Transportation and Sustainable Communities Initiative: Overview of Federal Sustainable Transportation Activities

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prepared by:

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NOTICE TO REVIEWERS

President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate science, space, and technology policies across the Federal Government.

Through its planning activities in 1997, the NSTC Committee on Transportation Research and Development (CTRD) has called for the development of Strategic Partnership Initiatives in a number of areas, including sustainable transportation. An interagency Transportation and Sustainable Communities Team has been formed to develop plans for research investments in this area.

This Overview represents the first step in what must, given the complexity of the topic, be an evolutionary process to coordinate Federal research activities related to transportation and sustainable communities, and to identify and realize new opportunities for partnerships on multiple levels. Comments on this Plan should be provided to William Lyons (617) 494-2579, lyons@volpe.dot.gov or Kevin Green, (617) 494-2106, green@volpe.dot.gov; USDOT/Volpe Center, DTS-49, Kendall Square, Cambridge, MA 02142.

Transportation and Sustainable Communities Initiative
Overview of Federal Sustainable Transportation Activities

Introduction

In its September 1996 *Transportation Science and Technology Strategy*, the National Science and Technology Council (NSTC) Committee on Transportation Research and Development (CTRD) identified twelve strategic partnership initiatives that address recognized national needs. An interagency Transportation and Sustainable Communities Team was subsequently established to develop investment plans for the following two initiatives:

- Local Environmental Assessment Systems -- development of data, models, and a comprehensive knowledge base to support analysis of transportation-related environmental impacts and alternative strategies by all levels of government and the private sector.

- Environmental Sustainability of Transportation Systems -- investigation of the technological and behavioral implications of alternative transportation infrastructures and development patterns to determine those that minimize impacts on long-term environmental sustainability.

Current Trends Addressed by this Initiative

Transportation accounts for as much as one-third of U.S. emissions of greenhouse gases.

By 2010, carbon emissions associated with oil consumption will be about 20% higher in the U.S. than in 1990, and about 40% higher globally.

After bottoming out in 2010 at levels about 30% lower than in 1990, nitrogen oxide emissions in the Northeast Ozone Transport Region will reverse course and begin climbing through 2015 and beyond.

120 million U.S. residents live in areas with unhealthy air, violating National Ambient Air Quality Standards.

Annual congestion costs are $6.6 b. in NY and $7.7 b. in LA, where it would require 665 new lane miles of highway annually to maintain current mobility.

Welfare reform may move 1-2 million people into the low income work force; only 6% of welfare recipients own autos; in one major urban area, transit only reaches 40% of entry jobs even within 1.5 hours.

The scope and structure of these initiatives were the focus of extensive deliberation. The Team has followed the approach of developing an integrated initiative for *Transportation and Sustainable Communities*, which addresses environmental and other aspects of "sustainability," and which includes the development of performance measures and analytical resources as key elements of the overall initiative.

Structure and Goals for this Initiative

The Transportation and Sustainable Communities Team is a subunit of the NSTC Committee on Transportation R&D, chaired by Deputy Secretary of Transportation Mortimer Downey. The Team is responsible for developing a National Research Agenda for Transportation and Sustainable Communities Research. In developing the Agenda the Team has produced this Overview Report to inventory and evaluate research at the Departments represented, and other relevant reports, including those cited. The Overview characterizes the status quo for research related to transportation and sustainability by the participating agencies at the point in time of this inventory. Based on this review the Team will develop a multi-year Research Agenda that will: (1) cite ongoing efforts that support sustainability goals; (2) indicate where additional research is required; and (3) define crosscutting and strategic research necessary to provide a framework for federal, state, Tribal and local policy making.

Because transportation sustainability is difficult conceptually and analytically, global in nature, and has enormous social and economic consequences, the Team recognizes that the Research Agenda will be tentative in nature and require extensive discussion and debate. As demonstrated by the "Car Talk" project, consensus will be a challenge. The Team's participatory process, which includes outreach to major stakeholders, should enable the participating agencies to agree on the research necessary to improve decision-making on transportation and sustainable communities.

Background

The Nation's transportation infrastructure is vital to our economy and the character of our society. Transportation can be considered as a means to an end. It supports economic development through access to jobs, services and other activities, and through the movement of goods. But as we approach the twenty-first century concerns about the environmental ramifications, social equity, and public expenditures of transportation have mounted.

Negative effects of transportation and land use patterns can include contribution to greenhouse gases and global warming, congestion, air and water pollution, inefficient use of land, and ecosystem fragmentation. The vital importance of these concerns to international environmental policy is demonstrated by the President's proposal in preparation for the world climate change talks in Kyoto, Japan in December 1997. The Kyoto Protocol on Climate Change reflects key proposals advanced by the U.S., in particular regarding the scale and timing of emission reductions, and the inclusion of market-based mitigation strategies such as emissions trading.

<u>President Clinton's Climate Change Proposal</u>
October 22,1997
Global climate change is the premier environmental challenge and opportunity of the 21st century, and the risks it poses justify sensible preventive steps. Addressing this issue is one of the United States' greatest imperatives, for this and future generations.

Domestically, the President has also proposed $6 billion in tax cuts and research and development to encourage innovation, renewable energy, fuel-efficient cars, and energy-efficient homes.

Although surface water quality in the U.S. has improved markedly over the past 25 years, nonpoint sources such as agriculture -- but also vehicular air pollution and highway runoff -- remain a serious challenge. The Vice President has directed the U.S. Environmental Protection Agency (EPA) and Department of Agriculture (USDA) to develop a Clean Water Action Plan to achieve three major goals: enhanced protection from public health threats posed by water pollution; more effective control of polluted runoff; and promotion of water quality protection on a watershed basis. The final Action Plan contains 111 key action items which are currently being addressed by federal, state, and Tribal agencies.

Vice President Gore's Clean Water Initiative
October 18,1997

In 25 years, the Clean Water Act has stopped billions of pounds of pollution from flowing into our rivers, lakes, and streams, and doubled the number of waterways that are safe for swimming and fishing…

This is also an appropriate occasion to recognize that, despite significant progress, the challenge for all of us in protecting our Nation's waters remains unfinished.

Despite these concerns and responses, there is a lack of understanding among the broad range of decision-makers on how best to balance the essential goals of economic prosperity, environmental quality, and social equity. A key goal of this Initiative is to explore how sustainable transportation-land use systems can contribute to this balance. The Initiative will develop a multi year Research Agenda for federal research and development to improve the understanding of the complex relationships between transportation systems, development patterns, environmental effects, and human needs; the dimensions of a sustainable transportation system; and how best to accomplish it. After considering the initiatives summarized in this report, the Team identified a series of research questions to be pursued in the later Research Agenda.

This report describes the consensus the federal interagency Team reached on the scope of transportation and sustainable communities, and develops and applies a framework to inventory and organize related federal programs. This report provides a foundation for the National Research Agenda to follow.

Approach to Transportation and Sustainability

The most frequently cited definition of sustainable development is that adopted by the World Commission on Environment and Development (the Brundtland Commission) in 1987: "A sustainable condition for this planet is one in which there is stability for both social and physical systems, achieved through meeting the needs of the present without compromising the ability of future generations to meet their own needs." The Brundtland Commission definition was selected

for this Initiative because it acknowledges that sustainability has social and community as well as physical dimensions.

To reflect the broad concerns and responsibilities of the agencies participating in this Initiative, this report takes a comprehensive approach to the much debated subject of sustainability. This approach enables the Team's work to be viewed as an extension of important recent studies. In addition to that of the Brundtland Commission, these include:

- The National Research Council's Transportation Research Board, Committee for a Study on Transportation and a Sustainable Environment (Toward a Sustainable Future, 1997). The report recognizes that research on sustainable transportation can cover both ecological and natural resource needs, as well as social and economic aspects. The report focuses on transportation's contribution to long-term irreversible environmental problems, specifically on long-term effects of motor vehicle transportation on climate and ecology. Concerns include the risk of losses in biological diversity and ecosystem functions from changes in air, water, and soil chemistry caused by chemicals emitted into the air by motor vehicles and from changes in habitats caused by road systems and other transportation infrastructure. Two approaches for reducing motor vehicle emissions are explored -- (1) changing travel behavior and (2) developing new transportation technologies that use less fuel or alternative fuels.

- The President's Council on Sustainable Development (Sustainable America -- A New Consensus for Prosperity, Opportunity, and A Healthy Environment for the Future, 1996), uses the Brundtland definition of sustainable development and includes the following in its vision statement: "A sustainable U.S. will have a growing economy that provides equitable opportunities for satisfying livelihoods and a safe, healthy, high quality of life for current and future generations." A key goal of the Council's report, Energy and Transportation**,** is to "improve the economic and environmental performance of the U.S. transportation system while increasing all Americans' access to jobs, services, and recreation." The report provides indicators of progress, and statements on national and economic security, efficient transportation, traffic congestion, and the need to improve accessibility while reducing travel.

- In an effort related to the work of the Council, the President established the *Policy Dialogue Advisory Committee to Assist in the Development of Measures to Significantly Reduce Greenhouse Gas Emissions from Personal Motor Vehicles*, known popularly as "Car Talk." Although the Committee did not reach a consensus, its work provides a valuable source of data for analysis of automobiles and greenhouse gas emissions.

- The World Bank (Sustainable Transport: Priorities for Policy Sector Reform, 1996), which considers economic and financial sustainability; environmental and ecological sustainability; and social sustainability. The report considers how transport policy can be formulated to further these goals.

- The Organization of Economic Cooperation and Development (OECD) and European Conference of Ministers of Transport (Urban Travel and Sustainable Development, 1995) concentrate on: the relationship between land-use and transport policies; increasing levels of urban automobile use and growing congestion, air pollution, noise, and acid rain; the risk of global warming; and formulating integrated policies and strategies to foster sustainability. The project has entered a second phase to evaluate the extent to which governments have adopted recommended policies and strategies and the results. OECD and ECMT have another project with the Pollution Prevention and Control Group's Sustainable Transportation Task Force. This Task Force has, among other things, developed a list of various projects relating to sustainability with case studies on sustainable transportation.

Transportation systems interact with other built, social, and natural systems to produce broad impacts. Within this context, transportation systems have major impacts on sustainability, as understood in the literature cited. This Initiative focuses on the inter-relationships between transportation decisions, including policies, investments, and strategies; and development strategies. These relationships produce environmental, social equity, and economic outcomes, sometimes characterized as the "Three E's." Transportation systems can be considered "sustainable" to the extent that they contribute to improved economic opportunity, social equity, efficient public expenditures, and environmental quality. In addition, this Research Agenda includes health as a human environment and sustainability measure. Transportation decisions affect individual, community and national health and well-being. Physical activity, through walking or bicycling can reduce the risk of premature mortality.

Conceptually, transportation decisions can be considered "more or less" sustainable in terms of promoting economic, environmental, and equitable outcomes, individually or in combination. Advancement of sustainability can be considered as a matter of degree, or as movement along a spectrum using indicators to measure accomplishment of desired goals and outcomes. Examples of indicators include levels of greenhouse gases and their affect on ecosystems or ease of access to employment by former welfare recipients. The related national (or local) goals discussed in the next section can be expressed in terms of these same indicators (e.g., reduce greenhouse gases by *x* by year *z*, attain the National Ambient Air Quality Standard for ozone by 2010, or provide access to public transit for *x* % of mobility impaired citizens by year *y*). The challenge for decision-makers is to achieve a balance among preferred sustainability goals and outcomes, some of which may be in competition or difficult to discern in the short-term.

Research results in specific *outputs* (for example, improved forecast models or data bases) which can be applied to produce desired *outcomes* (for example, applications of the model by planning agencies, or ultimately, applications that improve transportation efficiency, reducing greenhouse gas emissions).

This conceptual approach to sustainable transportation is represented in Figure 1. Because development of the Research Agenda is a "work in progress," the choice of outputs, outcomes,

and measures will be evolutionary and continue to be refined by participating agencies and key stakeholders.

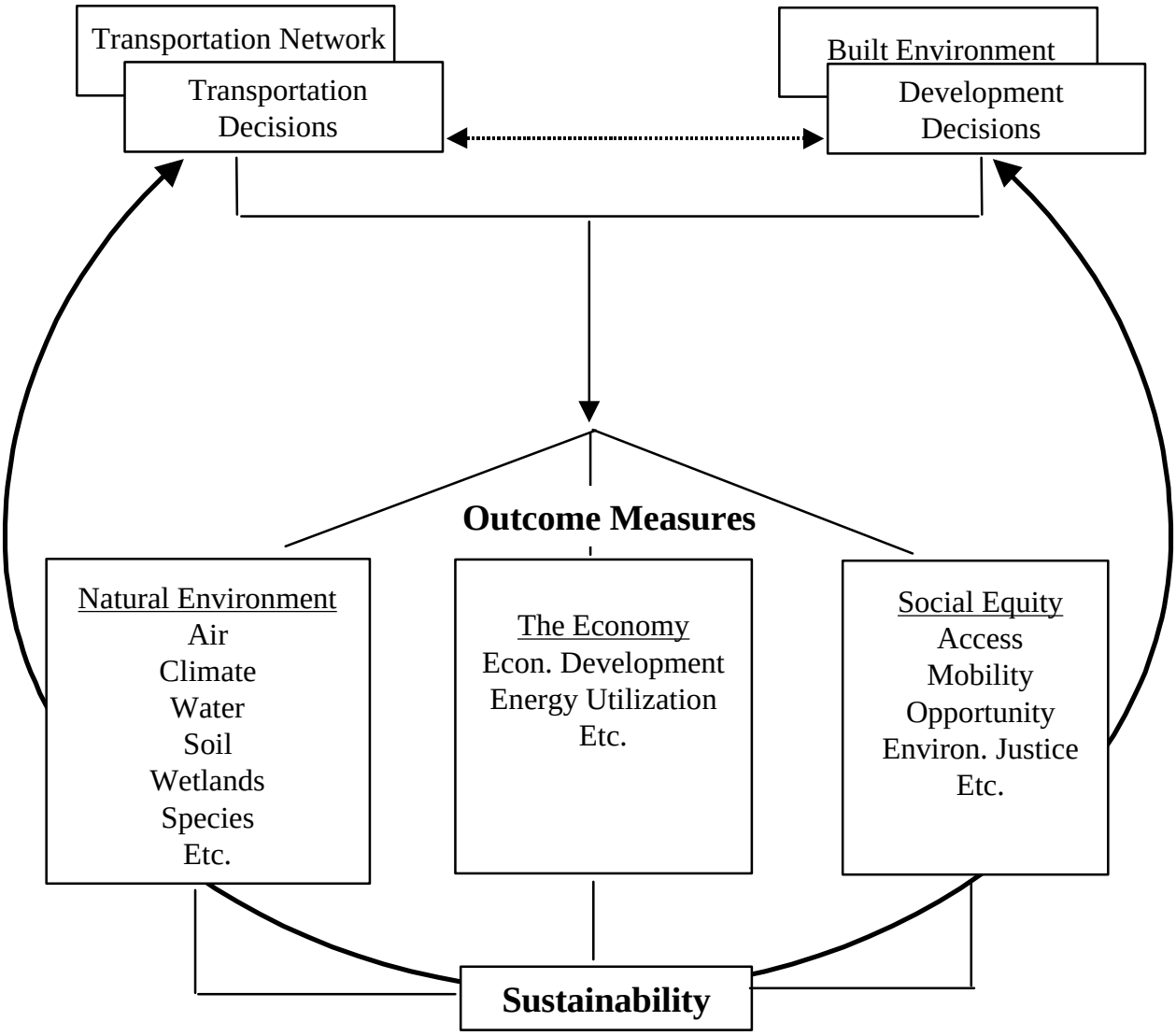

Figure 1. Transportation and Sustainability

Policy Context and Desired Outcomes

As indicated above, the scope of "sustainability" has been a prominent and fundamental consideration by the Team. Reduction of greenhouse gas emissions, particularly in the transportation sector, is a key sustainability focus within the Administration at this time. Nonetheless, issues such as metropolitan and rural "quality of life," including air and water quality, a vigorous economy, social equity, and meeting needs for housing are also of major importance.

Several basic goals or outcomes targeted by this Initiative either have been identified through Federal legislation, or are in the process of being negotiated at this time. The following examples of federal legislation, policies, and related goals set a broad context for this Initiative, as represented in Figure 1. These are not presented as a complete set, nor are they intended to limit the Initiative, which combines state and local with federal perspectives.

- Achievement of the goals of the National Environmental Policy Act (NEPA);
- Attainment of National Ambient Air Quality Standards (NAAQS), according to timetables established through EPA regulations implementing the Clean Air Act Amendments of 1990 (CAAA), as updated in 1997;
- Achievement of Energy Policy Act (EPAct) goals for market penetration of transportation fuels from domestic and/or nonpetroleum feedstocks;
- Achievement of targets for atmospheric concentrations of greenhouse gas (GHG) established by the UN Framework Convention on Climate Change (UNFCCC);
- Achievement of standards and goals of the Clean Water Act;
- Achievement of equal access for mobility impaired citizens to transportation, economic, and social opportunities as described in the Americans with Disabilities Act;
- Improvement of the performance of multi-modal transportation systems, and promotion of environmental, economic, and social equity goals through integration of transportation, land use, and air quality planning, as originally encouraged by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), and continued by the Transportation Equity Act for the 21st Century (TEA-21), June 1998.

Indicators of Sustainability

Sustainable Development Indicators (SDI) are various statistical values that collectively measure the capacity to meet present and future needs and meet public policy goals or outcomes. SDI will provide information crucial to decisions of national policy and to the general public. This Initiative benefits from and will build on the broad range of important research being undertaken on the topic of sustainability indicators. Examples include the work of the Interagency Working

Group on Sustainable Development Indicators (SDI Group). Since its conception in January 1994, the SDI Group has provided an effective forum for the exchange of ideas, methods, and data related to sustainable development indicators.

The SDI Group, which reports to the Council on Environmental Quality in the Executive Branch of the Federal government, provides information and advice to the President's Council on Sustainable Development (PCSD). In its February 1996 report, the PCSD recommended that the Federal government strengthen and intensify the current efforts of the SDI Group Acting on this recommendation, the current Administration pledged support for the SDI Group, which published An Experimental Set of Indicators in 1998.

As a first step, the SDI Group has selected 32 indicators to measure progress towards sustainable development in the United States -- these are summarized in Appendix A. The SDI Group solicited external review of the Proposed 1997 SDI list from a group of young high school students active in sustainable development, a gathering of corporate executives from Fortune 500 companies doing similar work, and a meeting of non-governmental organizations. The participating agencies are currently soliciting comments from within the Federal government. In next year's selection process, the SDI Group hopes to greatly broaden internal and external participation and review.

The Team is also reviewing other research related to indicators, including that of the EPA, the OECD, the United Nations, and the World Bank. The topic of appropriate performance measures will be a major emphasis of this Initiative. Continued development of this Transportation and Sustainable Communities Initiative will focus on the development of transportation-oriented indicators that relate to the set of broader outcome indicators, and will include close coordination with the SDI Group. This Initiative will ultimately include identification of a set of sustainability indicators applicable to a broadly defined federal research program. The complexity of the topic of indicators and their importance to this Initiative are demonstrated by the prominence they play within the research topics developed in the National Research Agenda for Transportation and Sustainable Communities.

Specific Planned Outputs

The activities proposed in this Overview Report, and being developed in the Research Agenda have as their objectives the following outputs:

- improved transportation and land use oriented indicators of and criteria for overall sustainability;
- improved understanding of the relationships between those indicators;
- improved data and models for characterizing the relationships between transportation and land use decisions and overall sustainability;
- improved menu of well-understood options for sustainable development and management of land and transportation systems;

- improved menu of technology options (for fuels -- vehicles are addressed in a separate initiative) for increasing the sustainability of transportation systems;
- improved understanding of the institutional and infrastructure changes required for widespread deployment of next-generation vehicle technologies and fuels, and the implications of such deployment;
- architecture that brings together transportation and infrastructure investment, ecosystem management data, economic indicators, and demographics in geographic information systems (GIS);
- evaluation of impact of above activities.

Federal agencies, including the agencies participating in this initiative, contribute to achievement of sustainable communities by several means, including but not limited to the following:

- expanding the understanding of choices with their positive and negative consequences;
- facilitating development of effective regional action entities that can better guide investment in transportation and other infrastructure, development and redevelopment, and equitable tax systems;
- assisting with drafting and state adoption of better statutes for planning and managing development;
- developing better forecasting, planning and impact assessment tools for use by regional bodies and localities;
- continuing technology research;
- supporting development and demonstration of sustainable community and transportation initiatives;
- evaluating the sustainable communities and transportation initiatives; and
- fostering public participation in decision-making and understanding of sustainability dimensions of alternative decisions.

The research and demonstration efforts to be developed in the National Research Agenda to follow this Overview Report will further efforts of federal agencies to work with each other and other levels of government and the private sector to contribute to sustainability. The outputs from these efforts support achievement of the sustainability outcomes described above.

Federal Participants

Access Board

Primary Responsibility: Develops minimum guidelines and requirements for standards issued under the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA); develops accessibility guidelines for telecommunications equipment and customer premises equipment under the Telecommunications Act; provides technical assistance on those guidelines, and enforces the Architectural Barriers Act.

Army Corps of Engineers

Primary Responsibility: Provide comprehensive engineering, management and technical support to the Department of Defense, other agencies, State and Local governments. Plan, design, build and often operate and maintain projects that provide river and harbor navigation, flood control, water supply, hydroelectric power, environmental restoration, wildlife protection and recreation; Protect the Nation's waterways and wetlands; operate the Nation's largest real estate program, with holdings the size of Kentucky at military installations and civil projects; Search for new technologies through research and development; Provide engineering, contracting and construction management services to support other Federal agencies on missions ranging from toxic waste clean up for the Environmental Protection Agency's "Superfund" to construction of space facilities for NASA.

Department of Health and Human Services, the Centers for Disease Control and Prevention (CDC)

Primary Responsibility: To promote health and quality of life by preventing and controlling disease, injury, and disability.

Department of Energy

Primary Responsibility: The Department of Energy, in partnership with its customers, is entrusted to contribute to the welfare of the Nation by providing the technical information and scientific and educational foundation for technology, policy, and institutional leadership necessary to achieve efficiency in energy use, diversity in energy sources, a more productive and competitive economy, improved environmental quality, and a secure national defense. *Participating Offices* in this Initiative include: Office of Transportation Technologies (OTT), Office of Energy Efficiency, Alternative Fuels, and Oil Analysis

Department of Housing and Urban Development

Primary Responsibility: to help people create communities of opportunity. The Clinton Administration's five Community Empowerment Principles define how the Department of Housing and Urban Development (HUD) seeks to accomplish its mission:

- A Commitment to Community
- A Commitment to Support Families
- A Commitment to Economic Lift
- A Commitment to Reciprocity and to Balancing Individual Rights and Responsibilities
- A Commitment to Reducing the Separations by Race and Income in American Life

Participating offices: Office of Policy Development and Research, Office of Community Planning and Development.

Department of Transportation

Primary Responsibility: Serve the U.S. by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets vital national interests and enhances the quality of life of the American people, today and into the future. Strategic DOT goals include:

- Safety: Promote the public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage.
- Mobility: Shape America's future by ensuring a transportation system that is accessible, integrated and efficient, and offers flexibility of choices.
- Economic Growth and Trade: Advance America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation.
- Human and Natural Environment: Protect and enhance communities and the natural environment affected by transportation.
- National Security: Advance the nation's vital security interests in support of national strategies such as the National Security Strategy and National Drug Control Strategy by ensuring that the transportation system is secure and available for defense mobility and that our borders are safe from illegal intrusion.

Participating Offices in this Initiative include: Office of the Secretary, Federal Highway Administration, Federal Transit Administration, Bureau of Transportation Statistics, and Research and Special Programs Administration.

Environmental Protection Agency

Primary Responsibility: Protect human health and safeguard the natural environment -- air, water, and land -- upon which life depends. Strategic EPA goals include:

- Clean Air
- Clean and Safe Water
- Safe Food
- Preventing Pollution and Reducing Risk in Communities, Homes, Workplaces, and Ecosystems
- Better Waste Management, Restoration of Contaminated Waste Sites, and Emergency Response
- Reduction of Global and Cross-Border Environmental Risks
- Expansion of Americans' Right to Know About Their Environment
- Sound Science, Improved Understanding of Environmental Risk, and Greater Innovation to Address Environmental Problems
- A Credible Deterrent to Pollution and Greater Compliance with the Law

Participating Offices in this Initiative include: Policy Planning and Evaluation; Research and Development; Water; and Mobile Sources.

Department of the Interior, National Parks Service

Primary Responsibility: Preserve unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations. The Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

Liaisons With Other Organizations
President's Council on Sustainable Development
Transportation Research Board, National Research Council

Potential Future Federal Participants
Department of Transportation (FAA, MARAD, NHTSA, USCG)
Department of Health and Human Services (other program offices)
Department of Agriculture
Department of Commerce
Department of State
Department of Defense
Council on Environmental Quality

Other Potential Participants
State Transportation Departments
American Association of State Highway and Transportation Officials
State Environmental Agencies
State and Territorial Air Pollution Program Administrators (STAPPA)
Association of Local Air Pollution Control Officials (ALAPCO)
Northeast States for Coordinated Air Use Management (NESCAUM)
Metropolitan Planning Organizations
National Association of Regional Councils
Association of Metropolitan Planning Organizations
Mayoral Offices
U.S. Conference of Mayors
National League of Cities
National Conference of State Legislatures
National Association of Counties
Environmental Advocates
State Public Health Agencies
Fuel Providers
Universities
Foreign Governments
Organization of Economic Cooperation and Development
European Conference of Ministers of Transport

Content and Activities

This section is an initial effort to characterize the broad range of research activities underway or planned by the federal agencies represented on the Sustainable Transportation Team. A subset of this research is applicable to transportation. Most of the transportation-related research funded by member agencies is conducted to meet a range of national needs. This Team has identified those activities that relate the most directly to sustainability, and has developed a cross-cutting framework used in this report to group related projects, and which can serve as the basis for future interagency coordination and planning. This strategic approach will be reflected in the report to follow presenting a national Research Agenda.

Table 1 presents a summary of Federal agencies conducting research related to the categories in the framework developed by this Team. It must be recognized that for many research programs identification of the portion of funds which can be labeled as supporting sustainable transportation is difficult and subject to interpretation. Project descriptions and budgets are based on the most current information available at the time of the report, and are subject to change. The budget information following Table 1 is, therefore, important as a means to characterize relative orders of magnitude of support for different categories of activity, within the context of overall research funding (for example, DOT's FY97 budget for surface transportation research was $655 million). Project-specific budget information presented in this report is of greatest value for planning purposes. This report is intended to provide a snapshot describing the activities underway at a specific point in time for use in guiding and focusing an inter-agency research agenda.

Table 1. Current Federal Research Supporting Transportation and Sustainable Communities

Research Area	Participating Agencies
1) Improve the Focus of National and Local Policy Debate on Implications of Sustainable Transportation	EPA, FHWA, FTA, FRA, BTS, DOE
2) Behavioral Research Associated with Development Patterns	EPA, FHWA, FTA
3) Influence of Transportation Infrastructure upon Travel Demand, Climate Change, and other Sustainability Goals	EPA, FHWA, FTA
4) Information Technology and Sustainable Transportation	EPA, DOE, DOT ITS Joint Program Office
5) Implementation Issues for Next-Generation Vehicles and Fuels	DOE, BTS
6) Fuels, Transportation and Sustainable Communities	EPA, DOE
7) Development of Improved Analytical Tools, Data, and Indicators	EPA, FHWA, BTS, HUD, USFS, USGS, USACE, DOE
8) Building Institutional Capacity to Address Regional Concerns	HUD, FHWA, EPA, HHS
9) Infrastructure Needs with Revitalizing Urban Areas and Cleaning up Infill Sites	HUD, FHWA, FTA, EPA, USDA, FEMA

Research in these areas is currently supported by federal funding estimated by the Team to be on the order of $70 million across participating agencies. Detailed funding information, where available, is provided for specific activities listed in the remainder of this report. Key findings from the Team's review of current Federal activities include the following:

- When vehicle technology development is considered as an initiative that is separate but related to sustainability, the most significant remaining federal funding for sustainable transportation research -- about $30 million in FY97 -- supports the development of processes to produce alternative fuels.

- Substantial funding has been allocated and planned for the development of advanced travel simulation models -- including total planned funding of $43 million through FY98 for the Transportation Analysis Simulation System (TRANSIMS) -- which could make major contributions to more sustainable transportation decisions.

- Many activities related to transportation and sustainable communities represent small areas within considerably broader research activities that do not specifically emphasize sustainability. For example, although the Federal Highway Administration (FHWA) conducts research on bicycle and pedestrian safety, it represents a very small part of the major on-going highway safety research program, funded at $8.65 million in FY97.

- Federal funding to assess implementation and sustainability issues that may be associated with advanced technologies has been very limited relative to the scale of direct funding for technology development. About $200,000 from DOT, DOE, and EPA has been expended on preliminary assessment of the energy and emission impacts of the Intelligent Transportation Systems (ITS) program, which was funded at $233 million in FY97. About $500,000 from DOT and DOE has been expended on preliminary assessment of potential implementation, energy, and emissions issues associated with next-generation vehicle and fuel systems. By comparison, overall annual funding for the Partnership for a New Generation of Vehicles (PNGV) program has been on the order of $200-$300 million since FY94.

1 Improve the Focus of National and Local Policy Debate on Implications of Transportation and Sustainable Communities

Basic Thrust

Projects in this category advance the dialogue among decision-makers across federal, state, and local agencies, the private sector, environmental and other advocacy groups, and ultimately, the public, on the national policy implications and critical choices of transportation and sustainable communities. Related research will articulate issues in a manner appropriate for decision-makers and the public. These efforts will contribute to an improved focus for discussions, identification of alternative policies and their implications, and improved national, state, Tribal, and local policies. To further the national dialogue, it will be crucial for policy makers and the public to understand the dimensions of transportation and sustainable communities. In particular, it is hoped that the efforts of this Team will contribute to progress on this topic among Federal agencies. Because of the close links between this topic and aspects of research described in the other topics in this plan, activities described in this section are limited to those that directly address how to present high-level policy information to decision-makers and the public.

Current Activities

Transportation and Community and System Preservation Pilot Program (TCSP) -- The TCSP is a comprehensive initiative of research and grants to investigate the relationships between transportation and community and system preservation and private sector-based initiatives. States, local governments, and metropolitan planning organizations (MPOs) are eligible for discretionary grants to plan and implement strategies that improve the efficiency of the transportation system; reduce environmental impacts of transportation; reduce the need for costly future public infrastructure investments; ensure efficient access to jobs, services, and centers of trade; and examine private sector development patterns and investments that support these goals. The TCSP is a FHWA program being jointly developed with Federal Transit Administration (FTA), Federal Railroad Administration (FRA), the Office of the Secretary, and the Research and Special Programs Administration/Volpe Center within the U.S. DOT, and the U.S. EPA. (FY99-03 $120 million)

Public Education **--** DOT and EPA have under development a multi-year, multi-million dollar public education campaign to inform the public of their transportation choices and the consequences of those choices. It is believed that with greater understanding of the congestion, air pollution and energy consequences associated with certain travel choices, greater efficiency in the use of transportation facilities and services can be achieved by encouraging higher-occupancy travel, trip-chaining and other transportation and lifestyle choices. If successful, these changes will relieve congestion, reduce emissions and limit energy use, ultimately reducing greenhouse gases and other negative impacts.

Air Quality Public Outreach/Education -- FHWA, FTA, and EPA will present transportation and air quality issues directly to the public through outreach and education strategies that highlight relationships between transportation alternatives and air quality impacts. The project targets behavior issues and the process through which personal travel decisions are made. The participating agencies agree that important progress toward national air quality goals might be accomplished through a better educated, more aware traveling public. The public outreach efforts seek to provide a better understanding of the air pollution impacts of routine daily decisions. ($3.2 million total, DOT $2 million, EPA $1.2 million).

DOT Policy Research -- The Office of the Secretary's policy office research program includes the following efforts related to sustainability: developing environmental, energy, and safety policies and policies for access for transportation disadvantaged ($100,000 in FY98).

FHWA's Environmental Research Program -- FHWA conducts several research activities related to sustainability ($5.5 million for FY97), including assisting MPOs and states in meeting Clean Air Act requirements; and increasing community and public involvement related to the community impacts of proposed transportation projects. Among research projects funded are a synthesis of literature on greenhouse gas inventory, impacts and strategies to reduce greenhouse gases ($50,000 FY97). FHWA contributed $200,000 to a National Academy of Sciences/Transportation Research Board (TRB) study on Transportation for a Sustainable Environment which focuses on bio-diversity and climate change impacts of transportation, and emphasizes the global nature of the problem. In addition to the FHWA share, $150,000 from the National Cooperative Highway Research Program and $150,000 from the National Cooperative Transit Research Program were contributed (NCHRP and NCTRP are drawdowns from TEA-21 transportation research and planning funds).

National Transit Institute -- The National Transit Institute (NTI) at Rutgers University was established under ISTEA in 1992 through a cooperative agreement with the FTA to conduct training and education for the transit industry. NTI's programs are developed in consultation with FTA and representatives from state Departments of Transportation, transit agencies, MPOs, and other transportation organizations. During its first three years, NTI delivered training to over 10,000 persons on topics that focus on improving understanding by transit professionals of linkages between transportation and land use, MPO planning and programming, and forecasting travel demand. (FTA $3 million annually)

Fostering Public Participation and Partnerships -- DOT has worked aggressively to expand public participation. Since the passage of ISTEA and continued under TEA-21, planning guidelines have encouraged a proactive approach to including the public in all stages of the transportation planning process. FTA and FHWA have developed notebooks, and instructional materials to foster effective public involvement. Under ISTEA and TEA-21, the Transportation Enhancements Program has successfully attracted wide-spread public participation. At the national level, the National Partnership for Transportation and Livable Communities suggests policy and program changes which reinforce community-initiated transportation projects. At the local level, the Partnership encourages local

community organizations and governments to implement projects which foster livability of local communities.

FTA Policy Research -- Through the Transit Cooperative Research Program, the Federal Transit Administration (FTA) sponsored "Assessment of the Economic Impacts of Rural Public Transportation." Also, FTA is identifying the land use, economic, neighborhood impacts (environmental and basic mobility), and congestion reduction impacts of public transit.

Advanced Data Collection and Analysis Techniques -- FHWA project to focus on efficient and effective ways to analyze and present data, emphasizing use by state and local governments of advanced technologies. Project will result in refinement of information on emerging issues and problems facing decision-makers, planners, and public/private sectors. (FHWA FY97 $1.3 million)

Incentives for Future Growth That Maintains Air Quality Goals -- EPA project to consider how society can grow without compromising air quality. Growth in Vehicle Miles Traveled (VMT) has been largely unaddressed and is a central factor in managing air quality progress in the future. Growth in sectors other than transportation, such as stationary sources, can be accommodated if innovative strategies to reduce the air quality contribution from the transportation sector can be found. If mobile sources are to contribute to further emission reductions, VMT-related solutions that affect the transportation infrastructure must be sought.

Clean Air Communities -- An EPA voluntary incentive program to improve air quality by encouraging smart land use, energy efficiency, and the use of clean technologies. Objectives are to: improve air quality, reduce emissions, reward air quality pioneers, and encourage state and local adoption of incentive programs.

Clean Cities Program -- A locally-based government/industry partnership, coordinated by DOE to expand the use of alternatives to gasoline and diesel fuel. By combining local decision-making with the voluntary action of partners, the "grass-roots" approach of Clean Cities departs from traditional "top-down" Federal programs. It creates and carries out an effective plan at the local level for establishing a sustainable, nationwide alternative fuels market.

Sustainable Development Challenge Grant Program -- $5 million will be awarded by EPA to 25 to 30 projects that link environmental management with sustainable development and economic revitalization. Projects will have a transportation, sustainable development, and metropolitan focus.

Impacts of Educational Programs on Episodic Control Measures -- Episodic measures have the potential to modify traveler behavior and ease emissions during periods of predicted high ozone. FHWA, EPA, and the State of California are cooperating on this project to demonstrate how public education programs can provide effective episodic control measures. The product will be an

analytical tool for projecting the transportation contribution to long-term air quality attainment. ($50,000, FY97)

Transportation Partners -- EPA project to work with non-governmental organizations, citizen groups, local governments, and businesses to develop innovative transportation solutions in communities across the country. The goal is to work with communities to develop practical transportation solutions that maintain mobility yet curb the growth of VMT -- reducing greenhouse gas emissions, and promoting cleaner air and water, and healthier natural habitats. By providing technical and strategic expertise, participants create transportation choices for economically vibrant and environmentally healthy places to live. Efforts focus on developing and implementing: (1) transit-, pedestrian-, and bicycle-friendly places; (2) market incentives to increase modal share of non-Single Occupancy Vehicle (SOV) travel; and (3) new information technologies to improve or replace SOV alternatives. The 300 project partners include local governments, civic organizations, and firms. (EPA $1.5 million for total program)

Transportation Partners: Baltimore -- A Transportation Partners project supporting transportation and sustainable communities efforts in the Baltimore areas's long-range transportation planning process. Baltimore is one of several cities that provide an excellent real world context for evaluating the potential effectiveness of transportation and sustainable communities policies. The MPO is interested in evaluating innovative alternatives and Maryland's Smart Growth legislation provides state support to evaluate growth management strategies. In addition to EPA, participants are the Environmental Defense Fund, Citizens Planning and Housing Association, and the Chesapeake Bay Foundation. Current efforts are directed toward encouraging more public participation in the planning process. (EPA $250,000)

The $mart Growth Network -- Urban sprawl has dominated post World War II development patterns across the U.S. Debates over growth and development have pitted pro- and anti-growth forces against each other over fiscal responsibility, environmental protection, preservation of community character, economic growth, public infrastructure investment, and provision of public services. "Smart growth" is intended to link development and quality of life, recognizing that where and how development occurs can determine whether it is a community asset or liability. The Smart Growth Network is a coalition of private and public sector, and non-government partners seeking to create smart growth in neighborhoods, communities, and regions across the U.S. Partners share information on construction trends, innovative financing for infill and brownfields development, and pilot money-saving investments which reap economic and environmental benefits. (EPA FY98 $1 million)

$mart Growth Conference -- this EPA conference, which is an activity of the Smart Growth Network, will highlight cost effective, best management practices for infrastructure and development targeting those groups that may not typically see themselves as having a role in air and water quality or providing environmental services. The workshop, held in Baltimore in December 1997, highlighted development and infrastructure that are economically and fiscally sound, preserve natural systems, and create a sense of community.

America Growing Smarter -- A summit in Baltimore for 1,000 participants to promote sensible land use and transportation policies and highlight similarities between Maryland's growth problems and solutions and those of the rest of the country. The meeting initiated Maryland's Smart Growth Initiative. A final report is being developed, and the Mass Transit Administration will continue to document progress of the Quality Community Surveys, Maryland's Comprehensive Transit Plan, and future conferences such as the Partners for Smart Growth. (FTA $128,000)

Quality Community Surveys -- Quality Community Surveys, using Visual Preference Survey methodology, are being used to complement the Maryland Smart Growth Initiative. This statewide laboratory allowed a test of extensive community involvement in the decision-making process. The surveys will be conducted in urban, suburban, and rural areas throughout Maryland. The project will explore how to apply the information accumulated to develop a statewide needs plan for transit investment. (FTA $100,000)

Livable Communities -- FTA initiated the Livable Communities Initiative to strengthen the link between transit and communities. Transit facilities and services that promote more livable communities are customer-friendly, community-oriented, well-designed, and result from a planning and design process with active community involvement. Objectives are:

- strengthening links between transit planning and community planning, including land use policies and urban design;
- stimulating increased participation by community organizations and residents, minority and low-income residents, small and minority businesses, persons with disabilities and the elderly in the planning and design process;
- increasing access to employment, educational facilities and other community destinations through high quality, community-oriented, technologically innovative transit;
- leveraging resources available through other Federal, State and local programs.

FTA, with the Office of the Secretary (OST) and FHWA, has initiated a DOT-wide effort to promote livable communities within empowerment zones (EZ) and enterprise communities (EC). Five demonstration sites were selected and a series of regional meetings were held in 1996. Examples are:

- Frederick Douglas Circle, Harlem, New York City - Central Park Conservancy, for a gateway to the Harlem Community and Central Park. (FTA $140,000)
- Los Angeles Neighborhood Initiative - improvements of neighborhood street scape and pedestrian facilities along transit corridors to "humanize" transportation with safe, attractive, transit environments, and attract new transit users with increased security and comfortable environments. (FTA $3.9 million)

Consideration of social equity in transportation decisions is required by the 1994 Executive Order, and U.S. Department of Transportation Orders on Environmental Justice, which ask federal agencies to consider the environmental impacts of their activities on disadvantaged communities.

In addition, TEA-21 encourages consideration of improving mobility for economically disadvantaged persons.

Access to Jobs and Jobs Link Programs -- The 1996 Federal welfare reform law includes strict time limitations and other requirements that will end assistance and require employment for large numbers of welfare recipients. Access to jobs, training and support services such as day care are critical requirements for low-income workers. Poverty and welfare eligibility rules mean that few welfare recipients own cars, and public transit often provides inadequate connections to jobs and training. Access to jobs has become increasingly difficult because of changes in land-use patterns; suburban sprawl has taken root as metropolitan areas flow outward from center cities. Entry level jobs in manufacturing, warehousing and service industry jobs have relocated from center cities to less accessible suburban areas.

FTA is sponsoring research on welfare reform and access to jobs to determine how the urban transportation planning process, as envisioned by TEA-21, contributes to solutions to access to jobs for former welfare recipients. The research includes cases studies of innovative approaches in St. Louis, Hartford, and Detroit. Related research considers use of GIS as a tool for improving access to jobs. The FTA Livable Communities Initiative integrates transit with jobs, services, schools and housing. FTA has worked with local communities to design and implement transit-oriented developments that link jobs, child care, and transportation. Seven of the Livable Communities Initiative sites are in or near Empowerment Zones and two are in Enterprise Communities. Building on the FTA Joblinks program, which provided transportation and training to urban and rural areas, TEA-21 includes $150 million annually for an Access to Jobs and Training Program. This program will support transit service planning and coordination of transportation among local and Federal agencies, with funds to be allocated on a competitive basis.

Environmental Justice Activities -- The Environmental Justice Orders emphasize the need to address adverse human health or environmental effects of programs on minority and low income populations and call for improved methodologies, research, data collection, and impact analysis. FHWA is making both orders a key part of response and operating guidance. In 1995 FHWA, FTA, and the Federal Railroad Administration and environmental justice organizations sponsored the National Conference on Environmental Justice and Transportation. Over 200 grassroots environmental justice leaders, civil rights advocates, legal experts, planners, academicians and government officials met to develop common strategies and form working partnerships.

Key recommendations were developed to improve research, data collection, and assessment techniques for environmental justice issues. This included health effects and community impacts, public involvement and community outreach, integration of National Environmental Protection Act (NEPA)/Environmental Justice/Civil Rights, transport of hazardous and radioactive waste, and equity of pricing and operational strategies. The Environmental Justice program will be developed around identifying and prioritizing which of the recommendations to research.

The EPA Office of Environmental Justice's Small Grants Program provides financial assistance to eligible community groups that are working on or plan to carry out projects to address environmental justice issues. (FY99 approximately $1.6 million)

EPA's Multimedia Environmental Justice Through Pollution Prevention supports pollution prevention approaches that address environmental justice concerns in affected communities. The grant funds will support (1) local environmental, environmental justice, community grass-roots organizations, as well as tribal governments that promote environmental justice using pollution prevention as the preferred approach, and (2) national and regional organizations that will, in partnership with local environmental, environmental justice, community grass-roots organizations, as well as tribal governments, promote environmental justice using pollution prevention as the preferred approach. (FY99 $750,000)

Community Impact Assessment: A Quick Reference for Transportation and Case Studies -- FHWA project to develop a guide to assess impacts of proposed transportation projects on communities within the existing NEPA Process. The methodology highlights practical uses of public involvement and encourages consideration of community impacts (including Title VI and Environmental Justice) when balancing the social, economic, and (natural) environmental impacts of projects during transportation decision-making. The project responds to interest in expanding the definition of environment beyond the physical/natural environment to include the human environment. The Order on Environmental Justice provided additional motivation for FHWA, State DOTs, and MPOs to focus on statutory requirements of the Civil Rights Act of 1964 and the CAAA. The TEA-21 focus on transportation planning suggested a broader need for a tool to help assess community needs and impact during transportation decision-making. The guide was published in FY96 and the five companion case studies will be published in FY98. ($95,000 for the guide and $110,000 for the case studies)

Long-term Highway Emission Burden Trends -- Many areas continue in long-run nonattainment and others may face that situation with the revised, more stringent National Ambient Air Quality Standards. Transportation stakeholders need a better understanding of future emissions projections before long-term mitigation strategies can be developed that use technology or other options. The FHWA project is designed to identify the contribution of highway vehicles to mobile source emissions, providing more pertinent information on the capability of the natural environment to absorb continued growth in a variety of vehicular source categories. Projections are being developed using a variety of socio-economic growth indicators, engine technology assessments, travel behavior assumptions, and other measures. (FHWA FY97 $100,000)

In general, the Bureau of Transportation Statistics (BTS) supports a broad range of activities related to improved data and indicators to support thinking about sustainability by policy, planning, and other decision-makers. BTS looks at “sustainability” as comprised of social, economic, and environmental elements. Additional details on related BTS activities are provided in research topic seven.

Interagency Working Group on Sustainable Development Indicators -- BTS is a participant in the SDI Group, comprised of staff from agencies with interest in developing sustainable development indicators -- data and methodology for assessing the Nation's progress toward sustainability. The outcome is a set of economic, environmental, and social indicators and methodology for assessing national progress toward sustainability.

Develop Partnerships -- EPA is fostering the development of a Federal Nonpoint Source Task Force to improve communication and collaboration among Federal agencies to make better use of existing authorities, technologies, and resources to protect water quality and prevent and reduce nonpoint source pollution nationwide. The Task Force includes FHWA and other Federal agencies which may collaborate on research, development, and implementation of water quality monitoring and assessment methods for nonpoint source pollution. (EPA $20,000)

Future Research Focus: What is sustainable transportation? How can transportation decisions be related to environmental and non-environmental (community, economics, quality of life, etc.) aspects of sustainability?

What are trade-offs between policies that promote transportation goals (e.g., mobility, accessibility, safety), environmental goals (air and water quality), economic goals (growth), social equity goals (equal access to opportunities), and other national goals (energy independence)?

How can pursuit of these goals be balanced? What indicators best measure outcomes related to sustainability goals? What are the potential conflicts between goals reflected in accessibility, mobility, social equity, or environmental measures? How can technical information be presented to decision-makers and the public to clarify complex trade-offs related to transportation and sustainable communities?

2 Behavioral Research Associated with Development Patterns

Basic Thrust

The inter-dependence between land use and transportation planning is complex, and not well understood or managed. Many land use and transportation decisions are made independently. Planners need to understand how land use affects the demand for transportation, and how changes in transportation systems can in turn affect land use and travel demand. Research is needed to determine how aspects of human behavior such as mode choice, travel demand, and driver behavior are affected by urban design policies and decisions, including development scale, the choice and scale of hierarchical transportation infrastructures, and their interaction. A goal is to identify development patterns desired by the public and that support economic growth, reduce travel volumes, and ultimately, reduce environmental problems and increase the safety of communities.

This category includes research on technical approaches that can be used to devise development patterns that produce cleaner and safer environments, and reduce VMT. Research is needed to

determine how development scale and choice and hierarchical transportation infrastructures affect human behavior, as reflected in mode choice, travel demand, and driver behavior.

Transportation decisions can also have effects on individual, community and national health and well-being. Vehicle emissions are major contributors to urban air pollution, which is regulated under the Clean Air Act to protect health. In addition, the argument is made that physically active communities, which encourage walking and bicycling options, are more economically viable, safer, and healthier. According to the CDC, despite widespread information that physical activity reduces the risk of premature mortality, including coronary heart disease and hypertension, more than 60 percent of American adults are not regularly active, and 25 percent are not active at all. Physical inactivity combined with poor nutrition causes at least 300,000 deaths a year in the United States.

These data reinforce the need to understand how to promote more active lifestyles through policy and environmental action endeavors.

Current Activities

Transit Oriented Development and Livable Communities Initiatives -- FTA program to consider innovative land use strategies for building and revitalizing compact, mixed-use, pedestrian, and transit-oriented development (TOD). FTA has examined transit supportive developments that are less dependent on automobile access and more conducive to transit riding, walking, and bicycling since this project began in 1990. TOD and community-sensitive transit involve mixed-use development on air rights or near transit stations and stops, safe pedestrian access, real-time customer information, innovative transit, parking management, and other transit-supportive traffic management techniques. FTA has developed guidelines for planning and design of land use patterns that are sensitive to the needs of public transit. These guidelines are meant to create an efficient environment for future growth in suburban areas.

Livable Communities includes demonstrations of innovative transit facilities as part of compact developments. Topics include the relationships between transit/land-use investments and strategies and travel behavior, specifically shifts in transit mode share and reduction in VMTs. There is interest in whether implications can be generalized, and how transportation and environmental benefits of TODs can be measured for use in investment decisions. In addition to providing over $49 million in capital project dollars to 21 cities, FTA has provided $900,000 in grant money for planning and technical assistance.

Parking Cash-Out and Transit Benefits: Alternatives to Driving to Work -- DOT and EPA promoted the legislative change to expand the Internal Revenue Code to allow greater flexibility for employers to broaden commuter benefits to employees to include a taxable salary equivalent in lieu of tax-free parking and to provide $65 in tax-free transit benefits to employees. DOT was also involved with establishing a cap on employer-provided tax-free parking, now set at $170.

These strategies provide a broad range of travel choices and economic incentives that discourage single occupant vehicle use and encourage transit use, car or van pooling, biking, or walking. The strategies produce multiple environmental and economic benefits, including reduction in peak-period single-occupancy vehicle trips, and lower greenhouse gas emissions. Prior to the passage of these strategies, FTA, FHWA, and EPA sponsored studies on the value of employer provided and downtown parking, and the impacts of commuter options, including these "fringe benefit" programs.

Bicycle-Pedestrian Safety — FHWA's Highway Safety R&D (FY97 $8.8 million) program includes a pedestrian and bicyclist safety effort in support of DOT's National Bicycling and Walking Initiative, which aims to double the number of pedestrian and bicycle trips and reduce the number of bicyclists and pedestrians killed or injured by 10%. This program will develop improved planning techniques, new methods for identifying problem locations, innovative engineering countermeasures and training tools to guide users in the implementation of improved pedestrian and bicycle facilities. The Consumer Product Safety Commission also has bicycle safety programs that fit into this category.

Projects Related to Healthy People Goals and Objectives -- A Centers for Disease Control study of the relationship between physical activity, including transportation choices, and health is at an early stage. Determining the most cost effective intervention and strategy is a very complex challenge. It is believed that the most effective approach will be a combined effort of behavioral interventions and policy and environmental actions to promote physical activity. Although, many questions remain about how best to promote physical activity in the general population, policies, environmental changes, facilities, programs, and media campaigns appear to be promising, but studies testing their effects are limited. The impact of land use, transportation, and architecture on health, particularly physical activity, is virtually unexplored.

The Costs of Sprawl -- Revisited -- With funds from the Transit Cooperative Research Program, Rutgers University, Brookings, Parsons, and ECONorthwest are conducting a study of sprawl issues. The goals of the project are to: review the literature on sprawl; analyze the effects of sprawl; to project the potential impact of the effects; and to view public policy measures that might deal with the effects.

Interactions Between Transportation Costs, Transportation Use, and Retail Structure -- The project will examine the impacts of alternative retail structures, specifically "big box" stores, and of related land use on vehicle miles traveled. The intent is to provide local areas with information on how to control VMT growth through land use strategies. (EPA $190,000 through FY98).

Traffic Calming -- A partnership between FHWA and the Institute of Traffic Engineering to investigate the state of the art of traffic calming techniques, nationally and internationally. Traffic calming discourages use of residential streets for through traffic while slowing traffic in general to enhance qualities of life, responds to child and other safety concerns, and reduces traffic-related noise. (FY97 $150,000)

Location Efficient Mortgages -- FTA, EPA, DOE, and several private foundations are sponsoring research on Location Efficient Mortgages (LEMs) to capitalize in mortgages the transportation savings achieved by residential and business location in pedestrian-oriented, mixed use developments. LEMs can greatly improve the ability of households and businesses to purchase real estate by foregoing an automobile-dependent lifestyle. LEMs offer the opportunity to reduce the tendency in existing mortgage practice to inadvertently encourage sprawl development. Overall, LEMs would reinforce existing transit-oriented development served by intensive transit services and would increase the appeal of TODs for new development served by transit. The Federal National Mortgage Association initiated a market test of LEM in Chicago in 1998. (Activity conducted through FY97, FTA $300,000; EPA $132,000; DOE $150,000)

Community Development Patterns and Water Quality: EPA supports research on community development concepts that follow conservation design techniques such as open space planning, cluster design, and low impact development featuring reduced impervious surfaces and increased stormwater infiltration capacity through maximizing open space, reducing street widths, eliminating street curbs and gutters, adding vegetated filter strips and grassed swales for stormwater runoff, and encouraging innovative subdivision design that incorporates these concepts. (EPA $75,000)

Environmentally Sensitive Low Impact Development: EPA is supporting research in Prince George's County, Maryland on implementing the concept of low impact development (LID). LID is a technique that serves to minimize environmental impacts through stormwater management, site planning, preservation of vegetation, forest cover, and natural habitat. The purpose of LID is to protect and enhance groundwater resources, stream water quality, and open space. (EPA $60,000)

Site Planning Round Table -- EPA is supporting a continuing dialogue on land development principles concerning impervious cover, conservation of natural areas, and effective control and treatment of nonpoint source runoff. Objectives of the Round Table are to identify the impacts and promote the benefits and economics of implementing cost effective site planning techniques within the context of sustainable community development. Members of the Round Table include FHWA, AASHTO, and others. (EPA $70,000)

Desired Outcomes: Improved understanding of the relationships between land use patterns and policies and the demand for transportation, and how changes in transportation systems can affect land use. This improved understanding will foster improved transportation investments, strategies, and related decisions that further sustainability.

Future Research Focus: How effective are land use policy and urban design as means to reduce automobile use and the resultant environmental effects? What is the impact of transportation on developable land supply, and land cost, including salvage costs? Why does the private sector continue to concentrate on production of low density, single use, non-contiguous developments? Why does the private sector not utilize infill sites and produce more integrated mixed use projects? How does transportation contribute to these land use decisions?

3 Influence of Transportation Infrastructure upon Travel Demand, Climate Change, and Other Sustainability Goals

Basic Thrust

Transport-related greenhouse gas emissions are the product of three basic factors: (1) the amount of travel, (2) the fuel intensity of transportation vehicles under real-world operating conditions, and (3) the full fuel-cycle carbon intensity of the transportation fuels used. The second of these factors is currently being addressed by the (PNGV, and by the broader next-generation vehicles initiative. The third, fuels, are addressed later in this report. The first factor, however, is dependent upon supply of and demand for transportation, which are in turn the function of a complex and interrelated set of underlying factors. Personal motor vehicle "supply" is perceived by individuals in the form of, for example, fuel, vehicle, repair, and parking prices; insurance premiums; highway tolls; and congestion delay.

There is an extremely important debate occurring over whether or to what extent providing additional highway transportation capacity "induces" or attracts new trips (Transportation Research Board special report, *Expanding Metropolitan Highways)*. A major issue is the balance between the short-term effects of reduced travel-time relative to long-term effects of new demand. At the same time, the level and nature of demand is evolving with changes in, for example, land use and demographics. Additional research is needed to clearly document both short- and long-term effects, especially the implications for greenhouse gas emissions. Research is also needed to determine whether transportation infrastructure can be designed in concert with development patterns to maximize accessibility.

The cost-effectiveness of alternative transit investments and strategies in terms of mobility and accessibility, as well as environmental goals, is of major interest. Continued research is needed on the extent to which new or extended public transit investments, particularly in urban rail systems or new technology, induce switches to public transit by automobile drivers, contributing to reductions in total travel, and emissions of greenhouse gases and criteria pollutants. With TEA-21's flexibility to transfer federal transportation funds between highway, transit, and other categories, there is interest in the extent to which pedestrian and bike facilities, transportation demand management, or transportation control measures produce environmental benefits.

Current Activities

(Overall costs for FHWA Policy Research, $5.3 million in FY97, $8 million in FY98 allocation; FHWA Highway Planning Research, $5.9 million in FY97, $12.8 million in FY98)

Relations Between Transportation Spending and VMT Growth -- EPA project that involves a model that demonstrates induced demand by establishing a linkage between transportation spending and VMT growth and by extension, greenhouse gas and other emissions. Efforts could have broad implications for federal transportation policy and how money is directed. The implication might

be that less money should be spent on capacity increases and more on alternatives and in-fill development. (Estimated funding is $400,000 during FY96-97, and probably another $100,000 in FY98)

Evaluation of Congestion Mitigation and Air Quality Improvement Projects -- ISTEA established and TEA-21 continues the Congestion Management and Air Quality (CMAQ) Program to provide a dedicated source of fund for transportation projects which help areas reach and maintain the air quality standards. CMAQ authorized $6 billion between 1992-1997 for transportation projects and programs to improve air quality and reduce congestion. Projects include bicycle, pedestrian, and transit improvements, as well as traffic flow improvements, and vehicle inspection and maintenance programs. The research project developed a framework to evaluate CMAQ projects using multiple criteria, including ability to reduce emissions and offer alternative choices to travelers. (EPA $23,750)

Desired Outcomes: Improved understanding of relationships between physical infrastructure, congestion, and travel volume (and, by extension, GHG emissions). A growth in understanding of causality will contribute, ultimately, to improved transportation investments, strategies, and related decisions that further sustainability.

Future Research Focus: To what extent are public transit investments in infrastructure (e.g., new or expanded urban rail systems, or new technology) able to attract automobile drivers and reduce total travel, as well as emissions of greenhouse gases and criteria pollutants? Do transportation control measures, singularly or in combination, produce important air quality benefits? Do expansions of highway capacity, designed to relieve congestion, induce additional long term travel, emissions of greenhouse gases and criteria pollutants? To what extent does an incremental investment in public transit service (one bus, one vanpool, or one railcar set) or technology (one fuel cell bus or advanced transit technologies such as automated vehicle location or smart cards) affect local greenhouse gas emissions?

4 Information Technology and Sustainable Transportation

Basic Thrust

Many information technologies offer solutions that may be able to increase the sustainability of transportation-land use systems. For example, telecommuting offers the promise of accessibility without mobility and may be particularly beneficial for promoting development of sustainable communities. An initial study by DOT (in collaboration with DOE and EPA) -- *Transportation Implications of Telecommuting* (1993) -- revealed that although telecommuting has the potential to provide significant transportation-related public benefits, estimates of any such impacts are highly uncertain, and benefits could be substantially diminished by the emergence of latent travel demand and the simulation of urban sprawl. Continuing research into the implications of transportation-related information technologies, such as telecommuting, electronic commerce (e-commerce), or adaptive transit dispatching, will be needed to clarify the net implications for sustainability.

Current Activities

Intelligent Transportation Systems -- The U.S. DOT research program ($233 million in FY97) includes support for *Evaluation/Program Assessment*, funded through FHWA, NHTSA, and FTA at $2 million in FY97 ($9 million requested for FY98). This includes field operational tests of ITS focusing on assessing improvements as measured in six primary measurement areas: (1) reductions in crashes, (2) reductions in fatalities, (3) increases in throughput, (4) reductions in travel time, (5) improvements in customer satisfaction; and (6) savings in public and private sector costs. In addition, the DOT's Joint Program Office for the ITS program is working with Department of Energy (DOE) and EPA to measure energy and emissions impacts of ITS. ITS research investigates uses of new technology for roads as well as public transit. ($200,000 total funding through FY97)

Desired Outcomes: Improved understanding of the potential effects of information technology on the different aspects of sustainable transportation, particularly travel demand, energy consumption, community effects (e.g., travel on formerly less-used streets), and emissions (criteria pollutants, toxics, and greenhouse gas). Improved understanding will contribute to transportation investments, strategies, and related decisions that further sustainability.

Future Research Focus: There is currently considerable uncertainty and debate regarding the extent to which ITS will alter travel demand and patterns, energy consumption, and emissions. For example, although idling-related emissions may be reduced, higher-speed emissions (NO_X and CO_2) could increase. In addition to reducing congestion, will ITS create the long term equivalent of additional road capacity, and induce new travel demand? How do investments in information technology to improve urban and rural transit, welfare to work, and coordination of social service providers compare to non-technological alternatives? There is similar uncertainty regarding the potential net effects of telecommuting. How rapidly will tele-substitution grow, and in what specific forms (telecommuting, teleconferencing, electronic shopping)? To what degree will latent demand be stimulated by any resultant reductions in congestion? Will people freed from a daily commute migrate further from urban areas?

Future Directions: DOT, DOE, HUD, and EPA will continue to collaborate on research supporting an improved understanding of ITS-related changes in travel demand and patterns, energy consumption, air pollutant emissions, and community effects.

5 Implementation Issues for Next-Generation Vehicles and Fuels

Basic Thrust

Advances in vehicle technology and alternatives to current petroleum-based fuels will play a critical role in making transportation more environmentally and economically sustainable. Government and industry have maintained significant funding for related technology research and development, as evidenced by the Partnership for a New Generation of Vehicles (PNGV). Research specific to

the advancement of vehicle technology, including PNGV activities, is addressed in a separate report on Next-Generation Motor Vehicles and Ships. Because applications of these technologies to public transit might have important links to important aspects of sustainability, for example, to social equity, these applications are summarized briefly in this section. Strategic planning for this research, however, will be conducted as part of the Next-Generation Motor Vehicles and Ships initiative.

Deployment of next-generation vehicles and alternative fuels could have major implications for the range of related infrastructures and the economy as a whole, and a systems approach will ultimately be important to understanding the comparative impacts of different combinations of fuels and vehicle technologies. Further, strategic analysis of different potential evolutionary pathways will be important for effective decision-making regarding the nature and timing of shifts in key attributes of the overall vehicle/fuel system. Different systems will undoubtedly have important differences in capital investment requirements, net GHG and other emissions, net renewable or non-renewable energy demand, as well as manufacturing, vehicle use, and support requirements.

Understanding such implications in advance through research will be critical to decision-making regarding the pace of deployment, and to balancing sometimes competing sustainability goals. In its review of the PNGV program, the National Research Council (NRC) has consistently called for study of such infrastructure and economic effects.

Current Activities

In FY96 and FY97 DOE has funded studies of supply and processing issues related to lightweight vehicle materials. It has also funded studies of capital investment requirements and net energy demand and emissions related to alternative fuels. In FY97 DOT funded a study through BTS of the potential impacts of next-generation vehicles on the manufacturing and vehicle support (e.g., maintenance) infrastructures. DOT and DOE are collaborating on these activities, with guidance from the U.S. Department of Commerce and the Office of Science and Technology Policy. ($500,000 in FY97)

Advanced Technology Bus -- FTA is involved with research on energy-efficient, lower-emitting vehicles. In partnership with the transit industry, FTA is developing the Advanced Transit Technology Bus (ATTB), a project that will eliminate over 10,000 pounds in weight from a typical 30,000 pound bus. Benefits from the weight reduction include lower fuel and brake costs as well as less road damage. The low-weight bus also uses advanced materials and a high-efficiency drive system to save fuel, reduce emissions, ease maintenance and provide a longer lasting non-corrosive body. ATTB Program was initiated in 1992 with two grants: one to the Los Angeles County Metropolitan Transportation Authority and the other to the Metropolitan Transit Authority of Harris County, Texas. ($60 million 7-year effort)

Desired Outcomes: Improved data and analytical methods for understanding the potential infrastructure and economic effects of next-generation vehicle technologies and alternative fuels. This understanding will contribute to better informed transportation decisions.

Future Research Focus: Scenarios for and implications of global penetration. Implications for component manufacturing, vehicle production, service and repair, highway design, and emergency response. Safety, health, and environmental issues associated with some fuels (e.g., dimethyl ether).

Future Directions: DOT and DOE will continue to collaborate on research regarding the potential infrastructure and economic impacts of next-generation vehicles and fuels.

6 Fuels, Transportation and Sustainable Communities

Basic Thrust

Transportation fuels play a prominent role in the sustainability of vehicle/fuel/land use systems. First, the price inelasticity of demand in the transportation sector contributes to the vulnerability of the U.S. economy to petroleum supply fluctuations. The development of commercially viable alternatives to petroleum-based fuels is a priority for addressing this formidable challenge. Second, and closely related, greenhouse gas emissions from the transport sector are heavily dependent upon the carbon intensity of transportation fuels and feedstocks, and to some extent, upon fuel characteristics (e.g., octane number) important to vehicle energy efficiency. Certain biomass fuel cycles will result in zero or even negative greenhouse gas emissions as the plants and crops (grown for biofuels production) absorb CO_2 equal to or in excess of the amount released during biofuels production, distribution, and combustion. Third, fuel specifications (e.g., sulfur, volatility, aromatics, olefins, etc.) factor heavily into transportation-related emissions of air pollutants important to regional and urban air quality.

Research in the area of alternative fuels, and in fuel quality is a critical complement to research on next-generation vehicle technologies (e.g., advanced ICEs, hybrids, emissions after treatment, and fuel cells) addressed in the report on Next-Generation Motor Vehicles and Ships, and will greatly enhance the prospects of some of the vehicle technologies under development. As in the prior area, development of public transit technology is summarized briefly here as an example of research that supports sustainability, although strategic planning will occur as part of another initiative focused on vehicles.

Current Activities

EPA is currently planning two projects exploring the use of natural gas and biomass as feedstocks for road transport fuels. These include: research in the area of alternative fuels, and in fuel quality is a critical complement to research on next-generation vehicle technologies (e.g., advanced internal combustion engines, hybrids, emissions after treatment, and fuel cells) addressed in the

report on Next-Generation Motor Vehicles and Ships, and will greatly enhance the prospects of some of the vehicle technologies under development.

- A $500,000 2-year in-depth comparative study of different single-process options for the production of hydrogen or methanol process from biomass or natural gas. This would continue and validate the results of ongoing EPA research in this area. (FY97 $1.173 million)

- A jointly sponsored project to demonstrate the feasibility of the Hynol process (conceived of at the Brookhaven National Laboratory) for converting biomass to transport fuels. The project would complete testing and demonstration of the various processing units and the integrated system at a test facility currently under construction at the University of California Riverside Center for Environmental Research and Technology. The total project cost is $6.0 million, of which $2.5 million has been funded to date. (FY97 EPA funds, including $233,000, pre-FY97, $573,000)

DOE is currently funding a wide range of transportation research ($203 million in FY97, $224 million in FY98) addressing advanced vehicle technologies, transportation biofuels, and vehicles operated on alternative fuels. Research specific to biofuels is addressed in this report. Research specific to vehicles is addressed separately in the report on Next Generation Motor Vehicles and Ships, as is research regarding the vehicle/fuel system. DOE transportation biofuels research (FY98 $27.7 million in FY97 $31.1 million) is currently focused in the following areas:

- Ethanol Production -- DOE research on ethanol production is currently targeting a procedure known as simultaneous saccharification and fermentation (SSF) for converting cellulose to ethanol. The process combines the cellulose hydrolysis and fermentation steps in one vessel to produce high yields of ethanol. Advances in genetic engineering are making the fermentation of hemicellulose sugars more productive as well. Continued improvements in such key technical areas will make biochemical conversion of biomass to ethanol an efficient and economical route to alternative fuels production. Over the last decade, the program has succeeded in reducing the predicted cost of biomass-derived ethanol from $5.40 to $1.90 per 113,500 British Thermal Unit (BTU) -- the average amount of energy in a gallon of gasoline. (FY97 $22.8 million)

- Biodiesel Production -- DOE and USDA have major research programs underway to reduce the cost of biodiesel production. These agencies have jointly funded research to identify high oil-content crops with diesel market potential. DOE programs include long-term research for producing algal strains with high lipid content and development of biodiesel conversion technologies using algal lipids and higher plant oils. The USDA has proposed an initiative to achieve lower crop production costs through improved conversion yields and cost-effective crop management techniques. (FY97 $750,000)

- Feedstock Production -- The DOE Biofuels Feedstock Development Program (BFDP) focuses on the development and demonstration of environmentally acceptable and commercially viable

biomass supply systems, such that the U.S. will be capable of meeting up to 15% of its primary energy demand from dedicated biomass fuels. The program includes short-term woody crop research, herbaceous energy crop research, environmental research, systems integration and analysis, scale-up, feasibility and demonstration, and data and information management. (FY97 $2.5 million)

- Regional Biomass Energy Program -- The goal of the Regional Biomass Program (RBEP) is to increase the production and use of biomass energy resources in five locations in the continental U.S. Programs have been established in (1) the Pacific Northwest and Alaska, (2) the Southeast, (3) the Great Lakes, (4) the Northeast, and (5) the Western U.S. Since its inception in 1983, the RBEP has been highly leveraged -- for every RBEP dollar invested, two dollars are contributed by RBEP partners from industry, trade associations, universities, private farm owners, and state agencies. (FY97 $1.7 million)

Fuel Cell Transit Buses -- FTA's Fuel Cell Bus provides the preliminary engineering and development activities necessary for domestic and commercial production of a 40-foot fuel cell bus with a domestically produced fuel cell. The program is directed by the Department of Energy and co-sponsored by the FTA. One prototype medium-sized fuel cell bus has been completed and two others are being built for demonstration and evaluation. This project supports the development of a domestic industry for the production of these fuel efficient and environmentally acceptable vehicles. This bus has an engine twice as efficient as a typical diesel bus engine with negligible emissions and easier maintenance but none of the range limitations of battery-powered buses. Preliminary test results indicate that emissions from a fleet of 200 fuel cell buses would be equal to those of one conventional diesel bus.

National Park Service's Alternative Fuels Evaluation -- The National Parks Service (NPS) Capital Region is the major participant in a Department of Interior (DOI) and DOE cooperative project to test the feasibility and effectiveness of compressed-gas operation of heavy park vehicles (refuse haulers and dump trucks). The six vehicles will be placed in service over the next two years. Most will be existing trucks re-powered for compressed gas operation. Four of the vehicles will use CNG and be operated in the Washington, DC area where an incipient fueling infrastructure exists. The other two will be propane powered and will be operated in Shenandoah National Park.

Desired Outcomes: Commercially viable processes for producing high quality transportation fuels from nonpetroleum or renewable feedstocks. Efficient, clean, safe, and commercially viable transportation vehicles that operate on these fuels. Well-identified strategies for transition to such fuels and vehicles, including a characterization of the options for supporting policies and investments.

Ultimate measures of success for transportation fuels research include (1) the degree of reduction of criteria pollutants, relative to conventional petroleum- fueled vehicles, per mile traveled; (2) the degree of reduction of net fuel-cycle CO_2 emissions from the U.S. vehicle fleet; (3) the relative cost of CO_2 emission reduction compared to the cost of reduction from stationary sources; and (4)

the potential for maximum displacement of imported petroleum.

Future Research Focus: Major categories could include feedstock availability, process economics, distribution infrastructure, vehicle compatibility, net emissions and energy demand, market acceptance, and safety.

7 Development of Improved Analytical Tools, Data, and Indicators

Basic Thrust

Planners and decision-makers require improved tools, including data, performance measures, and a new generation of analytical models to understand the complex relationships between transportation systems and land use and development strategies. Improved tools are essential to assess the implications for environmental and social sustainability of transportation decisions.

A fundamental need is to develop the capacity to forecast land use development based upon public plans, regulation, tax, and transportation infrastructure policy. Improved regional economic efficiency and productivity models are also crucial to understanding the relationship between transportation decisions and economic and equity aspects of sustainability.

Current Activities

Travel Demand Forecasting -- Research by DOT and EPA intended to improve the ability to forecast the effects of transportation improvements on air quality, energy, land development, and congestion. DOT participants include FHWA and FTA. These efforts will provide tools for state and local governments to use to meet the requirements of the TEA-21 and the CAAA.

DOT has spent approximately $5.5 million in FY96 and $5 million in FY97 on planning research related to global Climate Change, with $5 million requested in FY98. The spending falls into two categories, both aimed at providing better estimates of travel in the calculation of greenhouse gas emissions. The two categories are the TRANSIMS project and general improvements to travel forecasting procedures (Travel Model Improvement Program or TMIP). TRANSIMS uses household, traveler and traffic micro simulation, combined with new emissions procedures, to provide much better estimates of emissions, including greenhouse gases, than current methods permit. TRANSIMS has been committed to as part of the Climate Change Action Plan. Improving existing procedures will modify existing tools to enhance their ability to analyze travel issues.

The Travel Model Improvement Program -- DOT and EPA program to improve the ability to forecast the effects of transportation improvements on air quality, energy, land development, and congestion. These tools are needed by state and local governments to meet the requirements of TEA-21 and the CAAA. This program consists of five tracks focused on the following areas: short-term modeling improvements, long-term improvements (TRANSIMS), outreach, data collection, and land use modeling. (FHWA Travel Demand Model Improvements -- $1.122

million FY98 request; TMIP -- $5 million; TRANSIMS -- $43 million total -- expenditures to date, $17 million, to complete $8 million; deployment and technical support, $18 million)

Activities that are currently being conducted under TMIP include:

- Data Collection and Modeling Requirements for Assessing Transportation Impacts of Micro-scale Design -- Research and produce guidance for MPOs and related agencies on how to include urban design factors in the transportation modeling process. The guidance will assist agencies to determine the air quality effects of local land use decisions. The work, which in not yet underway, will be jointly funded by EPA and DOT under TMIP, and will have a two-year time frame. The work will be undertaken in FY98. (FY97: FHWA $175,000, EPA $125,000)

- TRANSIMS is a long term effort intended to completely overhaul the forecasting of travel behavior and assessment of air-quality and other impacts. TRANSIMS will predict the impact of congestion, trip chaining, and ITS on air quality, and will allow estimates of the impact of highways on subpopulations such as income and ethnic groups. Research will also explore how TRANSIMS might be used by states to improve forecasts for intermodal planning, estimating impacts of alternatives for movement of vehicles, freight, and persons using combinations of modes.

- Land Use Models -- Current land use models are more than twenty years old, and are inadequate for developing the forecasts require to determine the sustainability of combined land use and transportation decisions. TMIP provides some initial efforts to strengthen interaction between land use and transportation forecasting but recognizes that this is a moderate level of effort relative to the need for major improvement.

- Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions -- This product has been in development for several years and will be completed in FY98. It provides guidance on how to upgrade regional travel demand models to adequately model various transportation pricing policies, including parking taxes, congestion and road pricing, fuel taxes, modal subsidies, and emissions fees.

Air Quality Impacts of Regional Land Use Policies -- Research regional scale land use modeling to determine the air quality effects of different regional transportation and land use scenarios for the Sacramento area (such as no build, building additional highway capacity, building transit lines, congestion pricing of roads, etc.). The resulting document, intended for policy makers at the national, state, and metropolitan levels, will illustrate air quality benefits of regional policy scenarios that affect land use development patterns. The project has a one-year time frame. (EPA FY97 $120,000)

Assess the Current State of Land Use Modeling -- EPA project to document for state and local air quality and transportation agencies available land use models, the data needed to run them, their

feasibility for cities of various sizes, and how effectively the models capture travel demand impacts of the selected land use strategies.

Interactions Between Transportation Costs, Transportation Use, and Retail Structure -- Examine the impacts of alternative retail structures, specifically "big box" stores, and related land use on VMT to provide local areas with information on how to control VMT growth through land use strategies. (EPA $190,000 through FY98).

Measuring the Benefits of Public Transit Investments

The FTA is sponsoring a series of research projects to measure the broad benefits of investments in public transit, including environmental and equity effects.

- The Economic Value of Affordable Mobility -- Research to measure the economic value of affordable mobility. Individuals who can undertake the basic activities of daily life, including work, religion, health and education (particularly in urban areas), are likely to remain in communities and contribute to economic activity.

- Measuring the Neighborhood Benefits of Rail Transit Accessibility -- Research on the benefits of improved rail transit access, including improved proximity to rail stations. Benefits include improved property values, reduced auto dependence, lower transportation expenses, and improved development patterns, including reduced sprawl, congestion and air pollution.

- Congestion Management Benefits -- Project examines congestion reducing benefits of fixed guideway investments, looking at travel times in corridors with both expressways and transit fixed guideways. Research will determine monetary value of congestion reducing benefits associated with these transit investments. Previous FTA research examined transit's role in establishing travel times in congested corridors. Project will improve information about how FTA investments contribute to economic growth and trade, and creation of travel choices. (FTA FY98 $200,000, FY99 $200,000)

- Commercial Benefits of Transit Services -- Research to identify benefits of existing transit to business, as reflected in commercial property values and the value of other assets located near quality transit facilities. The research examines a variety of new data sources beyond real estate property values, using established tools of economic analysis to aggregate benefits to local, regional, and national economic growth and global competitiveness. (FTA $250,000)

Communities 2020 -- HUD has developed a planning and analysis GIS software that allows communities to analyze the spatial patterns of population socio-economic characteristics, infrastructure, and land use activity. 2020 combines Census data, transportation network information, local data, and HUD project information in a GIS system that allows analyses from a regional to parcel level. The software is available to all communities at a nominal cost. 2020 could be a vehicle for sustainable development and transportation review and action. Funding has

been by HUD. Further development and dissemination will occur in FY98-99.

Air Pollution Models

- Evaluation of the MOBILE Emissions Factor Model/Driver Behavior -- Research to examine various implicit assumptions in the MOBILE model and whether it can be improved to better account for these type of assumptions. FHWA and EPA project to evaluate the EPA's MOBILE5b emissions factor model in terms of its ability to estimate emissions reductions based on driver behavior. The study responds to concerns over the ability of MOBILE to conduct these analyses. (FHWA FY97 $119,148, projected $150,000)

- GREET Model -- Argonne National Laboratory has supported the DOE Office of Transportation Technologies (OTT) by developing the Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation (GREET) model. This model calculates fuel-cycle emissions of five criteria pollutants and three greenhouse gases, as well as petroleum consumption for various transportation fuels. The model currently includes 17 fuel cycles, examples of which include: petroleum to conventional gasoline, woody biomass to ethanol, and natural gas to hydrogen. The model is being tailored to specific Clean Cities, has recently been expanded to include heavy vehicles, and is currently undergoing refinement with respect to assumptions for electric and hybrid-electric vehicles.

Water Quality and Ecosystem Protection -- EPA is responsible for implementing the Clean Water Act by promoting and protecting water quality from its initial source as drinking water to its eventual disposal as waste water. Relative to transportation and sustainable communities, EPA seeks to protect runoff pollution from all land uses, including roads and highways, that contribute to erosion and sedimentation and other contaminants that potentially may degrade surface and ground water quality. EPA works in partnership with the FHWA, Corps of Engineers, and other stakeholders to help ensure that transportation projects are designed and constructed in a way that minimizes adverse impacts to wetlands and other aquatic resources. Additionally, EPA works with interested stakeholders to ensure that adverse impacts to aquatic ecosystems due to transportation projects are offset through activities such as watershed planning, wetlands restoration and enhancement projects.

USACE Projects -- Several U.S. Army Corps of Engineers (USACE) research programs directly support the development of analytical tools for Corps environmental planning and sustainability goals:

- Planning Methodologies and Watershed Management,
- Environmental Impact and Ecosystem Management & Restoration Research,
- Water Quality,
- Remote Sensing,
- Geographic Information Systems, and
- Characterization & Restoration of Wetlands.

These programs are motivated by the USACE Civil Works mission, yet they could be leveraged to strengthen the modeling capabilities of communities for transportation planning and related development. USACE has long participated in interagency research, development, and implementation activities aimed at reducing transportation's impact on the environment, for example, impacts on wetlands, and can build upon this experience. (USACE program totals: FY97 $4.915 million; $9.150 million proposed FY98)

In addition, several USACE programs and their existing interagency partnerships directly support environmentally-sustainable water transportation and harbor/waterway maintenance by their focus on maintaining an effective national water transportation system while minimizing or eliminating environmental impacts. These programs include: (1) Long-Term Effects of Dredging, (2) Inland Navigation, (3) Dredging Operations and Environmental Research (O&M), and (4) Zebra Mussel Control Research. (USACE program totals: FY97 $5.831 million; $13.600 million proposed FY98)

- Storm-Water Baseline Data Update -- FHWA and U.S. Geological Survey (USGS) project to provide highway agencies, Federal agencies and communities with data that are currently unavailable. EPA proposes amending its stormwater regulations under "Phase II" to reduce the current threshold for applying National Pollution Discharge Elimination System (NPDES) permit requirements for erosion and sediment control at all construction sites from 2.5 hectares (5 acres) to 0.4 hectares (1 acre). (EPA $40,000 to amend regulations)

- Efficiency of Water Quality Best Management Practices -- To provide highway agencies and communities with assistance in planning and constructing retaining basins and other water quality control devices for nonpoint source runoff. EPA supports research to address post-construction impacts by promulgating stormwater regulations under the NPDES permit program that require the inclusion of site-appropriate and cost effective structural Best Management Practices (BMPs) promoting on-site stormwater infiltration techniques and nonstructural BMPs (effective planning and zoning to protect open space and maintain infiltration capacity) to address the significant sustainability effects of community development on water quality. (EPA $60,000)

- Development and Implementation of Hydrogeomorphic Wetlands Assessment Methodology for Use in Wetlands Management Activities -- Corps of Engineers and EPA project to evaluate wetlands mitigation projects, indicates they are often inadequate to replace lost functions and values, or do not meet watershed management needs. The project will contribute to improved ability to determine the significance of highway impacts to wetlands and the design and construction of mitigation measures. (past $300,000; present $250,000)

Evaluation of Ecosystem Linkages Affected by Highway Use in Mountain Ecosystems -- University of Montana, U.S. Fish and Wildlife Service (USFWS), Montana Department of Fish, Wildlife, and Parks, and U.S. Forest Service (USFS). Highways have significant impacts on ecosystems through fragmentation and loss or alteration of natural habitats for large and small animals.

Impacts include changes to ecosystem functions and conditions, including loss of species. This project will evaluate the seasonal response of large carnivores (grizzly bears) to the use and location of highways. Grizzly bear movements and habitat use in response to highway locations are being monitored and mapped using GIS and Global Positioning System (GPS) radio collars to plot critical habitats. (Total FY97/98 $180,000)

Data Collection and Performance Measures

Under TEA-21, urban areas should direct investments toward improved performance of regional transportation systems. The emphasis is on connections between modes, and better management of networks. All modes must be considered equally in solving transportation problems. This balanced approach depends on identification of performance measures that allow trade-offs between environmental, economic, social, and other urban goals, and cost-effective access to required data. Basic data are required on the demand, supply, and price of land, and on inventories of land use to allow monitoring and forecasting of trends.

- Advanced Data Collection and Analysis Techniques -- Research focuses on alternative sources of data, innovative collection methods, and efficient and effective means to analyze data. Emphasis is on advanced technologies, such as GPS and GIS, and integrated intermodal information systems to improve decision-making. (FHWA $1.328 million FY98 request)

- Geographic Information Systems and Public Transit -- FTA has supported development of a broad range of applications of geographic information systems for public transit management and planning. Work includes development of a national GIS database of all transit systems to provide information on local levels of service and accessibility of transit, with periodic analysis of ridership by distance to service and wait time.(FTA FY94-97 $1.85 million)

- System Plan and Program Evaluation -- Improve the ability to compare the total social costs and benefits of transportation investments. Develop multi-modal performance measures and management systems to improve monitoring and evaluation of transportation systems. (FHWA FY98 request $956,000)

- Intermodal Analysis -- Develop guidance and technical assistance on statewide intermodal transportation planning. Research, to be completed in future years, includes development of: intermodal data bases, freight modeling, and “best practices” on bicycle and pedestrian planning. (FHWA FY98 request $1.1 million)

- Water Quality Data Systems -- Several data systems track water quality impacts reported by the states and other water monitoring activities which can be plotted via geographic information systems, and other software. (EPA budget $3.5 million)

- Index of Watershed Indicators -- Presents a description of fifteen separate water resource indicators that describe the condition and vulnerability of aquatic resource health and stressors in the nation's watershed scale. (EPA budget $1.5 million approximately)

- The BTS Annual Report -- Examines the environmental consequences of transportation, and how public and private actions are mitigating the effects. Emphases include urban air quality and international comparisons. The 1996 report emphasizes identifying which environmental problems associated with transportation are being tackled successfully, and which problems are getting worse or are resistant to current policies and approaches. The report discusses data and methodological issues involved in developing full accounting of the social costs and benefits of transportation. The 1997 report featured a section on mobility and access, exploring mobility's importance in the American society and economy, and the transportation system's facilitating role in providing access to opportunities. The 1998 report focuses on long distance passenger travel and freight activity.

- Interagency Working Group on Sustainable Development Indicators -- BTS is a participant in the SDI Group, with representatives from agencies that share an interest in developing sustainable development indicators -- data and methodology useful for assessing the Nation's progress toward sustainability. BTS is working with the SDI Group to develop an indicator relevant to transportation and sustainability.

- International Workshop on Transportation and Environmental Statistics -- Co-sponsored by BTS, the UN Economic Commission for Europe, and the International Union of Public Transport to discuss national and international statistics for use in analysis of the relationship between urban passenger transport and the environment. The Workshop may lead to future cooperative endeavors between U.S. and other national and international agencies on developing integrated transportation and environmental statistics and indicators.

- Indicators of the Environmental Impacts of Transportation -- EPA report completed last year, presenting quantitative national estimates of the magnitude of transportation's impacts on the natural environment. It addresses all primary modes of transportation and all environmental media (air, water, and land resources), and covers the full "life-cycle" of transportation from construction of infrastructure and manufacturing of vehicles. The report also presents a framework for developing indicators and for categorizing transportation activities that affect the environment, and describes how to apply indicators to analyze environmental impacts of transportation. (EPA FY96 $115,000)

National Park Service Evaluations of Automobile Alternatives -- Major efforts are underway to develop alternatives to private automobile transportation to and within the central facility and attraction areas of three national parks experiencing critical peak congestion -- Zion, Grand Canyon, and Yosemite. The NPD intends to evaluate the performance of all three projects to transfer the lessons learned to other parks. Zion will purchase 31 propane-fueled buses to operate in two loops by the summer of 2000. All three park efforts will integrate improved facilities for

walking and bicycling with the transit projects. (Funding for FY95 - 98 totals more than $15.7 million, most from NPS appropriated funds, plus fees, ISTEA, State of Utah, Cinemax Theater)

Grand Canyon National Park is moving from general to detailed planning on a complete new transit-based transportation system that integrates light rail, alternative-fuel buses, and pedestrian and bicycle facilities. Substantial involvement on the part of the USDOT is envisaged, and a DOI-DOT Memorandum of Understanding to provide a framework for this and other cooperative efforts is nearing completion. Yosemite National Park envisages a virtual phase-out of private car transportation from Yosemite Valley, most likely through deployment of an alternative fuel shuttle bus system serving both visitors and employees. (Funds earmarked to date, appropriations and fee demonstration funds, total $41 million)

Desired Outcomes: Develop a new generation of integrated land use, travel demand, and environmental forecasting models. Apply the technical planning tools to improve forecasts of the effects of transportation improvements on congestion, energy, air quality, and land development. Provide details and accuracy in forecasts required to implement the CAAA. Develop analytical methods and tools to assist states and local agencies in transportation analysis and economic development decisions from the standpoint of land use and environmental impacts. The ultimate outcome will be improved transportation investments, strategies, and related decisions that further sustainability.

Future Research Focus:
What are the most cost-effective investments in models and other analytical tools? How can long term improvements to the state-of-the-art be balanced with shorter term incremental improvements?

How can transportation, land use, and environmental models be further integrated?

Can models be refined to identify the effects of small scale system management strategies (such as traffic signal coordination) or demand management strategies (such as congestion pricing) individually or in combination?

What are appropriate performance measures to compare broad impacts (environmental, social equity, mobility, accessibility) of very different transportation investments and strategies (new road or transit capacity, improved management of infrastructure, technology, pricing, parking)?

Can land use models be updated and integrated with transportation models to demonstrate the degree to which transportation infrastructure and strategies, and travel behavior, can influence urban form and vice-versa?

8 Building Institutional Capacity to Address Regional Concerns

Basic Thrust

The institutional capacity to address regional concerns is critical to sustainability. Transportation, land use, and environmental planners deal with and must balance concerns and problems that are typically regional in nature, including air and water quality, economic growth, distribution of jobs and housing, mobility, congestion, and accessibility. While there are models of effective regional entities -- Portland, OR, the Twin Cities, and the San Francisco Bay Area are often cited -- there are also many examples of fragmented processes that waste resources and reduce the ability to confront and resolve regional concerns related to sustainability. With the broad variation among distribution of roles and responsibilities among states, cities, counties, and regional authorities, there will never be a single answer -- "one size will not fit all."

No single institutional approach will meet the needs of every region in every state. Rather than a single standard institutional structure, there is a need for thorough information on the effectiveness of alternative models and options. Options can include different institutional structures and models for cooperative planning and decision-making, involving local, regional, state, and Federal agencies responsible for transportation, land use, and environment, as well as regional stakeholders, including citizens, freight industry, developers, and others in the private sector. The importance of cooperative, comprehensive, participatory planning is a basic principle of TEA-21, and the foundation for extensive efforts by the US DOT.

Current Activities

"Growing Smart" -- The American Planning Association, with funds from HUD, DOT (FHWA, FTA), EPA, USDA, Federal Emergency Management Administration and several foundations, is developing a guidebook on state statutes for planning and managing development and redevelopment in urban and rural areas. The guidebook will include model statutes and commentary on state, regional, and local planning, and public powers to implement plans (regulatory, investment, and tax actions). The project will develop a national planning statute clearinghouse and data base of state legislative materials, and a "best practices" guidebook on state statutes and development management law for governors and legislators. A DOT/HUD community revitalization/transportation demonstration program provides teams of experts to work with cities and MPOs. Substantive issues include balanced growth management and revitalization; jobs/housing balance with housing choice; transportation/land use integration; economic development: efficiency and competitiveness; social equity; environmental protection and hazard mitigation; and fiscal implications of settlement patterns. The work is being conducted in three phases:

Phase I: State and Regional Planning -- relationships and responsibilities between state, regional and local planning efforts, 10/94 - 6/96.

Phase II: Local Planning -- model legislation dealing with local planning, 5/96 - 12/97.

Phase III: Tools to Manage Change -- model legislation, 6/97 - 9/99.

Start: 1994; completion: 1999. (Total funding $1.7 million).

Regional Connections -- HUD's Regional Connections proposal will fund local partnerships to design and implement smarter growth strategies across jurisdictional lines. Strategies will address smarter growth in new growth areas as well as coordinated reinvestment in already built-up and infrastructure-rich areas of participating regions.

Applicants will include states and groups of localities as well as regional entities (councils, MPOs, or business councils), and must show partnerships with a wide array of stakeholders. Eligible activities will include planning, institution building, and part of the costs of implementing inter-jurisdictional projects, including: community participation; regional data systems and analyses; participation by businesses and other community institutions; or re-writing critical planning guidelines.

Regional Connections will encourage more coordinated use of Federal housing and community development, transportation, workforce and economic development, and environmental dollars to support smarter growth. Outcomes will be measurable differences in development patterns and benefits over time, such as: reduced average commute times; increased built densities in growth areas; increased investment rates and tax ratables in older built-up areas; reduced school crowding; more balanced jobs/affordable housing ratios region wide; preservation of open space; and other measures of livable communities. (HUD FY00 $50 million proposed)

TEA-21 Management Oversight -- FTA and FHWA, with the support of the USDOT/Volpe Center, have analyzed the extent to which the evolving TEA-21 processes influence metropolitan area decisions on transportation investments and strategies. The project, which began with passage of ISTEA in 1991, includes 23 comprehensive technical reviews, conducted with the assistance of EPA, of transportation planning in major metropolitan areas. Topics include effectiveness of institutional planning and decision-making, as well as use of technical tools, financial planning, integration of transportation planning for Clean Air Act conformity, and public involvement. In addition to individual published reports, the reviews were drawn on for a report directed toward political officials on positive national trends in response to ISTEA. (FTA FY98 $200,000)

Training for State and Local Officials -- FHWA and EPA partnership to develop a training course for state and local transportation officials. Instruction will focus on the environmental concerns of erosion and sedimentation from construction sites and on best management practices to control erosion and sediment during construction, and in operation and maintenance of transportation systems. The course will be available in May 1998. (Budget $1 million)

Institutional Aspects of Urban Runoff Management -- EPA sponsored research for a comprehensive review of the institutional framework of urban stormwater runoff management programs. (EPA budget $50,000)

Future Research Focus: How can institutional structures be designed that will allow effective coordination of planning land use, for example, concerning sprawl and infill, with transportation? What are options for overcoming fragmented decision-making?

9 Infrastructure Needs Associated with Revitalizing Urban Areas and Cleaning up Infill Sites

Basic Thrust

Urban infill development can reduce the need for building new transportation infrastructure and reduce VMT growth. Brownfields typically are abandoned sites which are mildly contaminated but require only minimal clean-up efforts. Redevelopment of these and other urban sites can promote sustainability, since these uses can eliminate the need to put new development projects outside urban areas. Urban brownfield sites also often have unmet transportation infrastructure requirements that need to be addressed. Technological solutions, such as information technologies, may be able to contribute to a transportation solution for abandoned urban areas.

Current Activities

Empowerment Zones and Enterprise Communities (EZEC) -- HUD, DOT, USDA, Department of Health and Human Services (HHS) are supporting empowerment zone and enterprise community projects to revitalize low-income communities and businesses.

HOPE VI Revitalization -- HUD is funding the revitalization of deteriorated public housing neighborhoods in over 30 cities with the provision of approximately a half a billion dollars annually. The public housing revitalization includes the redesign of public housing projects that combines housing demolition and rehabilitation, deconcentrations, the provision of supportive services, and efforts to improve resident access to employment. The revitalization is being monitored and evaluated over several years. (HUD FY98 $800,000)

Model Solutions to Recycling Brownfield Areas -- HUD, with the Lincoln Institute of Land Policy (LILP), is funding a study of five older declining urban industrial areas that have been successfully redeveloped. The project is to produce model strategies and related action programs for the restoration of productive uses to declining and under used urban industrial areas. (HUD funding FY97 $50,000, matched by $15,000 from the LILP)

EPA Brownfields Program -- The EPA is creating partnerships with government, business, community leaders and citizens to return brownfield properties to the tax rolls, create jobs and restore a sense of community pride. (EPA FY98 $86.4 million)

Other relevant activities are included in areas 2 and 8.

Outreach

The Federal agencies contributing to this Plan, individually and in some cases jointly, conduct and participate in a wide range of on-going activities that: (1) disseminate information on activities, products, and plans, and (2) provide stakeholder input into agency decision-making regarding research programs and implementation policies. During the preparation of this Plan, the Team drew directly upon the following additional outreach activities:

- June 1997 Transportation and Sustainable Communities Team Meeting -- This included presentations from representatives of the NRC and Surface Transportation Policy Project (STPP). The NRC discussed the approach followed in its report Toward a Sustainable Future, which focused on an in-depth consideration of long-term and potentially irreversible environmental impacts of U.S. transportation systems. Climate change was a prominent element of this approach, which also addressed habitat disruption and species loss. However, reversible impacts upon urban air quality were not addressed. The STPP summarized proceedings of an October 1996 workshop *Goals for a New Era—A Research Agenda for Sustainable Transportation*, which addressed "sustainability" of transportation systems in terms of irreversible environmental impacts, but also in terms of impacts on, for example, urban air quality and social equity.

- September 1997 Transportation and Sustainable Communities Team Meeting -- This included presentations from a representative of the PCSD, who summarized the status of the Council's activities, in particular the Metropolitan and Rural Communities Task Force. Discussion included how PCSD activities might complement those of this Team.

The Team sponsored a session on *Transportation and Sustainable Communities -- Research and Implementation* at the TRB Annual Meeting in January 1998. Speakers and panelists included representatives from NRC, the World Bank, the PCSD, the Urban Land Institute, the Environmental Defense Fund), the International Energy Agency (IEA), and U.C. Davis.

Outlook and Next Steps

This report demonstrates that there is an important and relevant body of sustainability-related research underway in a number of programs, and documents and organizes that body of research into an overall framework.

To date, the Transportation and Sustainable Communities Team has reached important milestones in its work:

- consensus on the scope of its activity
- an initial inventory of current research activities
- organization of those activities into a framework through which several new opportunities for collaboration have been identified.

The Team has also identified important research gaps, including:

- Implementation and evaluation of changes in development patterns and their impact on travel, environmental and other outcomes.
- Research and development of improved transportation and land use forecasting models and methodologies.
- Innovative public participation and communication techniques (research and implementation).
- Impacts of urban design and transportation systems on physical activity and health.
- Equity impacts of alternative urban design and transportation systems.
- Economic impacts of transportation investments, including economic growth and equity.

Specific immediate term gaps include:

- The sustainability pilot programs in the DOT 1998 Budget submission for FHWA were not funded. These should be initiated under existing programs, including the TEA-21 Transportation and Community and System Preservation Program.

- Some agencies may require internal sustainability coordinating mechanisms. DOT, for example, requires such a mechanism for coordination between the Office of the Secretary and the various Departmental operating administrations.

- In parallel, these agencies may require strategic sustainability research programs. Such a program should be initiated within DOT to support participation of DOT executives in development of broader government wide sustainability policies.

Federal research must contribute to closing these gaps through improving understanding of the relationships between transportation and development decisions and sustainability. Elected officials, policy makers, the private sector, and the public must have this knowledge to successfully work together to reach decisions on transportation and development that foster rather than diminish sustainability.

Ultimately, the challenge for decision-makers is to move toward balance between preferred sustainability outcomes, some of which may be in competition. This conceptual approach to transportation and sustainable communities is described in Figure 1. Although outcomes and measures will continue to be refined and balanced, it is unlikely that there can be a broadly accepted single integrated measure of overall sustainability.

This Overview Report represents the first step in what must, given the complexity of the topic, be an evolutionary process to coordinate Federal research activities related to transportation and sustainable communities, and to identify and realize new opportunities for partnerships on multiple levels. This can be contrasted with, for example, the PNGV, which has a very clear primary objective, and a well-bounded technology focus.

As mentioned above, these results have been accomplished with valuable input from external stakeholders.

Subsequent phases of this effort will move toward greater strategic coordination among member agencies of the current research activities identified thus far, toward greater linkage with non-federal researchers, and toward clearer identification of opportunities to fill gaps in ongoing and planned research.

The Team will continue its efforts in developing the National Research Agenda for Transportation and Sustainable Communities to build on the foundation provided by this initial document, to develop a Strategic Plan. In a later phase of work the Team plans to expand outreach to include interested stakeholders, circulation of this Overview Report and the Research Agenda for external review, and a briefing to senior management of the participating agencies on results of the team process.

Glossary of Acronyms and Abbreviations

ABA	Architectural Barriers Act
ADA	Americans with Disabilities Act
ALAPCO	Association of Local Air Pollution Control Officials
ATTB	Advanced Transit Technology Bus
BTS	Bureau of Transportation Statistics
BTU	British Thermal Unit
CAAA	Clean Air Act Amendments of 1990
CDC	Centers for Disease Control and Prevention
CMAQ	Congestion Management and Air Quality Program
CTRD	Committee on Transportation Research and Development
DOE	U.S. Department of Energy
DOI	Department of Interior
DOT	U.S. Department of Transportation
ECMT	European Conference of Ministers of Transport
EPA	Energy Policy Act
EPA	U.S. Environmental Protection Agency
EZEC	Empowerment Zones, Enterprise Communities
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse Gases
GIS	Geographical Information Systems
GPS	Global Positioning Systems
HHS	Department of Health and Human Services
HUD	U.S. Department of Housing and Urban Development
IEA	International Energy Agency
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
LEM	Location Efficient Mortgages
LILP	Lincoln Institute of Land Policy
MPO	Metropolitan Planning Organization
NAAQS	National Ambient Air Quality Standards
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research Program
NEPA	National Environmental Protection Act
NESCAUM	Northeast States for Coordinated Air Use Management
NPS	National Parks Service
NRC	National Research Council
NSTC	National Science and Technology Council
OECD	Organization of Economic Cooperation and Development
OTR	Northeast Ozone Transport Region
PCSD	President’s Council on Sustainable Development

PNGV	Partnership for a New Generation of Vehicles
SOV	Single Occupancy Vehicle
SDI	Sustainable Development Indicators
STAPPA	State and Territorial Air Pollution Program Administrators
STPP	Surface Transportation Policy Project
TCSP	Transportation and Community and System Preservation
TEA-21	Transportation Equity Act for the 21st Century
TOD	Transit-Oriented Development
TMIP	Travel Mode Improvement Program
TRANSIMS	Transportation Analysis Simulation System
TRB	Transportation Research Board
UNFCCC	UN Framework Convention of Climate Change
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VMT	Vehicle Miles Traveled

Appendix A. Proposed 1997 Sustainable Development Indicators

Capital Assets (425): Total value, in dollars, of U.S. tangible reproducible capital, excluding all public infrastructure, as defined in the National Asset Accounts

Community Group Participation (40): The average number of hours per week per capita devoted to participation in community organizations

Consumption Expenditures Per Capita (125): Total dollar value of goods and services purchased by consumers per year as defined in the National Income Accounts.

Contaminants in Biota (432): Chemical contaminants in Land, estuarine, & marine biota

Crime Rate (449): Overall crime rate for the United States

Energy Consumption Per Capita (158): Total energy consumption divided by total population organized by type of energy source (coal, oil, gas, nuclear, renewable, etc.).

Family Function (433): Measure of families effectively performing its basic functions. This serves as a placeholder until a better, more specific measure gets defined.

Fish Catch to Growth ratio (428): Total fish landings (including by-catch) divided by the fish population growth rate

Greenhouse Climate Response Index (215): Arithmetic average of (1) percent of U.S. with much above normal minimum temperatures, (2) percent of U.S. with much above normal precipitation during the months of October through April, (3) percent of U.S. in extreme or severe drought during the months of May through September and (4) the percent of the U.S. with a much greater than normal proportion of precipitation derived from extreme one day precipitation events (exceeding 2 inches).

Greenhouse Gas Emissions (141): emissions of greenhouse gases, which are CO_2, CH_3, NO_2, CFCs, and ozone

Groundwater Contamination (353): Area of land with contaminated ground water

Income Distribution (133): distribution of income per capita arranged to show the percentage of the population at various levels of income

Invasive Exotic Species (23): The total number of invasive species and their distribution in the United States

Investment Percentage of GDP (264): Investment share of Gross Domestic Product (%), including research, technology development, invention, and innovation, as defined in the National Income Accounts. This includes both public and private investment.

Major Land Use, Including Urban (423): The total land area in the United states broken down by major estuarine and land ecosystem. This includes both urban and agricultural land.

Materials Use per Capita (429): Total metric tons of materials in use divided by total population organized by type, including recycled

Outdoor Recreation Services (431): Total number of visitor days per person attributed to outdoor recreation and tourism

Ozone Depleting Substances (329): Production and consumption of ozone depleting substances

People in Clean Air Nonattainment Areas (1): Number of people living in areas that do not meet air quality standards

Population Health (451): A placeholder indicator to measure the status of health in the population

Receipt of Health Care (452): % of population with adequate access to health care as a function of income level

Soil Types (390): Land area organized by soil type

Species In Trouble (444): The total number of species in trouble in the United States.

Teacher Capabilities (437): The average capacity or skill level of individual teachers to instruct students

Test Scores by Economic Group (414): Standardized achievement test scores organized by economic group

Timber Harvest to Growth Ratio (427): Total timber harvest divided by total timber growth rate per year

Total Managed Waste (422): Total mass of waste managed in man-made facilities in the United States organized by type (including nuclear), by site, and by hazard level. This does not include waste already released in the environment or in abandoned, uncontrolled sites.

Total Population (442): Total population in the United States organized by geographic area

Toxic Land Area (75): Area and percent of land experiencing an accumulation of persistent toxic substances, including superfund and brown field sites

Water Consumption to Renewal Ratio (447): Total water consumed per year divided by the total water resource growth rate per year

Water Quality Index (446): Index of water quality measuring the appropriate concentrations of selected chemical physical, and sanitary constituents of water at stations

Work Force Skill Level (448): The average level of experience, capability, knowledge, and social skills of the individuals in the work force