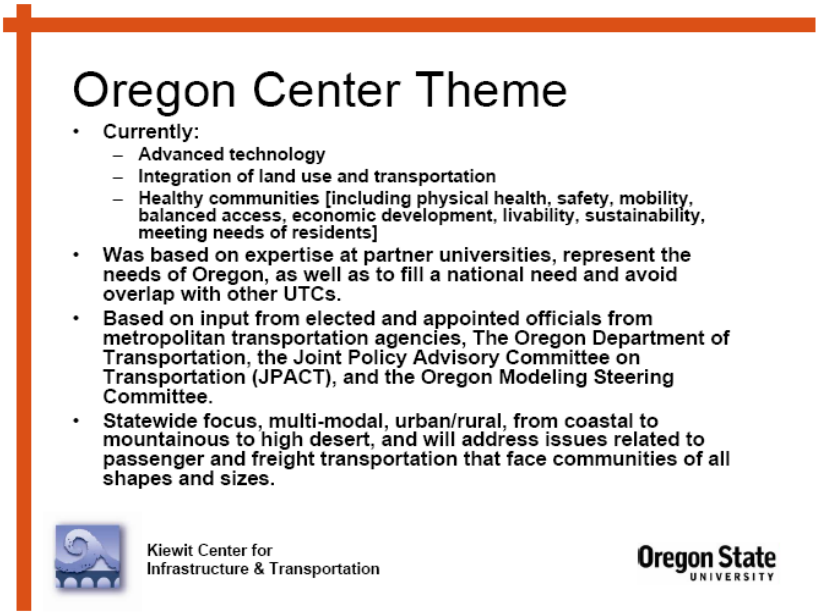
Oregon Center Theme
• Currently:
– Advanced technology
– Integration of land use and transportation
– Healthy communities [including physical health, safety, mobility, balanced access, economic development, livability, sustainability, meeting needs of residents]
• Was based on expertise at partner universities, represent the needs of Oregon, as well as to fill a national need and avoid overlap with other UTCs.
• Based on input from elected and appointed officials from metropolitan transportation agencies, The Oregon Department of Transportation, the Joint Policy Advisory Committee on Transportation (JPACT), and the Oregon Modeling Steering Committee.
• Statewide focus, multi-modal, urban/rural, from coastal to mountainous to high desert, and will address issues related to passenger and freight transportation that face communities of all shapes and sizes.
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External Advisory Board

- City of Portland
- METRO
- Washington County
- Multnomah County
- Clackamas County
- City of Lake Oswego
- City of Beaverton
- City of Gresham
- SMART Transit/City of Wilsonville
- Port of Portland
- City of Vancouver
- Trimet
- Lane Transit District
- City of Eugene
- Lane Council of Governments
- City of Bend
- City of Klamath Falls
- Klamath County Commission
- Southwest Washington Regional Council

University of Washington
Oregon Model Steering Committee
Oregon Trucking Association
American Automobile Association
Bicycle Transportation Alliance
Association of Oregon Counties
Alliance for Community Traffic Safety (ACTS) Oregon
League of Oregon Cities
Oregon Concrete & Aggregate Producers Association
Oregon Association of County Engineers and Surveyors

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External Advisory Board (cont'd)

Parsons Brinckerhoff/PB Farradyne
Kittelson & Associates
DKS Associates
David Evans and Associates
Darryl Anderson Consulting
CH2M Hill
IBI Group
Parametrix
Coral Sales
HNTB
TY Lin
OBEC
Hamilton Construction
Morse Bros.
Oregon Steel Mills
Cascade Steel Rolling Mills
Farwest Steel
American Bridge

Freightliner
Union Pacific
Burlington Northern
Shortline Railroad
Oregon Transfer
UPS
Fed Ex
Conway
Flexcar
Nike
Adidas
The Bike Gallery

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Strategic Plans

Undergraduate Education Activities

- Enhance transportation curriculum within Oregon and within Region X Consortium
- Summer internships for research at undergraduate level
- University support of undergraduate research used as match

Graduate Education Activities

- Permission to support international students
- Fund course modules, course materials
- Inventory of course and program needs across campuses
- Increase number of students in existing transportation graduate degree programs
- Recruiting fellowships (~$2,000 to cover fees not covered by tuition remission) for domestic students and permanent residents
- Support student conference as part of Region X consortium
- Poster competition from Northwest Transportation Conference cash awards also used as match.
- Scholarships can be considered as match
- Transportation student group fund raising and awards (e.g., ITE Traffic Bowl cash awards) used as match.
- Local campus graduate fellowships can be used as match
- University support for graduate student travel to present at conferences can be used as match

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Strategic Plans

Project Selection

- Rigorous, peer-reviewed research selection process
- Guided by a diverse external BOA and the EC.
- Balance selection of worthy projects that address advanced and applied research with linkages to articulated USDOT and other transportation agency priorities.
- The evaluation process for project selection will be clear and transparent.
- Faculty at partner university campuses know and understand the process.
- Viewed both internally and externally as innovative, efficient, fair and objective, with balance among campuses, disciplines, modes and with statewide appeal.
- A linkage with ODOT process is already in place.
- Timeline Stage 1 Dec.; Stage 2 Mar.; Decisions in April
- *No guarantees*

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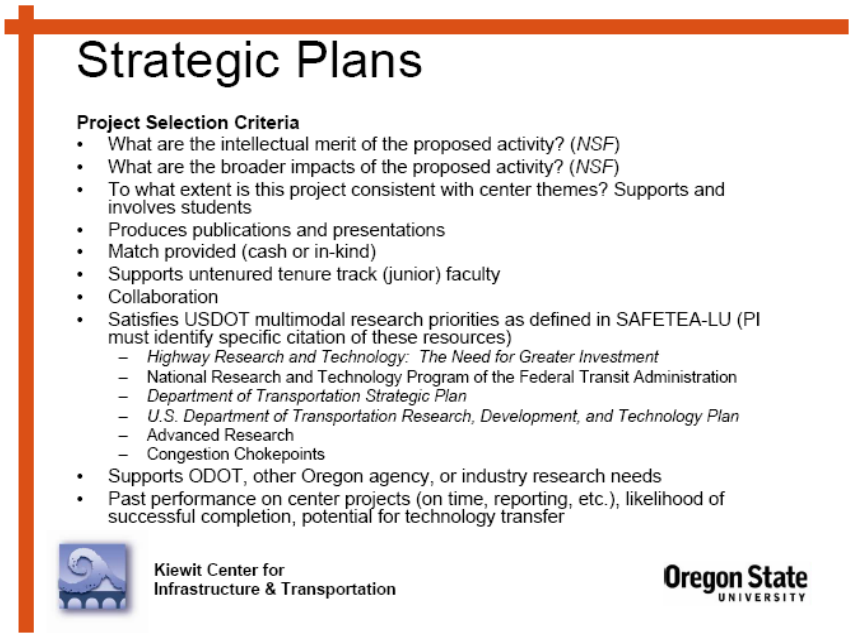
Strategic Plans
Project Selection Criteria
What are the intellectual merit of the proposed activity? (NSF)
What are the broader impacts of the proposed activity? (NSF)
To what extent is this project consistent with center themes? Supports and involves students
Produces publications and presentations
Match provided (cash or in-kind)
Supports untenured tenure track (junior) faculty
Collaboration
Satisfies USDOT multimodal research priorities as defined in SAFETEA-LU (PI must identify specific citation of these resources)
Highway Research and Technology: The Need for Greater Investment
National Research and Technology Program of the Federal Transit Administration
Department of Transportation Strategic Plan
U.S. Department of Transportation Research, Development, and Technology Plan
Advanced Research
Congestion Chokepoints
Supports ODOT, other Oregon agency, or industry research needs
Past performance on center projects (on time, reporting, etc.), likelihood of successful completion, potential for technology transfer
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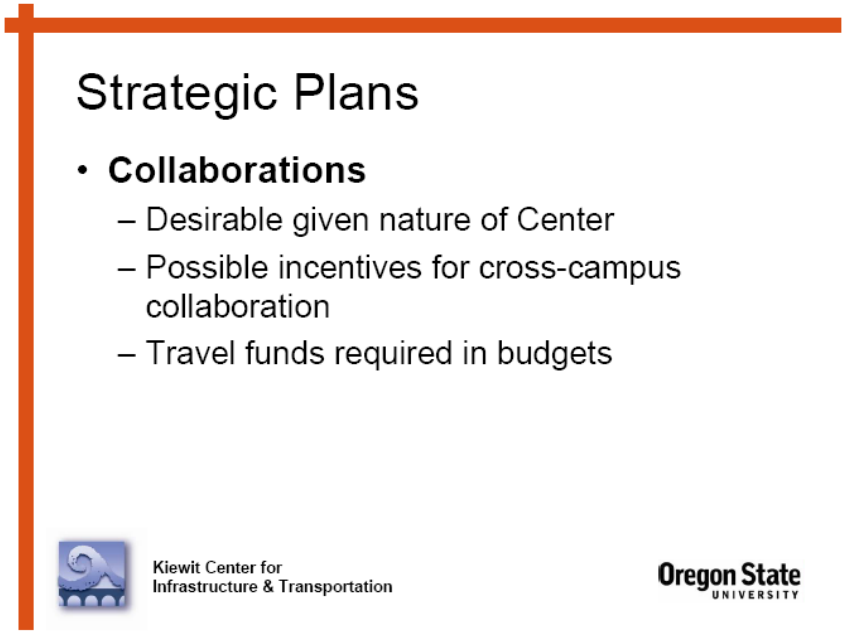
Strategic Plans
Collaborations
Desirable given nature of Center
Possible incentives for cross-campus collaboration
Travel funds required in budgets
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Strategic Plans

- Expectations
  - Peer-reviewed journal publications
  - Conference presentations
  - Participation in center activities
  - UTC Affiliation attribution/acknowledgement
  - Service as proposal reviewer

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Oregon State University

Future

- Information
  - Executive Committee Meetings
  - Kiewit Center Meetings and emailing
  - Oregon UTC Meetings: Fall retreat
  - Regional UTC Meetings
  - National UTC Meetings
- Foster OSU working groups to focus on areas of mutual interest and with other groups across various departments, colleges, and universities

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Future

- What can you do?
  - Provide comments on what you have heard (email or meetings)
  - Center name?
  - Review national research priorities in your area
  - Review draft strategic plans
  - Provide timely feedback
  - Attend national planning meetings and report
  - Let me know what I can do for you
  - Be patient (but if not, call or email me)

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Appendix 5: Examples of ODOT Environmental Research

Oregon Department of Transportation

ODOT Research Continuing Projects (2005)

Protecting Stream Habitat around Construction Sites

Highway construction and maintenance activities sometimes require work to be done directly in streams. This work disturbs soil and rock in the stream bed creating turbidity. This project tested a new approach to reducing turbidity generated by construction in streams by using a substance called chitosan. The chitosan gathers soil particles together and thus causes them to settle out of the water more quickly, or to be more easily removed through filtration.

The field testing was conducted in Oak Creek on the west side of Corvallis, Oregon. This test site had the added benefit of having numerous years of water quality, limnology, fisheries, and entomology data collected by an Oregon State University Limnology class. This longitudinal data will help in exploring possible negative, or positive, effects that the chitosan may have had on the stream ecosystem. The results of this project indicate that chitosan can accelerate, or facilitate, the removal of suspended sediment from a stream by being directly added to the stream. Accomplishing this improvement requires adequate dosing and mixing of the chitosan in the stream.

Details of the field testing results prompted followup lab testing that indicates chitosan's effectiveness is strongly influenced by properties of both the water (i.e. pH) and the sediment (i.e. mineralogy of clay particles). Careful, site specific evaluation of these factors will need to be done prior to any future use.

Advanced Technology for Deer and Elk Crossings

Animal-vehicle collisions affect human safety, property and wildlife. In the United States more than 1 million annual collisions cause an estimated 211 human fatalities, 29,000 human injuries and over one billion dollars in property damage. In most cases the animals die immediately or shortly after the collision.

Historically, animal-vehicle collisions have been addressed through signs, reflectors, mirrors or fences. Warning signs have limited effect, however, because drivers habituate to them; mirrors or reflectors may not be effective; and fences isolate populations. Fencing has been combined with wildlife crossing structures to address these limitations; but due to relatively high cost, such crossing structures are rare.

These facts encouraged 15 DOT's and FHWA to join efforts and find alternatives to the existing measures for prevention of vehicle-game animal collisions, leading to the *Animal-Vehicle Crash Mitigation Using Advanced Technology* pooled fund study, launched in 1999. The Western Transportation Institute (WTI) at Montana State University was invited to lead the investigation, and to explore the prospects for a relatively new mitigation strategy based on animal detection. Animal detection systems detect large animals such as deer, elk and moose, as they approach the road. Sensors activate signs that warn drivers when large animals are on or near the road.

The STS System (Sensor Technologies & Systems, Inc.), using microwave detection, also in combination with active signing, was installed on Highway 191 in Yellowstone National Park south of Big Sky, MT. The STS system had initial performance issues, but with some effort and additional investment, it became operational, allowing valuable data to be collected and an evaluation of system performance. There were also issues with the National Park Service regarding the Highway 191 test site, but those issues appear to have been successfully resolved.

Today the STS system is operable and the project is just beginning to collect data on operational performance. The project is scheduled to continue for three years, until June 2008, in order to assess both operational performance and system durability under extreme environmental conditions.

ODOT Research Reports (2000 – 2005)

http://www.oregon.gov/ODOT/TD/TP_RES/ResearchReports.shtml

Allan, Jonathan C., Ron Geitgey, and Roger Hart. 2005. *Dymanic Revetments for Coastal Erosion in Oregon.* Oregon Department of Transportation Research report SPR 620. Salem, Oregon. August.

Gravel beaches have long been recognized as one of the most efficient forms of "natural" coastal protection, and have been suggested as a form of shore protection. "Cobble berms," "dynamic revetments" or "rubble beaches" involve the construction of a gravel beach at the shore, in front of the property to be protected. These structures are effective in defending properties because the sloping, porous cobble beach is able to disrupt and dissipate the wave energy by adjusting its morphology in response to the prevailing wave conditions. Dynamic revetments are much easier and cheaper to construct than a conventional riprap revetment or seawall. They are also aesthetically pleasing compared with "hard" engineered solutions. There remain, however, unanswered questions about their design particularly along the high-energy Oregon coast – the sizes and types of gravel to be used, their slopes and crest elevations, the volume of material to be included in the berm, and where the material may be obtained to construct such features.

This study involved an examination of the morphological and sedimentary characteristics at 13 naturally occurring gravel beach study sites along the Oregon coast. Heights of the gravel beaches ranged from 5.7 to 7.1 m (19-23 ft), while the slopes of the beaches varied from 7.7º to 14.1º. Mean grain-sizes were found to range from -4.9Ø (30 mm) to -7.0Ø (128 mm), and were classified as well sorted to moderately well sorted. However, a comparison of these parameters among stable versus eroding gravel beaches revealed no clear discernable pattern. A key difference in the stability of the gravel beaches was the volume and width of gravel contained on the beach, with beaches containing larger volumes of gravel (> 50 $m^3.m^{-1}$ (538 $ft^3.ft^{-1}$)) and larger widths (> 20 m (66 ft)) being the most stable. Based on this analysis, a crest elevation of ~7.0 m (23 ft), mean grain-size of no less than -6.0Ø (64 mm), and a beach slope of 11º was recommended in future designs of dynamic revetments for the Oregon coast.

While numerous quarry sites were identified that could supply crushed rock for the building of a dynamic revetment, rounded gravels were more difficult to locate and tended to be located farthest from the coast, increasing the costs that would be incurred to transport the material.

ECONorthwest and Portland State University. 2001. *Corvallis Case Study: Indirect Land Use and Growth Impacts of Highway Improvements.* Oregon Department of Transportation Research report SPR 327. Salem, Oregon. June.

To improve environmental analysis of indirect land use impacts of highway capacity improvements, this study analyzed the land use and growth patterns of 20 Oregon communities over 20 years. Using a Geographic Information System and aerial photos, growth patterns were categorized and mapped. Factors related to land use and transportation were evaluated for their relationships to resulting growth patterns. These relationships were further investigated in six in-depth case studies of development prior to, during, and after construction of a highway capacity improvement.

ECONorthwest and Portland State University. 2001. *La Grande/Island City Case Study: Indirect Land Use and Growth Impacts of Highway Improvements.* Oregon Department of Transportation Research report SPR 327. Salem, Oregon. April.

To improve environmental analysis of indirect land use impacts of highway capacity improvements, this study analyzed the land use and growth patterns of 20 Oregon communities over 20 years. Using a Geographic Information System and aerial photos, growth patterns were categorized and mapped. Factors related to land use and transportation were evaluated for their relationships to resulting growth patterns. These relationships were further investigated in six in-depth case studies of development prior to, during, and after construction of a highway capacity improvement.

ECONorthwest and Portland State University. 2001. *A Guidebook for Evaluating the Indirect Land Use and Growth Impacts of Highway Improvements.* Oregon Department of Transportation Research report SPR 327. Salem, Oregon. April.

In 1998, the Oregon Department of Transportation undertook a study of the impacts of highway capacity improvements on land uses and growth, particularly at the urban fringe. The objective was to better understand the "cause and effect" relationships among highway capacity, travel demand and development patterns. A variety of factors to resulting growth were evaluated for their ability to predict growth. Case studies of six communities provided an in-depth understanding of the pressures which drive development decisions and land use change.

This guidebook provides guidance to ODOT staff for completing environmental analysis and documentation on indirect land use impacts of highway improvements, based on findings of the study. One finding was that most highway capacity increases do not cause development to be dramatically different from local land use plan guidance, or from what would have occurred in absence of the highway improvement. In Oregon, local governments hold the tools to determine development patterns, using zoning and public utilities such as water, sewer and roads.

This guidebook is not a directive, but a compilation of recommendations for a systematic look and consistent approach to predicting the indirect land use impacts of highway improvements. Appendices A-F of this report provide background on the study findings, including the literature review, growth trends analysis and six in-depth case studies. Also included in the appendices are a discussion of population and employment forecasting issues and a summary of ODOT processes for project evaluation.

Edgar, Rob.2000. *Evaluation of Infrared Treatments for Managing Roadside Vegetation*. Oregon Department of Transportation Research report SPR 376. Salem, Oregon. December.

Environmental concerns have prompted many agencies to seek alternatives to herbicides in controlling vegetation on roadway shoulders. This study was implemented to evaluate the potential for infrared technology to address this need. Infrared technology users radiant energy to kill unwanted vegetation. Intense heat generated by liquid propane coagulates plant proteins and burst cell walls, killing seedling plants and destroying the tops of established vegetation. Repeated treatments at regular intervals deplete the root reserves of established plants and leads to their decline and eradication. Infrared treatments were applied at three rates (8, 6, and 4 treatments/year) along Oregon highways from November 1996 through June 1999. These treatments were compared to shoulders treated with herbicides and to shoulders where vegetation was left unmanaged (controlled sites). Results suggest that infrared technology can keep vegetation under control on roadway shoulders.

Gregory, Stan, Jeff McEnroe, Peter Klingeman, and Josh Wyrick. 2004. *Fish Passage through Retrofitted Culverts.* Oregon Department of Transportation Research report SPR 325. Salem, Oregon. November.

Long term and short term studies of fish movement were conducted at several retrofitted culverts within Oregon. This was done to assess the effectiveness of retrofitting culverts with baffles to improve fish passage. The long term results showed that the baffle equipped culverts do in fact allow fish passage, even though the fish in the study areas did not appear to move a great deal in any part of the study reaches. The short term results indicated a definite improvement in the ability of juvenile steelhead trout to move upstream after the addition of certain baffle configurations. Measurements of

hydraulic conditions showed that the baffles do create areas of lower flow velocity, deepen the flow, and create resting pools. These observations indicate that fish can and do move through culverts retrofitted with baffles and that the addition of baffles can improve the ability of juvenile fish (especially steelhead trout) to move upstream through a culvert.

Klingeman, Peter, Marvin Pyles, David Hibbs, and Boone Kauffman. 2002. *Roadway Applications of Vegetation and Riprap for Streambank Protection.* Oregon Department of Transportation Research report SPR 324. Salem, Oregon. January.

Riprap is commonly used for roadway protection at streams. However, vegetation is generally not a component of such protection. Environmental impacts such as increased water temperature and decreased quality of stream habitat may result from the removal of riparian vegetation during riprap construction. Near waterways containing threatened or endangered species, regulatory agencies require that remedial measures be taken if riparian vegetation is removed. This study considered issues and options for streambank protection. An overview and analysis of the literature is provided. Roles for vegetation as part of streambank protection are considered. Techniques are given for use of vegetation with riprap and potential project opportunities are described. A comprehensive list of suitable species for streamside stabilization and riparian enhancement is included.

Li, Qilin, and Laura Kegley. 2005. *Assessing the Effectiveness and Environmental Impacts of Using Natural Flocculants to Manage Turbidity*. Oregon Department of Transportation Research report SPR 615. Salem, Oregon. October.

The objective of this research was to determine the feasibility of using chitosan as a natural flocculant to control turbidity during in-stream construction work. A series of field tests in Oak Creek, Corvallis, OR were conducted in order to test the effectiveness for turbidity control and the environmental impacts of applying chitosan directly into a stream environment. No significant removal was obtained with chitosan doses up to 0.5 mg/L under the conditions tested, mostly due to high pH of the creek and other unfavorable water quality parameters. Water quality analysis for total organic carbon, total phosphorus, total Kjeldahl nitrogen, and biochemical oxygen demand showed that chitosan does not adversely impact the aquatic environment at low doses.

Due to the inconclusiveness of the field test data, a series of bench-scale tests were conducted to evaluate the effectiveness of chitosan under controlled conditions, as well as its responses to different test conditions, e.g. pH, initial turbidity, chitosan dose and sediment type. The bench scale tests were conducted using water collected from Oak Creek and a standard jar tester. It was found that flocculation efficiency depends strongly on sediment type. However, the most critical factor that determines the effectiveness of chitosan seems to be an unidentified water quality parameter, which is likely related to the organic matter in the stream.

Wood, Tamara. 2001. *Herbicide Use in the Management of Roadside Vegetation, Western Oregon, 1999–2000: Effects on the Water Quality of Nearby Streams*. Water-Resources Investigations Report 01–4065.United State Geological Survey. Portland, Oregon

No abstract provided.

Appendix 6: List of Participants

Academic

Contact Information	Expertise/Interests
Robert Bertini PSU, Center for Transportation Studies bertini@pdx.edu 503.725.4249	New data sources, sensor technology, data analysis, data fusion; traffic flow theory and macroscopic modeling; performance measures and evaluation of transportation systems, programs and policies; safety data analysis and improvements for pedestrians and bicyclists; multimodal traveler information, routing and control; and sustainability through new mobility services and alternative fuels
Kevin Boston OSU, Forest Engineering Kevin.Boston@oregonstate.edu	Forest transportation planning, forest road design and management systems and supply chain management for the primary forest industry
Roger Ely OSU, Biological Engineering ely@engr.orst.edu 541.737.9409	Biodeisel, hydrogen production
Stan Gregory OSU, Fish and Wildlife stanley.gregory@oregonstate.edu 541.737.1951	Stream ecosystems: channel dynamics, woody debris, water chemistry, benthic algae, invertebrates, fish, salamanders, and riparian vegetation. Landscape perspectives for stream ecosystems. Influence of human activities on ecosystem structure and function. Historical reconstruction of rivers and riparian forests. Development of restoration perspectives and practices that are consistent with natural stream processes.
Chris Higgins OSU, Engineering chris.higgins@oregonstate.edu 541.737.8869	Passive structural control, structural testing, steel structures and connections, earthquake and wind engineering, repair and retrofit of structures, high-performance materials, historic structures and materials.
Wayne Huber OSU, Civil Engineering wayne.huber@orst.edu 541.737-6150	Urban hydrology, stormwater management, non-point source pollution, and transport processes related to water quality. He is one of the original authors of the Environmental Protection Agency's Storm Water Management Model (SWMM) and continues to maintain the model engine for the EPA and for the user community.

David Hulse
U of O, Landscape Architecture
dhulse@uoregon.edu
541.346.3672

Land use planning, landscape ecology, geographic information systems

John Lambrinos
OSU, Horticulture
lambrinj@hort.oregonstate.edu
541-737-3484

Landscape ecology

Jim Lundy
OSU, Engineering
Jim.Lundy@oregonstate.edu
541.737.4979

Properties and uses of Portland cement and polymer-modified concretes; use of waste materials in construction; asphalt material characterization, composites, and the design, specification, construction, and rehabilitation of pavements

Starr McMullen
OSU, Economics
s.mcmullen@orst.edu
541.737.1480

Transportation economics and policy

James Meacham
U of O, Geography
jmeacham@uoregon.edu
541.346.5788

Cartography, GIS, Atlas and Map Design

Ann Nolin
OSU, Geosciences
nolina@geo.oregonstate.edu
541.737.8051

Cryosphere-climate interactions, snow hydrology, remote sensing of snow and ice, surface energy balance modeling, radiative transfer modeling, digital image processing

Lei Zhang
OSU, Engineering
lei.zhang@oregonstate.edu
541.737.4934

Impacts of transportation projects and policies on land use and the environment, economic evaluation of transportation and land use projects, transportation systems analysis; transportation planning and policy; network economics; travel behavior; travel demand modeling; road pricing and financing; intelligent transportation systems; traffic operations.

NGO

Contact Information	**Expertise/Interests**

Rob Fiegner
Native Seed Network
rob@nativeseednetwork.org
541.753.3099

http://www.nativeseednetwork.org/
The interest of the Native Seed Network include all aspects of native seeds – native plant materials from local genetic sources to conserve biological diversity and maintain the adaptive capability of plant populations, communities, and ecosystems, and finding economically viable solutions to native plant materials needs. The Native Seed Network also works to safeguard existing native plant populations from over-collection.

Erica Graetz
The Climate Trust
egraetz@climatetrust.org
503.238.1915

http://www.climatetrust.org/
The sole mission of The Climate Trust is to promote climate change solutions by providing high quality greenhouse gas offset projects and advancing sound offset policy.

Tom O'Neil
Northwest Habitat Institute
habitat@nwhi.org
541.753.2199

http://www.nwhi.org/index/
The development of a management tool that uses species, habitats, and functions to calculate the intrinsic value of any wildlife-habitat type. This tool is being used by several resource agencies and is the foundation for the accounting of debits and credits for a Statewide Mitigation Banking Program.

Peter Schoonmaker
Illahee
schoon@illahee.org
503.222.2537

http://www.illahee.org/
A non-profit organization, Illahee provides participants with practical tools for understanding the nature of our home here in the Pacific Northwest and for taking care of it. We provide the region opportunities for science-based policy-relevant environmental inquiry.

Sarah Vickerman
Defenders of Wildlife
svickerman@defenders.org
503.697.3222

http://www.biodiversitypartners.org/about/Aboutwest.shtml
Current priorities of Defenders of Wildlife include working with states to develop comprehensive wildlife conservation strategies, improving conservation incentives for private landowners; preventing and controlling ecological damage caused by invasive species; strategically restoring damaged landscapes to improve habitat and water quality; managing forests to prevent catastrophic wildfire; integrating habitat conservation into local land use decisions; and developing useful ecological indicators to monitor the success or failure of conservation programs.

Private Sector

Contact Information | **Expertise/Interests**

Richard Angstrom Oregon Concrete & Aggregate Producers Association, Inc. rich@ocapa.net 503.588.8271 (then dial 8)	http://www.ocapa.net/ The purpose of the Oregon Concrete & Aggregate Producers Association, Inc. is to advance in every legitimate way construction and the construction materials industries in the state of Oregon.
Bill Annen NRC Environmental Services BAnnen@nrces.com 503.283.1150 503.209.5167 cell	http://www.fossenv.com/about.htm NRC Environmental Services Inc. (NRCES) is dedicated to providing superior hazardous and non-hazardous waste management and emergency response services to a wide variety of private industrial and government clients.
Sean Darcy Stormwater 360 sdarcy@stormwater360.com 800.548.4667	http://www.stormwater360.com/ CONTECT Stormwater Solutions Inc is a progressive, innovative company with a mission to preserve and protect water resources worldwide. As a division on CONTECH, we help our customers meet regulatory requirements by providing a variety of stormwater management solutions.
Ned Dempsey Century West Engineering jndempsey@CenturyWest.com 503.419.2130	http://www.centurywest.com/ Century West Engineering Corporation (Century West) has been supporting communities throughout the Pacific Northwest by providing a wide range of technical expertise and services for over 32 years. By combining the skills of our planners, engineers, geologists, and environmental scientists, we are able to quickly adapt and respond to a wide variety of project needs.
Ann Gardner Schnitzer Steel Industries, Inc. agardner@schn.com 503.417.2041	http://www.schnitzersteel.com/ Schnitzer Steel Industries, Inc., (SSI) still deals in scrap metal, but on a massive scale. SSI is one of the nation's largest recyclers of ferrous metals, a leading recycler of used and recycled auto parts through its chain of Pick-N-Pull self service auto parts stores, and a manufacturer of finished steel products. The company, with its joint venture partners, currently processes over 4.9 million tons of recycled metals a year. In addition, the company's steel mill, Cascade Steel Rolling Mills, Inc., has an annual production capacity of 700,000 tons of finished steel products including concrete reinforcing bar, wire and coiled web, and fence posts.
Deborah Hart Redman HDR, Inc. Deborah.redman@hdrinc.com 503.423.3879	http://www.hdrinc.com/ HDR is an architectural, engineering and consulting firm. As an integrated firm, HDR provides a total spectrum of services for our clients. Our staff professionals represent hundreds of disciplines and

	partner on blended teams nationwide to provide solutions beyond the scope of traditional A/E/C firms.
Jessica Harris-Adamson Associated General Contractors, Oregon-Columbia Chapter jessica@agc-oregon.org 503.682.3363 or 800.826.6610	http://www.agc-oregon.org/ The mission of the Heavy/Highway/Utility Council of the Associated General Contractors is to work for the continued availability of public work for AGC members through fair and competitive selection methods. Support efforts to maintain sustainable growth management. Promote strategic and professional alliances.
Jim Huddleston Asphalt Pavement Association of Oregon jhudd@apao.org 503.363.3858	http://www.apao.org/ The Asphalt Pavement Association of Oregon, Inc., (APAO) is a nonprofit trade organization representing the interests of the asphalt paving industry.
Jason Neil Oregon Bridge Delivery Partners jason.neil@obdp.org 503.551.7244	http://www.obdp.org/ Provides program management for the Oregon Department of Transportation's OTIA III State Bridge Delivery Program.
Jake Polvi Sustainable Engineering jakepolvi@sengr.com 541.410.3050	
Ron Polvi Sustainable Engineering ronpolvi@sengr.com 503.835.7394 503.302.5750 cell	
Scott Richman David Evans & Associates csr@deainc.com 503.499.0593	http://www.deainc.com/ DEA service areas are energy, land development, transportation, and water resources. DEA is an employee-owned Oregon corporation governed by an eight-member board of directors. The firm combines the talents of architects, engineers, landscape architects, planners, scientists, and surveyors to provide its clients access to a complete range of services.
Eric Strecker GeoSyntec Consultants estrecker@geosyntec.com 503.222.9518	http://www.geosyntec.com/ GeoSyntec Consultants service areas include transportation infrastructure, environmental restoration and operations, natural resource management, solid waste, and water resources. GeoSyntec provides private

	and public sector clients with earth and environmental sciences consulting services; environmental, geotechnical, and hydrological engineering consulting and design services; and construction management and quality assurance services for projects involving these practices.
Richard Upton CH2M Hill (Salem) rupton2@ch2m.com 503.378.0661 ext. 212	http://www.ch2m.com/corporate/ CH2M Hill offers a full range of services including Architecture & Planning , Environmental Management & Planning, Engineer-Procure-Construct (EPC) & Design-Build, and Sustainable Solutions, to name a few.

Public Sector

Contact Information	**Expertise/Interests**
Chris Bayham Association of Oregon Counties cbayham@orlocalgov.org 503.585.8351	http://www.aocweb.org/crp/ The County Road Program (CRP) was established in 1990 as a cooperative program with the Oregon Association of County Engineers and Surveyors (OACES). Its purpose is to enhance county road capabilities through the development of management programs and shared technical assistance. The goal of CRP's environmental services [http://www.aocweb.org/emr/] is to minimize the impact of county roads on the environment by increasing environmental management with integrated training and guidance and with the coordination of Oregon counties' participation in environmental rule/policy making and legislative proposals.
Jerri Bohard ODOT Planning Jerri.l.bohard@odot.state.or.us 503.986.4165	http://egov.oregon.gov/ODOT/TD/TP/ ODOT Planning's mission is to provide direction for long term management and improvement of Oregon's transportation system and to promote the cost-effective us of public funds through effective research, development and technology transfer.
Simon Wray Oregon Department of Fisheries and Wildlife Central Region Office simon.n.wray@odot.state.or.us 541.388.6444 ext. 21	Habitat Division
Kevin Downing Department of Environmental	http://www.deq.state.or.us/ Air Quality Division; Diesel emissions and the Oregon

Quality kevin.downing@state.or.us 503.229.6549	Clean Diesel Initiative.
Damon Fordham ODOT Sustainability damon.fordham@odot.state.or.us 503.986.3491	http://www.oregon.gov/ODOT/TD/TP/otpSustain.shtml The mission of the sustainability and transportation choice committee is to update and develop policies that support livable communities and the development of a sustainable transportation system.
Hal Gard ODOT Geo-Environmental Section howard.a.gard@ODOT.state.or.us 503.986.3508	http://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/about_us.shtml The Geo-Environmental Section is responsible for coordinating environmental regulatory compliance for all transportation improvement programs in the state which use federal funds. The section is responsible for statewide practices, standards, training, expertise, and asset management for geology, geotechnical, and environmental disciplines within ODOT.
Barnie Jones ODOT Research Barnie.P.JONES@odot.state.or.us	http://www.oregon.gov/ODOT/TD/TP_RES/ResearchProgram.shtml The Research Unit oversees the state's federally funded research, development and technology transfer program with particular emphasis on new technology intended to enhance the performance of Oregon's transportation systems. Major current research focuses on safety, infrastructure repair and preservation, maintenance practices, innovative contracting and project delivery, sustainable environmental practices, and the land-use, transportation connection.
Paul Ketcham Metro ketcham@metro.dst.or.us 503.797.1726	http://www.metro-region.org/ Regional Transportation Planning http://www.metro-region.org/article.cfm?articleID=137 The Regional Transportation Plan is the blueprint that guides investments in the region's transportation system to reduce congestion, build new sidewalks and bicycle facilities, improve transit service and access to transit and maintain freight access.
Jim Mitchell City of Corvallis Transportation Division jim.mitchell@ci.corvallis.or.us 541.766.6900	http://www.ci.corvallis.or.us/index.php?option=content&task=view&id=456&Itemid=398 The Transportation Division helps provide orderly movement of goods and services and protects public health and safety through a number of diverse services including streets, street lights, sidewalks, bikeways, public buildings, vehicle fleet, radio and telephones, mapping services, municipal airport and industrial park, public

transit, and neighborhood traffic calming. The Division manages programs and services to reduce single-occupancy vehicle trips by providing alternate modes of transportation and providing transportation demand management services. Many services are performed through public agency and private partnerships.

Lori Sundstrom
Portland Development Commission
sundstroml@pdc.us
503.823.3346

http://www.pdc.us/
The Portland Development Commission's vision is to be a catalyst for positive change in the creation of a world-class 21st Century city; a city in which economic prosperity, quality housing and employment opportunities are available to all. Their mission is to bring together resources to achieve Portland's vision of a diverse, sustainable community with healthy neighborhoods, a vibrant urban core, a strong regional economy and quality jobs for all citizens.

Appendix 7: Workshop Agenda

Transportation and the Environment:
Linking Researchers, Transportation Providers, and Industry

Thursday, 9 February 2006, 12:00 – 4:30PM
CH2M HILL Alumni Center, Room 111A/B
Oregon State University
Corvallis, Oregon

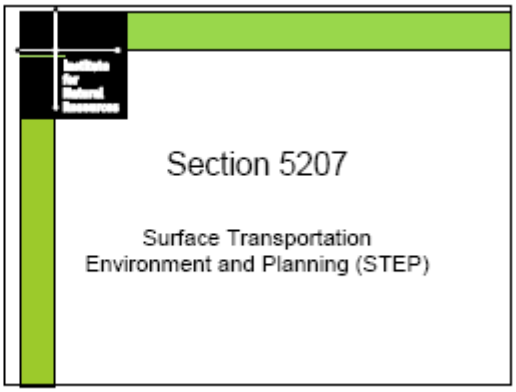
Meeting Goal

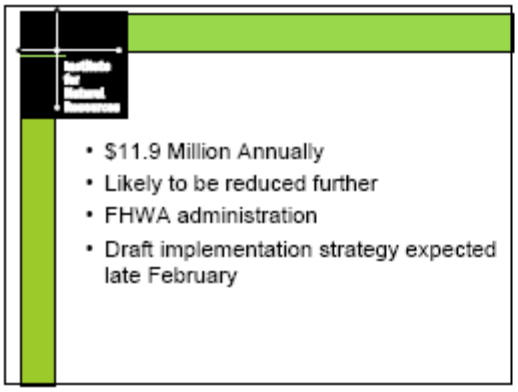
To develop a private-public network of transportation professionals, OUS academics, and ODOT personnel interested in cooperative research in the State of Oregon as it relates to road ecology and to use the outcomes of the workshop to help develop a research agenda that will strategically position the state of Oregon to propose innovative and relevant research targeted toward the research agendas set out in HR3, Sections 5203 and 5209.

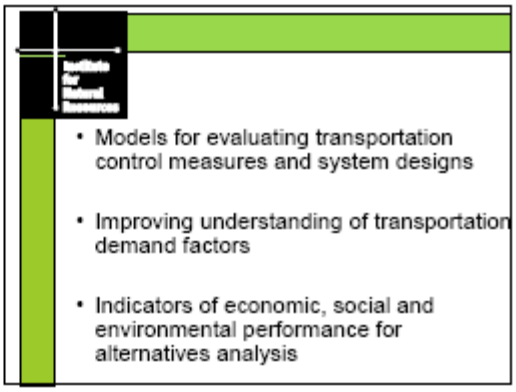
Draft Agenda

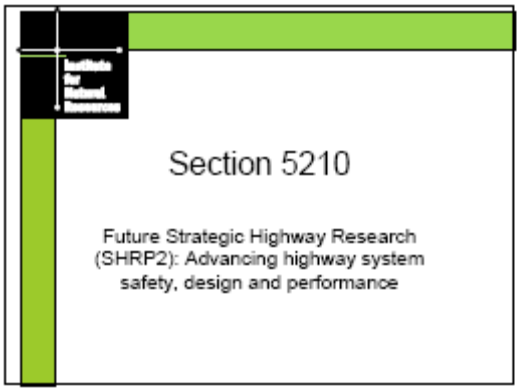
Time	Topic
12:00	***Lunch*** (served)
12:15-12:20	Welcome – *Lisa Gaines*
12:20-12:30	Introductions – *all*
12:30-1:10	Presentation: Status of the TRB Cooperative Research Programs – *Gail Achterman*
1:10-1:20	Set up of Round Tables – *Lisa Gaines*
1:20-2:05	Round Tables 1: Oregon Transportation Industry Needs and Research Opportunities – *small groups*
2:05-2:50	Round Tables 2: Setting Priorities – *small groups*
2:50-3:00	***Break***
3:00-4:00	Round Tables 3: What did we come up with? – *small groups*
4:00-4:25	Issues/Concerns; What/Who Are We Missing? Next Steps – *all*
4:25-4:30	Workshop Check-out – *Lisa Gaines*
4:30	***Adjourn***

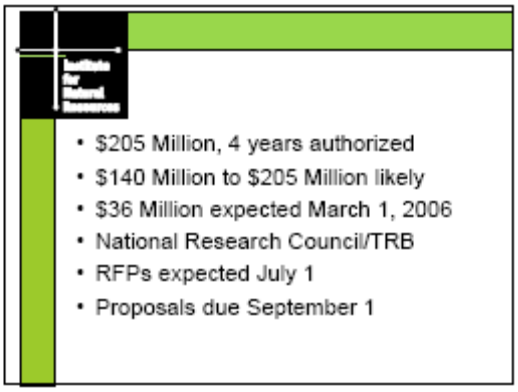
Appendix 8: Workshop Opening Presentation











Focus Areas

- Safety
- Renewal
- Reliability
- Capacity

Opportunities for Oregon

AEED, OECDD and Oregon, Inc.

Academic Excellence and Economic Development Working Group
Kirby Dyess, Chair

Growing Oregon's Economy Through Postsecondary Excellence

Oregon State Board of Higher Education, July 15, 2005

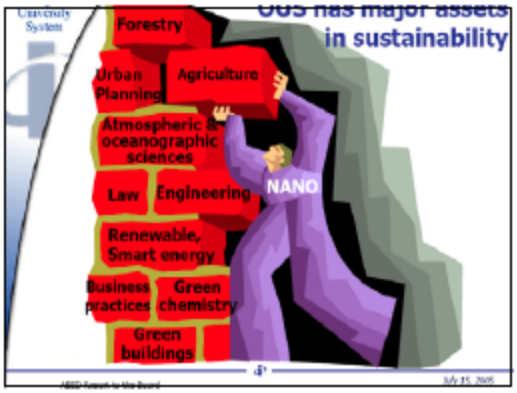
AEED baseline goal – opportunity areas that:

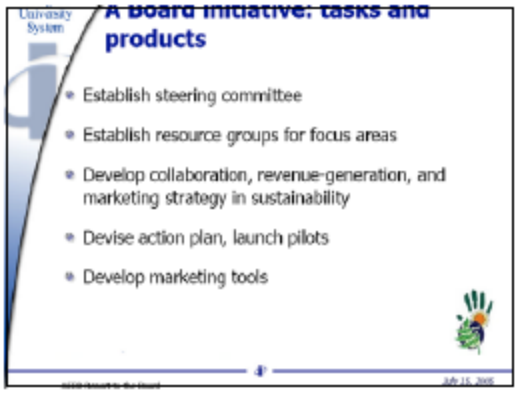
- Show measurable ROI over 20 years, with milestone results
- Touch every part of Oregon
- Build on existing or emerging momentum
- Draw on, reinforce excellence in academic programs and research
- Offer opportunities that are exciting and easy to conceptualize

Reviewed nearly a dozen areas ...

July 15, 2005

Connecting research opportunity areas with clusters


OUS has major assets in sustainability
Forestry
Urban Planning
Agriculture
Atmospheric & oceanographic sciences
Law
Engineering
NANO
Renewable, Smart energy
Business practices
Green chemistry
Green buildings


A board initiative: tasks and products
Establish steering committee
Establish resource groups for focus areas
Develop collaboration, revenue-generation, and marketing strategy in sustainability
Devise action plan, launch pilots
Develop marketing tools


OECDD Efforts
•Roadmap for Innovation
•Oregon Innovation Council


Today's Objectives
• Link transportation professionals and researchers
• Identify new cooperative research opportunities
• Identify next steps to position Oregon to compete for new research funds

Appendix 9: Funding Resources

Federal Highway Administration
http://www.fhwa.dot.gov/orgrdat.htm

Foundation Center
http://fdncenter.org/

Grants.Gov
http://www.grants.gov/

National Cooperative Research
http://www4.trb.org/trb/crp.nsf/rfps
http://www4.trb.org/trb/crp.nsf

ODOT Research Program
http://www.oregon.gov/ODOT/TD/TP_RES/ResearchProgram.shtml

Appendix 10: Examples of Information Resources

American Association of State Highway & Transportation Officials (AASHTO)
http://www.transportation.org/

Center for Transportation Studies, Portland State University
http://www.cts.pdx.edu/index.htm

The Center for Transportation Studies strives to stimulate and conduct multidisciplinary research on transportation issues, facilitating the dissemination of information and encouraging the implementation of research results. The Center for Transportation Studies is committed to providing relevant research to assist local, state, and regional agencies in their work; expanding the pool of highly talented students who choose to work in the area of transportation planning and engineering; and building upon our collective efforts to make the metro region and Oregon a place where innovation, creativity, and collaboration lead to sustainable communities.

Center for Transportation and the Environment, North Carolina State University
http://cte.ncsu.edu/cte/

The Center for Transportation and the Environment (CTE) conducts research, education, and technology transfer that seek to mitigate the impacts of surface transportation on the environment. CTE hosts two keyword-searchable online research databases—Wildlife, Fisheries, and Transportation Research Database and the Federal Highway Administration Environmental Research Program Database—both of which can be found at http://cte.ncsu.edu/CTE/TechTransfer/searchDatabases.asp.

Converge Resource Center, North Carolina State University
http://www.converge.ncsu.edu/index.html

The relationship between surface transportation and the environment is profoundly complex. The topics section (http://www.converge.ncsu.edu/sub_research_topics.asp) of the CONVERGE web site highlights the 21 topics of greatest concern regarding transportation and the environment with links to various media-specific webpages. The website also has an annotated bibliography of books printed between 1928 and 2003 (http://www.converge.ncsu.edu/utility_pages/bib_trans_environ.asp).

Federal Highway Administration
Planning, Environment, and Realty (HEP)
http://www.fhwa.dot.gov/hep/index.htm

STEP Implementation Strategy, Functions, and Emphasis Areas
http://www.fhwa.dot.gov/hep/step/strategy.htm

Linking Land Use and Transportation
http://www.fhwa.dot.gov/planning/ppasg.htm

Green Highways
http://greenhighways.org/

The Green Highways Initiative is a voluntary, collaborative, public/private effort designed to identify & promote streamlining and environmental stewardship in transportation planning, design, construction, and/or operation and maintenance through integrated partnerships, flexibility, rewards, and market-based solutions.

The Goal is to foster partnerships for improving upon the natural, built and social environmental conditions in a watershed, while sustaining life-cycle functional requirements of transportation infrastructure (safety, structural & service levels) – providing for conditions that are "better than before".

The Green Highways Initiative was created to promote innovative streamlining and market-based approaches toward sustainable solutions for transportation and environmental improvements. Partnership development consists of integrated public/private partnerships with federal/state transportation and regulatory/resource agencies, contractors, industry, trade associations, academic institutions, and nongovernmental organizations to develop and champion Green Highways efforts.

International Conference on Ecology and Transportation
http://www.icoet.net/

OSU Kiewit Center for Infrastructure and Transportation
http://kiewit.oregonstate.edu/

The Kiewit Center for Infrastructure and Transportation was initially established in 1962 as the *Transportation Research Institute*. The Kiewit Center serves as the umbrella organization for almost all research within the Civil, Construction and Environmental Engineering Department. In addition to conducting funded and unfunded research, the Center provides a variety of outreach activities to support practicing professionals throughout the Pacific Northwest. The Center participates in the Council of University Transportation Centers (CUTC) through the Region 10 TransNow University Transportation Center, located at the University of Washington.

Road Ecology Center, University of California Davis
http://johnmuir.ucdavis.edu/road_ecology/

The Center also is showcasing the book *Assessing and Managing the Ecological Impacts of Paved Roads* (National Resource Council, 2005) which can be read free online at http://www.nap.edu/catalog/11535.html

Transportation Research Board
http://www.trb.org/

University Transportation Centers
http://utc.dot.gov/

U.S. Fish and Wildlife Service
Ecology and Biology Online Resources
http://www.fws.gov/refuges/roads/road_ecol_biol.html

Appendix 11: Comments

Comment A
On page 3, the explicit link of the UTC to JPACT is no longer applicable. There will a Board of Advisors (BOA) which will include representation from some JPACT agencies but will represent all stakeholders, public and private. The funding level after application of rescissions, Federal obligation limits and other adjustments, is likely to be closer to $11-12 Million rather than $16 Million. Rob Bertini may have a more up-to-date number.

Comment B
I skimmed the report and it looked fine. The one issue that may not have gotten the attention in the report that it did in the workshop is the potential for transportation agencies to pool resources with other investors to address mitigation needs at an ecologically significant scale. It is clear that no one agency or program working in isolation can effectively address habitat conservation and restoration needs, especially in a highly fragmented landscapes facing intense growth pressures. Research could help determine optimum project scale and configurations most likely ensure long term ecological integrity. Policy research is also needed to determine how best to administer a cooperative ecological investment strategy that is beneficial to transportation agencies and private bankers, and produces better environmental results than current approaches.

Comment C
Focus on effects to ecosystem services, i.e. the benefits that healthy functioning ecosystems provide to human populations, rather than effects to habitats and species.

When discussing scale we should not only be looking at larger scale regional and ecosystem effects, but should also be looking at longer time scales. For example, what are the transportation and ecosystem services needs going to be in 100 years and what decisions can we make now that will facilitate those needs. The effects of global warming should be integrated into our decisions e.g. how will warmer temperatures affect hydrology and the hydraulic design needs of the transportation system, how will this effect species and habitat distribution, etc.

Stormwater quantity is a significant issue as well as quality. ODOT is required by regulatory laws to address the effects of it's transportation system on both stormwater quality and quantity and both can be challenging - particularly in built (urban) environments.

Culverts - providing fish passage and natural channel processes are major challenges with culverts. Research regarding cost effective designs, retrofits and construction techniques that address these issues would be beneficial.

Comment D

…I reviewed the document that was attached and would say that _____ was close to right when he commented that there is something for everyone, with the exception of the Material Source Program. This group definitely covered a wide range of topics with a major emphasis on ecosystems and other environmental issues.

If there taking suggestions for additional topics that have an environmental flare to them and would also include something for the material source program, why don't you suggest that this group use the resources at their disposal to look for alternatives to the use of asphalt products in pavements.

This document talks about the difficulty in forecasting oil cost. What should be included in this statement is not only the oil cost but the impacts of the rising cost of fuel, and along with this goes the uncertainty associated with the supply of both fuel and oil products. If an alternative could be found, other than the obvious - concrete, then ODOT would be a leader in reducing the demand for oil, the cost of projects might drop, process would likely change and we may find the alternatives to be more environmentally friendly. The potential environmental benefits might be significant.

In the planning section where they talk about the difficulty in forecasting oil cost, there should be an additional bullet regarding the forecasting the need and cost of aggregate products. With the increase in population comes the demand for more roads and a huge increase in the opposition for material sources while at the same time an increased expectation in high quality transportation facilities. Like we have been preaching for a long time, more than 90% of every roadway is built out of earthen materials. With the increased need and higher expectations while at the same time seeing increased environmental sensitivity and opposition from the public, someone better be forecasting the needs and cost for materials, and developing solutions for where the material will come from to sustain the demand.

The other thing you may point out to these folks is the need to identify and research ways to utilize lower quality materials for embankment construction, base and pavements. With the current state of construction, the time lines for most projects and the current specifications ODOT projects seeming leads to the waste of huge volumes of soil materials because they are difficult to handle in construction. For example on the Keubler project large volumes of excavated material was scheduled for disposal and considerable amounts of rock or "all weather fill" was needing to be imported. With help from these researchers new techniques could be developed that would allow for the use of this lower quality material with acceptable performance, reducing the requirements for disposal and excavation, reducing traffic, congestion, exhaust and noise from hauling vehicles. This would lead to lower project cost and reduced environmental impacts. Those would be my suggestions for improvements to the list of research topics and how to actually add a few things to the list that will truly provide something for everybody.