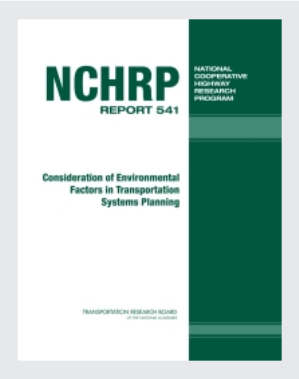

Consideration of Environmental Factors in Transportation Systems Planning

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 541

Consideration of Environmental Factors in Transportation Systems Planning

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Atlanta, GA

SUBJECT AREAS
Planning, Administration, and Environment • Public Transit • Freight Transportation

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in Cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD

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FOREWORD

By Ronald D. McCready
Staff Officer
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This report describes the transportation planning process and discusses where and how environmental factors can be addressed effectively at the state and metropolitan levels. This report should be especially useful to federal, state DOT, MPO, and local transportation planners, as well as other practitioners concerned with addressing environmental factors within transportation systems planning, priority programming, and project development planning leading to implementation.

Transportation systems plans provide the basis for selecting and developing transportation projects. However, because of their long time frames and broad scopes, systems plans often are developed without detailed consideration of how plan implementation will affect the built and natural environment. This creates problems in that some important projects may be very difficult, if not impossible, to implement because of environmental consequences that could have been identified, considered, and possibly avoided much earlier in the planning process. Furthermore, insufficient consideration of environmental factors in transportation systems planning may cause decision makers to miss opportunities to adopt plans that are fully consistent with statewide and regional environmental goals and to implement larger scale environmental mitigation and enhancements.

Typically, environmental factors are more closely examined during project development and, in some cases, during corridor or subarea planning. Federal and state law and sound planning practice call for considering environmental factors within the development of transportation systems plans. However, few processes, procedures, or analysis methods are generally accepted for considering environmental factors in transportation systems planning. In addition to "fatal flaw" analyses, other environmental considerations are more appropriately addressed at the systems planning level. These include purpose and need determinations, areawide air- and water-quality impacts, ecosystem analysis, watershed evaluations, secondary and cumulative impacts, and social and community impacts. Although cost-effective, macro-scale analysis methods, such as GIS applications and air-quality modeling, could be used to develop and evaluate systems plans, these and other methods are not applied widely in systems-level transportation planning. If elements of transportation systems plans are to proceed through project development to implementation, systems-level environmental considerations must be addressed earlier in planning.

The objective of this research was to identify, develop, and describe a process, procedures, and methods for integrating environmental factors in transportation systems planning and decision making at the statewide, regional, and metropolitan levels.

The research focused on environmental issues within the long-range transportation planning processes of state DOTs and MPOs and included the following: (1) a comprehensive review of recent literature; (2) a survey of approaches employed by DOTs, MPOs, and environmental regulatory agencies; (3) a review of federal regulations and

guidance on environmental factors; and (4) case studies to synthesize current practice in environmental planning. A planning process was developed that describes how and when various methods can best be applied in developing systems-level transportation plans. The process addresses decision-making relationships; technical requirements (e.g., data and analytical methods); necessary staffing capabilities; public involvement; interagency coordination; financial commitments; and methods for tying the systems planning considerations to more detailed processes such as corridor planning, subarea planning, modal development planning, priority programming, and project development.

Under NCHRP Project 8-38, "Consideration of Environmental Factors in Transportation Systems Planning," the Georgia Institute of Technology in Atlanta, Georgia, reviewed current practice in dealing with environmental issues within the state and metropolitan transportation planning processes. The report describes procedures, methods, and institutional arrangements for successful consideration of environmental factors in transportation planning. The report also presents a broad framework for assessing, evaluating, and integrating environmental issues and concerns into systems-level transportation planning and decision making. Detailed supplementary information on relevant regulations and guidance and the results of the project survey are presented in *NCHRP Web-Only Document 77.*

CONTENTS

CONSIDERATION OF ENVIRONMENTAL FACTORS IN TRANSPORTATION SYSTEMS PLANNING

SUMMARY

INTRODUCTION

This report presents an approach for integrating environmental factors in systems-level transportation planning and decision making. The approach was based on a comprehensive assessment of state- and metropolitan-level practices for addressing the environment in transportation planning. To facilitate the implementation of research findings, the approach is compatible with existing planning techniques, procedures, and institutional arrangements. However, the approach is flexible enough to take advantage of changes in planning regulations, institutional relationships, and emerging technologies that will help make transportation agencies better stewards of the environment.

A conceptual framework of transportation systems planning and project development is used to show where environmental factors could be incorporated to improve this process. As shown, environmental considerations can be included in many of the steps that normally constitute system planning and project development.

RESEARCH OBJECTIVE AND APPROACH

The objective of this research was to develop an approach, including procedures and methods, for integrating environmental factors in transportation systems planning and decision making at the state, regional, and metropolitan levels. The research consisted of the following tasks:

1. A review of recent and ongoing research and literature on the consideration of environmental factors in transportation and other infrastructure systems planning, highlighting innovative procedures and methods and reporting on their effectiveness in improving transportation decision-making.
2. A survey of procedures and methods used in state DOTs, metropolitan planning organizations (MPOs), and environmental regulatory agencies for consideration of environmental implications of systems-level plans and decisions.
3. A review of federal and state policies, regulations, and guidelines that can be expected to influence the consideration of environmental factors in transportation systems planning and decision making.

4. A set of case studies of state and metropolitan planning processes to synthesize current successful procedures, methods, and institutional arrangements for integrating environmental concerns into transportation planning.
5. Development of a planning process that provides a broadly applicable framework for assessing, evaluating, and integrating environmental concerns within transportation systems plans and decisions.
6. An application of the framework to demonstrate its potential effectiveness and show how it can be used to identify opportunities and challenges for enhancing environmental stewardship through transportation planning.

The benefits of considering environmental factors in transportation systems planning include the following:

- Transportation agencies can avoid or at least minimize environmental impacts as they relate to network investment decisions;
- Projects that jointly meet both transportation purposes and enhancement of environmental quality can be identified more easily when environmental factors are considered;
- Identifying sensitive environmental areas or regions can provide an important context for much broader community development planning;
- Environmental sensitivities as they relate to project characteristics can be carried through all steps of planning, thus resulting in better projects, or at least better mitigation strategies;
- Needs and purpose justification required in project development can be provided earlier in the process when environmental factors are considered;
- When combined with interagency partnerships, considering environmental factors in system planning can expedite environmental resource agency reviews in project planning; and
- Although considering environmental factors often means spending more staff time in the early stages of planning, this is more than offset with staff-time savings later in project development.

MAJOR FINDINGS

This research has examined many different examples of how DOTs and MPOs have considered environmental factors in transportation systems planning. In several cases, transportation agency officials are actively involved in comprehensive efforts to more effectively integrate concern for the environment, community development, and infrastructure provision. However, in most instances, this research found that transportation agencies are more concerned with what happens during project development (with respect to environmental impacts) than with developing more environmentally sensitive plans. Considering environmental factors in system planning requires a comprehensive examination of not only planning, but also of how an organization has structured its interaction with environmental resource agencies and other environmental stakeholders. The following 12 questions are intended to help transportation officials assess the level to which their agencies are integrating environmental considerations into planning:

1. Has your agency included concern for the environment in its mission or vision statement? Have guidelines or standard operating procedures been developed to disseminate this vision throughout the agency?

2. Has transportation planning included environmental issues in the goals and objectives statement?
3. If your agency has defined a set of performance measures relating to system or agency performance, are environmental measures a part of this list?
4. Does your agency collect data on environmental conditions on a systematic basis? Are sufficient resources available for continuing such data collection?
5. Has your state or region developed an inventory of sensitive environmental resources? If so, is this inventory used for planning or project development purposes, in particular, in efforts to avoid or minimize environmental impacts caused by project implementation?
6. Does your state or metropolitan area's transportation planning provide sufficient information that can be used in a determination of "need and purpose" for subsequent project development?
7. Does your agency systematically consider environmental factors in the definition of alternatives? Is at least one of the alternatives designed to minimize environmental impacts to the extent possible?
8. Has your agency defined project alternatives that both provide transportation benefits and enhance environmental quality? Does your agency actively pursue such project alternatives?
9. Do the criteria used to evaluate alternatives include the range of environmental concerns that are of most interest to the community and to environmental stakeholders?
10. Does your state or metropolitan transportation plan explicitly consider environmental factors in its description of desired future investments?
11. Has your agency entered into partnership arrangements with environmental resource agencies and environmental stakeholders in order to develop common understandings of how environmental factors will be considered in system planning and project development?
12. Do your agency's public involvement and outreach efforts specifically target environmental quality and its relationship to transportation system performance as an issue brought to public attention?

Several important findings from this research are as follows:

- The scientific literature is increasingly identifying a **systems-level perspective** on environmental impact determination as being the most appropriate.
- States having **strong environmental laws**, not surprisingly, have undertaken more efforts to consider environmental factors in transportation systems planning.
- State and MPO officials expect to see more attention being given to the types of environmental impacts that are **best addressed at a systems level**.
- A small number of states and metropolitan areas have taken major steps in **integrating environmental factors into transportation systems planning**.
- The importance to decision making of including environmental factors in systems planning very much depends on the degree to which effects can be **defined at a level that allows an understanding of consequences.**
- The availability of **powerful database management capabilities** has spurred more intensive efforts to identify sensitive environmental resources.
- The concept of assessing the level of environmental sensitivity of habitats, ecosystems, and watersheds has been used by several planning and transportation agencies as a **starting point for more comprehensive community planning**.

- Some planning efforts are defining **transportation plan alternatives** that focus on minimizing environmental impacts.
- Successful consideration of environmental factors in system planning will require **substantive public involvement and participation of environmental stakeholders**.
- By conducting environmental assessments earlier in systems planning, **project development has been made more effective**.
- State DOTs are implementing other changes to agency operations to **expedite projects through project development**.
- A **context-sensitive solutions (CSS) approach** to project development is viewed by DOTs and MPOs as a "win–win" situation.

INSTITUTIONAL STRATEGIES TO IMPLEMENT CHANGE

Each of the successful efforts identified in this research of incorporating environmental factors into the policy, planning, or project development activities of a transportation agency was implemented with deliberation and consideration of how such a change could be best carried out in the organization. Although each of the case studies presented different aspects of incorporating environmental factors into organizational procedures or agency culture, the strategies usually had many common characteristics. These characteristics include the following:

- *Top Management Support*—Every example of successfully incorporating environmental considerations into systems planning examined in this research had either an elected official or a top agency official as its champion. Whether enabling the interagency partnerships that are often critical in such a process and/or changing organizational structures or mindsets, support is needed from top managers in the agency.
- *Organizational Assessment*—A realistic assessment of an organization's capabilities in implementing a new approach toward planning and project development is often a prerequisite for organizational change. Such an assessment would examine not only organizational structure and interagency relationships, but also whether the right mix of personnel skills are available in the agency.
- *Internal Implementation Strategies*—Implementing a new process or design approach requires careful thought on how change will be implemented. Examples from this research range from establishing an agency task force with responsibilities to recommend action, to the creation of a new high-level management position with responsibility for the "environment."
- *Institutionalize Change in Standard Procedures*—Institutionalizing change within organizations usually requires a careful assessment of what motivates the individuals providing the service or producing the product. Within transportation agencies, this usually means understanding the standard operating procedures that guide agency action. Many of the state DOT efforts highlighted in this research institutionalized their activities by changing the standard operating procedures for both planning and design.
- *Resources*—The obstacle most cited by DOT and MPO officials as hindering the incorporation of environmental factors into transportation planning was "competing objectives that detract from environmental considerations." In one sense, this could be interpreted as a resource allocation problem. The case studies illustrated the level of support that was deemed necessary to assure success. In New York, the DOT hired environmental managers for every district in the state to act as cat-

alysts for the Environmental Initiative. In Minnesota, the DOT dedicated full-time staff to the effort of changing the organization's internal procedures. In Florida, millions of dollars have been spent on the environmental screening tool that serves as the foundation of the efficient transportation decision-making (ETDM) process. All of these efforts were critical to the success of the initiatives in each agency.

- *External Implementation Strategies*—Much of the success in considering environmental factors in systems planning relies on establishing agreements with environmental resource agencies that articulate the respective roles of each participant in planning and project development. The usual means of doing this is through memoranda of understanding. The more complex planning efforts highlighted in this research (i.e., those for the Lake Tahoe Region; Pima County, Arizona; and Riverside County, California) involved a large number of agencies, numerous environmental groups, and extensive public participation. The success of these efforts was in part as much due to managing the process as it was in technical analysis.
- *Defining Benefit*—Changing organizational procedures and approaches to transportation planning and project development could require significant changes in the attitudes and mindsets of agency staff. Convincing environmental resource agencies to change their standard procedures and approaches similarly require such changes. The case studies indicated that one of the necessary first steps in bringing about such change is clearly articulating what benefits will occur when a new approach is adopted.
- *Partnership Benefits*—Environmental resource agencies often hesitate to participate in a process where environmental factors are considered early in system planning. This hesitation is primarily caused by a concern that such early participation could be construed as approval of a project long before some of the specific effects are known. State transportation agencies that have successfully formed partnerships with their respective resource agencies have done so by promising to consider seriously the likely effect of transportation projects on the environmental factor at issue, and often supporting environmental staff review.

FUTURE RESEARCH

In many ways, this research project suggests a rethinking of how systems planning is conducted in the United States. At the very least, it suggests a different mindset among most transportation planners and engineers of how environmental factors should be considered during planning. This research project also focuses attention on the types of environmental issues that will likely be faced in the future, and thus the types of expertise that will be necessary if these issues are to be dealt with in a serious way. The following proposed research topics are designed to get the transportation profession to this point:

- *Understanding the systems effects of ecosystems, human development, and transportation investment*—Scientists have been focusing on ecosystem health for many decades and are just now beginning to understand many of the complexities that characterize ecosystem health. Some attention has been given to the negative effects of human activity on ecosystems, although most of this research has been at the macro level (e.g., number of wetlands and wetland functionality lost). Very little attention has been given to the relationship between ecosystem health and transportation investment. Such research would examine the basic science

involved with this relationship and develop methods and tools that can be used to investigate ways of reducing the influence of transportation-induced disruptions. This research would have to be truly multi-disciplinary to bring the scientists knowledgeable about ecosystems together with engineers and planners who understand the construction and operational characteristics of transportation system performance.

- *Understanding the political, social, and land-use contexts for transportation planning, and how they influence the opportunities for, and constraints on, considering environmental factors during systems planning*—This research has identified several cases where initial steps have been taken to integrate community planning, infrastructure provision, and environmental assessment. In many cases, these planning activities have evolved in separate institutional constructs, and it is only through the intervention of community activists, political leadership, or legislative mandate that such integration has been attempted. Research is needed to better understand the different social and political contexts that foster such coordinated planning, as well as those that serve as a hindrance.
- *Developing tools for integrated environmental/transportation systems planning*—Although the survey of MPO officials indicated that the inadequacy of analysis tools for addressing environmental problems at the systems level was not considered a serious constraint, it is likely that these officials did not have the integrated concept proposed in this research in mind. It is very clear from this research that one of the prerequisites for getting mutually beneficial systems planning participation from the environmental and transportation communities is to have an analysis capability that provides important indications of potential problems. This was shown in Florida to be one of the key determinants for environmental resource agency participation. Although GIS capabilities are important points of departure for identifying sensitive environmental areas, additional analysis tools and methods are needed to develop a level of comfort at the systems level that the decisions being made are done so with good information.
- *Investigating the use of monitoring and surveillance technologies*—The sensitivity of ecosystem health to disruption is often so fragile that minor changes in conditions can have significant negative effects. If environmental quality is an important planning concern, then systems planning should include the continuous monitoring of the environmental health of the state or region. This could entail the use of satellite imagery, environmental sensors, biological indicators, and community quality-of-life measures. Minnesota DOT's movement toward environmental indicators as part of its family of performance measures is indicative of the types of direction that DOTs and MPOs might take.
- *Developing environmental resource protection/conservation plans*—Such plans are not new to environmental professionals, but they are new to transportation officials. This research project would examine the process used to develop these types of plans and answer questions such as the following: What are the goals of such studies? Who is involved? What are the typical results? What have been the factors of success and failure? What are the data needs? How do the results relate to transportation systems planning? Given the principles of ecosystem management that have come to the fore in environmental policy, the transportation community needs to know more about what these types of studies mean to transportation systems planning.
- *Developing performance measures to track progress toward environmental goals*—Various experiences with sustainable transportation planning (both in this country and internationally) suggest that performance measurement and public

reporting are critical components of demonstrating agency accountability and credible progress toward environmental goals. While a comprehensive set of performance measures and indicators may not have been identified by any particular agency, several agencies—including Oregon DOT, Washington State DOT, Pennsylvania DOT, and Eugene, Oregon's Lane Council of Governments—have undertaken programmatic initiatives on performance measurement and reporting. This research will examine the links between environmental goals/objectives and measures/indicators of performance, appropriate scopes of measures for tracking how well agencies are achieving predefined goals, the need for a dynamic set of measures to reflect changing emphases on various environmental issues, and best practices of performance measurement for considering the environment in transportation planning.

- *Assessing organizational strategies for environmental stewardship*—Except for New York State DOT, there are very few examples where transportation agencies have examined all of their activities from the point of view of environmental stewardship. This research project would develop guidelines on how an organization could conduct such an analysis (different for the ISO 14001 approach). All of the organizational activities would be examined and strategies developed to foster increased consideration of environmental factors in all aspects of an agency's daily functions.

CHAPTER 1

INTRODUCTION AND RESEARCH APPROACH

INTRODUCTION

Understanding the environmental consequences of transportation investment decisions has been a concern of transportation decision-makers for many decades. Although before 1970 many transportation plans performed a cursory examination of the likely community and environmental impacts of proposed system investment, it was not until the 1969 National Environmental Policy Act (NEPA) and its application to all types of federally funded projects that environmental analysis and assessment became an important component of transportation planning and project development. Initially, the major effect of NEPA occurred in project development where environmental assessments or environmental impact statements were conducted to determine the significance of potential environmental impacts and to identify strategies to mitigate these effects. In response to a growing societal awareness of environmental quality and numerous federal and state laws concerning the consideration of various environmental impacts, state and metropolitan transportation plans began to include "environmental impact" as an important part of evaluation. Other studies, such as alternatives analysis, major investment studies, and corridor studies, also examined the probable environmental impacts of proposed transportation alternatives. However, identifying project-specific environmental problems or so-called "fatal flaws" usually did not occur until a project had entered project development, usually many years after the project had first been considered.

National experience has shown that waiting until the project development stage of transportation decision-making to deal with environmental issues that might have been resolved earlier (for example, during systems planning) can result in significant delays in project completion. In addition, identifying, defining, and prioritizing projects that occur in transportation planning and programming might have had different (and better) results if more information on likely effects had been available earlier. An important question thus becomes, is there some way of considering environmental issues earlier in systems planning that will help to reduce project development time later on and lead to better projects?

This report presents an approach for integrating environmental factors in systems-level transportation decision-making, at the state, regional, and metropolitan levels. The approach was based on a comprehensive assessment of state- and metropolitan-level practices for addressing the environment in transportation planning. To facilitate the implementation of research findings, the approach is compatible with existing planning techniques, procedures, and institutional arrangements. However, the approach is flexible enough to take advantage of changes in planning regulations, institutional relationships, and emerging technologies that will help make transportation agencies better stewards of the environment.

RESEARCH OBJECTIVE AND APPROACH

The objective of this research was to develop an approach, including procedures and methods, for integrating environmental factors in transportation systems planning and decision making at the statewide, regional, and metropolitan levels. The research consisted of the following tasks:

1. A review of recent and ongoing research and literature concerning the consideration of environmental factors in transportation and other infrastructure systems planning, highlighting innovative procedures and methods and reporting on their effectiveness in improving transportation decision-making.
2. A survey of procedures and methods used in state DOTs, metropolitan planning organizations (MPOs) and environmental regulatory agencies, for consideration of environmental implications of systems-level plans and decisions.
3. A review of federal and state policies, regulations, and guidelines that can be expected to affect the consideration of environmental factors in transportation systems planning and decision making.
4. A set of case studies that synthesize current, successful state and metropolitan planning, including procedures, methods, and institutional arrangements for integrating environmental concerns into transportation planning.
5. The development of planning that provides a broadly applicable framework for assessing, evaluating, and integrating environmental concerns within transportation systems plans and decisions.
6. A demonstration of how environmental stewardship can be incorporated throughout transportation planning.

Several important concepts serve as the foundation for the research plan that guided this project. These concepts merit attention here because they provide the basis for the specific tasks and the corresponding research approaches undertaken during the research.

The trend in environmental assessment in most fields has been toward a broader "systems" perspective. Although this research project is one of the first to examine a systems-level consideration of environmental factors in transportation, others have examined the concept of taking a systems perspective on the interaction between the natural and built environment. In many ways, the concepts of sustainable development and sustainable cities (discussed in Chapter 2) reflect the idea of considering environmental factors earlier in planning and decision-making. The important connection between the ecosystem and human activity has been recognized for a long time by biologists and ecologists and has found its way into professional practice in many environmental disciplines, and there is much the transportation profession can learn by looking at these other disciplines.

The definition of affected areas within individual environmental impact categories and, therefore, the boundaries of analysis, have been broadening. Some environmental impacts have been viewed from a systems, or regional, perspective. A good example of this is air quality, which has received considerable attention with regard to the regional application of processes and tools. Other impact categories have been evolving along similar lines. Water quality and water resource planning, for example, have been expanding the boundaries of analysis to include entire watersheds. Wildlife and natural habitat analysis now encompasses entire ecosystems. Environmental justice considerations are being viewed as more than neighborhood-specific effects; programmatic effects on entire populations are part of the analysis. Therefore, effective environmental assessment of specific environmental impacts requires a much broader analysis perspective, and a strong linkage to systems-level planning.

Consideration of environmental factors in transportation systems planning must be more than a glorified "fatal flaw" analysis. Historically, environmental factors have been incorporated into planning and project development decisions as potential problems that need to be identified and mitigated. This is primarily because of the engineering approach of reducing the scale of analysis to such a level that the "environment" was simply a consequence of facility development. The real challenge, and one that is likely to characterize infrastructure decision-making even more in the future, is to consider how the environment can be enhanced by infrastructure decisions, rather than how we mitigate negative environmental impacts. How do we build with the natural environment instead of through it? How do we make sure infrastructure investments improve the quality of life of all groups of society? Driven by such a concept, transportation agencies become stewards of environmental resources, and engineering decisions become an important means of enhancing the environment.

Transportation systems planning is an important input into the investment and operations decisions that strongly influence transportation system performance. Linking environmental considerations to transportation systems depends on determining what is transportation systems planning. Systems planning consists of many steps, all of which can be viewed as potential opportunities for integrating environmental considerations. As will be discussed later in this report, systems planning ranges from the initial definition of a community vision to the actual monitoring of the performance of the projects that have been implemented. The view adopted in this research is that the primary purpose of systems planning is to provide the information necessary and needed by decision makers to make choices about investment in the transportation system. This information not only relates to expected changes in transportation system performance resulting from that investment, but also to other types of expected effects on the natural and built environment. In a society increasingly sensitive to environmental quality and community quality of life, this information must include an understanding of environmental consequences.

Some aspects of current environmental analysis should be moved earlier into the planning process. Much of the experience with connecting (rather than integrating) environmental analysis and transportation planning has led to repetition and seeming redundancies in the process. System plans that considered environmental issues were followed by corridor studies that considered the same issues. Eventual project-level analyses also considered these same issues, because they were required to do so by regulation. In many cases, this redundancy was appropriate because of the need to analyze environmental impacts at different scales of analysis. At other times, however, the repetition seemed unnecessary. A possible example of this is the determination of "purpose and need" for environmental analyses. This step could be undertaken at the systems planning level and carried through the entire process (with appropriate safeguards to make sure that such determination remains valid over the lifetime of the systems plan). This research project looked for similar opportunities where integration, rather than simple connection, could occur.

Advances and enhancements in the technology of analysis and planning have made the consideration of environmental factors earlier in systems planning more feasible and the results easier to understand. The decade of greatest environmental awareness and community activism was arguably the 1970s. Following the passage of NEPA in 1969, numerous government agencies and universities set about developing the methods and tools that would be used to analyze and evaluate the environmental impacts of infrastructure development. Because the focus of NEPA was on specific projects, many of these methods were developed for application at the micro scale, where clear connections and relationships

between a transportation project and its surrounding environs could be established. Very little effort was made to examine a much broader application of environmental analysis to a region or a substantial portion of a region, except in the case of air quality analysis where it was obvious that a valid examination of the problem required a scale of analysis at least at the level of an air basin (except for carbon monoxide). Two major problems led to such a limited experience with methods and tools applied at this level of analysis. First, the science was not yet fully developed for many environmental topics that could direct the development of valid models or techniques. Second, power of the computer, although developing rapidly, had not yet reached a level where reasonably priced and timed analyses of regionwide effects could be conducted. In both cases, significant advancements have been made. In particular, the level of sophistication of analysis tools has been increased dramatically with the introduction of geographic information systems (GIS), monitoring of changing environmental characteristics through satellite imagery and global positioning systems (GPS), and creation of powerful new simulation models that can replicate the physical phenomena associated with changing physical conditions.

The evolution of agency relationships and the resulting organizational mindsets have created significant institutional barriers to promoting a closer integration of environmental factors and transportation planning. In most cases, concern for environmental quality rests with agencies and organizations whose major mission is to minimize harm to the natural and built environment. The history of transportation and environmental agency interaction in project development efforts has often included strong conflict over the intent and substance of environmental regulations. Even within state transportation agencies, environmental units are often at odds with the more traditional highway engineering groups with respect to the level of consideration that should be given to environmental factors in project development. Any effort to better link environmental factors to system planning probably will have to consider how institutional barriers to such an effort can be surmounted.

ORGANIZATION OF THE REPORT

The remainder of this report is organized as follows. Chapter 2 discusses the evolutionary context and key characteristics of environmental stewardship in transportation planning. This was achieved by examining important bodies of literature, identifying ongoing research on similar topics, and reviewing federal and state legislation, policies, and regulations as they relate to how environmental considerations have been or should be considered in systems planning. Special attention was given to literature created outside the United States, especially from Europe, where incorporating environmental considerations earlier in decision making has been developed to a much greater extent than in the United States. Appendix A presents guidelines on environmental assessments undertaken in Europe. Appendix B lists many of the state laws and policies that influence how transportation agencies approach environmental assessment. Both Appendix A and B are contained in *NCHRP Web-Only Document 77.*

Chapter 2 also reports on the results of a national survey of state DOTs, MPOs, and state environmental agencies. This survey was an important point of departure for this research because it provided a snapshot in time of how states and metropolitan areas are viewing environmental factors in the context of transportation systems planning. In addition, the results of the survey were used to identify potential case studies of where the linkage between the environment and transportation investment was considered effectively in systems planning. The survey instruments used for this research are found in Appendix C, contained in *NCHRP Web-Only Document 77.*

Chapter 3 discusses how environmental factors can be integrated more deeply throughout transportation systems planning and project development. In particular, this chapter suggests where such factors can be considered early in the process and highlights case study strategies for doing so. Because systems planning is defined very differently for state-level transportation planning versus metropolitan-level planning, the chapter presents the research results targeted at both implementation environments. Case studies of both state and metropolitan transportation planning and decision making are used to illustrate how current best practice integrates environmental considerations into transportation systems planning.

Chapter 4 discusses emerging analysis methods and tools for integrating environmental considerations into transportation systems planning. This chapter takes advantage of concurrent NCHRP research that looked at different tools and techniques for environmental analysis, as well as reports on the activities of states and MPOs developing their own tools. As might be expected, the tools and methods appropriate for different parts of systems planning very much relate to data availability, agency modeling expertise, the importance of a particular environmental issue to the decision makers in a particular agency, and the level of guidance provided by federal agencies or through professional organizations.

Chapter 5 synthesizes the research results and presents overall conclusions. The institutional strategies used to foster change in transportation agencies are emphasized. This final chapter also identifies future research directions.

CHAPTER 2

CONTEXT AND CURRENT STATE OF THE PRACTICE

INTRODUCTION

The past 30 years have been an important era in environmental policy. Federal and state laws passed during this time provide a more serious and comprehensive consideration of environmental factors in decisions that would clearly affect the environment. Advances in science and technology have allowed us to understand the often tenuous relationship between the natural and built environments. Science and technology also showed great promise in helping reduce the negative environmental impacts of human activity, the best transportation example likely being the improvements in motor vehicle engine technology that have continually lowered the tailpipe emissions of new automobiles over time. However, even as such progress is being made, scientists warn about the significance of the continuing loss of habitat, of diversity in these habitats, a declining availability and quality of water, the increasing human consumption of non-renewable natural resources, and the loss of "community" associated with modern urban form.

Chapter 2 provides a context for the research results presented in the remaining portions of this report. This research project reviewed many different bodies of literature associated with linking environmental considerations and transportation planning. This literature is summarized in the first section of this chapter. In particular, the research team wanted to obtain a better idea of how other countries are approaching transportation and environmental planning. Special attention was given to the European Union, which has taken more active steps than the United States in fostering a closer linkage between transportation and environmental planning. Appendix A, available as NCHRP Web-Only Document 77, provides extensive coverage of the European Union approach toward environmental assessment.

The legislative and regulatory requirements for better linking environmental considerations and transportation planning and decision making are an important starting point for any discussion of what needs to be done and why. The second section of this chapter discusses laws, policies and regulations that provide a legislative framework for environmental stewardship in transportation planning. Appendix B, available as NCHRP Web-Only Document 77, provides an extensive list of state laws that refer to some link between transportation and environmental analysis.

Finally, an important beginning point for any research is an understanding of the current state of the practice. This research conducted a national survey of state DOTs, metropolitan planning organizations (MPOs), and state environmental agencies to determine both what is being done to consider environmental factors in transportation systems planning and to obtain from transportation and environmental professionals what they think the key issues will be in the future. The third section of this chapter reports on the results of these surveys.

LITERATURE REVIEW

Many bodies of literature are important to this research. A web-based and library search of the literature was conducted. The material most relevant to this research is described in this section. The literature search was divided into four major areas—the environment perspective (which includes contributions from biology, ecology, and sustainability), context-sensitive solutions, transportation planning, and international practice in environmentally oriented planning and decision making. The environmental perspective was included in this literature review because it was considered difficult to understand how environmental factors could be better integrated into systems planning without understanding how the environment should be defined. Thus, those concepts of environmental science that are most conducive to being considered in systems planning (e.g., the systems-level approach toward ecosystems) were highlighted in the literature search.

In addition, although a context-sensitive solution (also referred to as context-sensitive design) is more appropriately considered as a project development effort and not one normally associated with systems planning, many of the characteristics of this approach to project design were considered important for the concepts being examined in this research. Thus, both the literature search, as well as information gathered from case studies, included experience with context-sensitive design.

Environmental Perspective: Biology, Ecology, and Sustainability

The environmental literature is full of articles and books that present varying perspectives on the importance of the environment to society. The literature ranges from biology

(*1*), which focuses on the important relationship between ecosystems and the built environment, to public health (*2, 3*), which examines the risks to public health caused by human intrusion into the natural environment. The common theme throughout much of this literature is that nature, society, and technology are related in many complex and interconnected ways. As noted by Knox and Marston (*4*), "humans are not separate from nature, but are an integral part of it."

Two key ideas emerging from this literature are that the physical environment should be considered as an ecosystem, and that ecosystems have a carrying capacity that determines their ability to sustain life. These concepts are important in that they orient environmental planning to the systemic level, where larger environmental impacts are felt. Thus, the connections and interrelationships between transportation systems and natural ecological systems could be important in transportation systems planning interested in likely environmental impacts. This perspective necessarily focuses attention on what characterizes an ecological system.

An ecosystem can be defined as an area where living organisms interact with each other and with the nonliving (or abiotic) components of their environment. The interdependence among the many different components of an ecosystem is of particular interest in that disruption of this interdependence (for example, by removing or reducing wetlands) could have an important effect on the viability of the entire ecosystem. Much of the literature on ecosystems focuses on the effect of human action on the functioning of ecosystems as well as with the connection between ecosystems and broader environmental health concerns (*5*). The reader is referred to several authors for excellent overviews of the evolving study of ecosystems (see, for example, *6–8*).

The concept of carrying capacity is linked very closely to the viability of ecosystems. The carrying capacity of an ecosystem reflects the ability of an ecosystem to be "disturbed" while still carrying out its basic natural functions. As noted by White (*9*), the "ecological footprint" of a city is based on "the pattern of consumption, aggregated into a single measure of the land required to support various activities, such as food and transport requirements, energy use, landfill requirements, and so on." Perhaps the best example of this literature is found in Wilson (*10*), which states that "the appropriation of productive land—the ecological footprint—is already too large for the planet to sustain, and it's growing larger." At the global scale, studies of what it takes to support the economic functioning of developed countries have concluded that "we need more than three 'planet Earths' to support the current world population at a level of consumption typically found in rich countries." (*11*)

Figure 1 illustrates the relationship between human activity and ecosystem stability. This figure shows the changing characteristics of vegetation in Aiken, South Carolina, as the city "footprint" expanded over the past 100 years. The change from primarily pine savanna to mixed pine hardwoods in the area surrounding the city is explained mostly by the increasing levels of impervious surface in the region, thus increasing runoff (*12*). This changing dynamic also suggests that considering environmental factors in transportation systems planning necessarily must examine the secondary and indirect effects of such investment on development patterns and magnitudes, and thus eventually on the natural environment.

One of the most important themes in the growing literature on urban environments is the concept of the city as an ecosystem (see, for example, *13*). As noted by Tjallingii (*14*) and expanded upon in Newman and Kenworthy (*15*), "the city is conceived as a dynamic and complex ecosystem. This is not a metaphor, but a concept of a real city. The social, economic, and cultural systems cannot escape the rules of abiotic and biotic nature." Based on this concept, policy and planning principles can be developed to guide both governmental and individual decisions relating to community development and urban design. Basic to this approach, however, is the idea that environmental and community concerns need to be considered early in community development decision-making.

The concept of sustainability also is an important part of the environmental literature and has been adopted as a design concept in fields such as architecture (*16, 17*), city planning (*18–20*), and manufacturing (*21, 22*). Sustainable development is now a stated policy objective for many nations (*23*). Sustainability or sustainable development has many meanings. Perhaps the most appropriate definition for this research project comes from Roseland (*24*) in which sustainable development is defined as the "economic and social change to improve human well-being while reducing the need for environmental protection." Inherent in this definition is a proactive approach to progress that considers environmental impacts and social equity issues very early in community decision-making.

In the last decade, several existing organizations have had their responsibilities expanded and several new organizations have been created to address issues of sustainable development. In the United States, such agencies included the Environmental Protection Agency, which took on new responsibilities and the Department of Energy, which created the Center for Excellence for Sustainable Development. In addition, some states have adopted or are considering policies to promote sustainability in transportation planning and project development. For example, the Maine Sensible Transportation Policy Act of 1992 ensured that transportation decisions, including the commitment of funding, were to be made based on a transportation policy founded on sustainable principles.

Table 1 shows some of the important principles or precepts that several authors have identified as essential to sustainability. Note that many of these principles are likely to be important to the concept being examined in this research. For

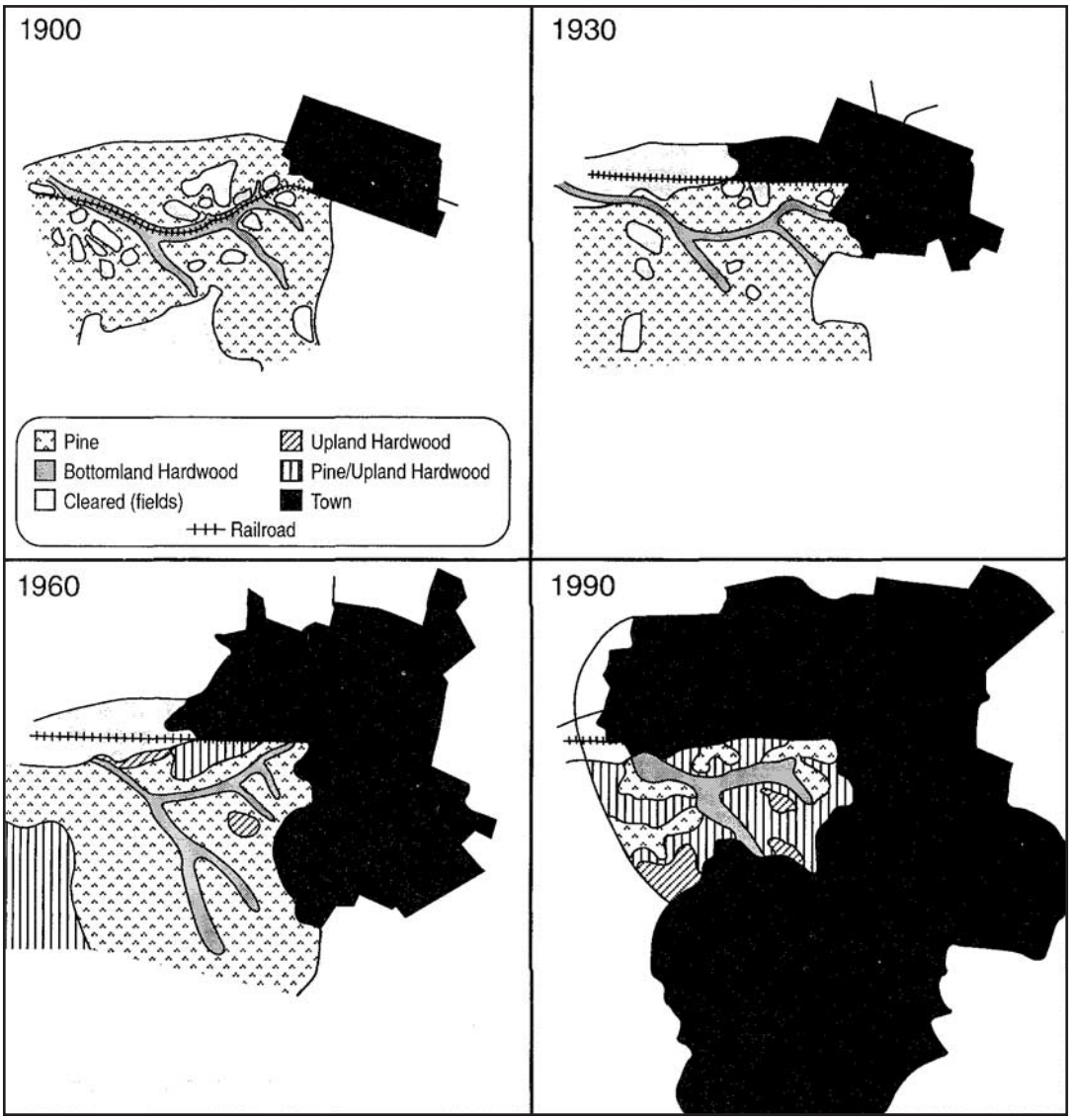


Figure 1. Impact of urbanization on an urban ecology, Aiken, SC.
Source: Wilds and White, 2001 (*12*).

example, those particularly relevant include (1) defining and avoiding environmentally sensitive areas, (2) using system design and management to balance societal needs and those of the natural environment, (3) designing with nature, (4) using investment to enhance ecological health not just to avoid further damage, and (5) relying on interdisciplinary skills to address fully the wide range of issues.

Context-Sensitive Design/Solutions

Engineers have been considering environmental impacts in project development for many years. As noted in Schulze (*27*), "engineering designs are now expected to result in products or management plans whose use or implementation will not endanger important ecological conditions and processes." However, only recently has serious examination been given to how nature and society can be improved through design and engineering (see, for example, *28*).

Better integration of environmental and community considerations into transportation engineering design is not new. In fact, some of the earliest professional manuals on urban highway design stressed the importance of such considerations when designing and constructing a highway in an urban environment. In practice, though, such guidance was considered secondary to the primary function of the road—providing fast

TABLE 1 Important principles for sustainability

From Eco-Cites to Living Machines, Principles of Ecological Design (*25*)	***Toward Sustainable Communities*** (*26*)	***Eco-City Dimensions, Healthy Communities, Healthy Planet*** (*24*)
• The living world is the matrix for all design. • Design should follow, not oppose the laws of life. • Biological equity must determine design. • Design must reflect bioregionality. • Projects should be based on renewable energy sources. • Design should be sustainable through the integration of living systems. • Design should be co-evolutionary with the natural world. • Building and design should help to heal the planet. • Design should follow ecology.	• Bring into harmony human and natural systems on a sustainable basis. • Balance long-term societal and natural system needs through system design and management. • Rediscover/emphasize resource conservation. • Halt diminution of biodiversity. • Embrace an eco-centric ethic. • Develop new mechanisms and institutions that balance the needs of human and natural systems. • Adopt regional planning based on sustainability principles.	• Base planning units on natural boundaries. • Design with nature. • Consider global and cumulative effects. • Encourage inter-jurisdictional decision making. • Ensure consultation and facilitate cooperation and partnering. • Initiate long-term monitoring, feedback, and adaptation of plans. • Adopt an interdisciplinary approach to information. • Adopt a precautionary but positive approach to development that aims not just to avoid further damage but also to reduce stresses and enhance the integrity of ecosystems and communities. • Ensure that land use planning integrates (rather than merely "balances") environmental, social, and economic objectives. • Link ecosystem planning with other aspects of democratic change, social learning, community building, and environmental enlightenment.

and reliable movement of vehicles. Increasingly, transportation professionals have been criticized for this perceived preference to accommodating the motor vehicle at the expense of other design goals. Many transportation agencies have been responding by closely reexamining their standard approaches to urban highway design, and by incorporating more flexibility into both the physical design of the road and the adjacent roadside.

One of the more important developments in transportation project development over the past 10 years has been the movement toward a transportation project design approach that is both environmentally sensitive and reflective of a community's desires. For example FHWA, AASHTO, the Bicycle Federation of America, the National Trust for Historic Preservation, and Scenic America produced a design guide in 1998 entitled *Flexibility in Highway Design* that encouraged highway designers to consider environmental and community concerns early in project development (*29*). The movement toward more environmental and community-sensitive project development was known originally as context-sensitive design (CSD), although the term now generally accepted for this approach to project development is context sensitive solutions (CSS).

Context-sensitive solutions can be defined as when a transportation project is developed from the very beginning collaboratively with many different stakeholders, each of whom has a different perspective on what the project should be and how it might affect the surrounding natural and community environment. As noted in a recent NCHRP report, "CSD recognizes that a highway or road itself, by the way it is integrated within the community, can have far-reaching effects (positive and negative) beyond its traffic or transportation function. The term CSD refers to as much an approach as it does to an actual outcome" (*30*).

One of the seminal events in CSD/CSS as it has evolved in the transportation field occurred in 1998 when the Maryland State Highway Administration sponsored a national workshop entitled, *Thinking Beyond the Pavement*, which promoted a nontraditional approach to highway design (*31*). The participant-defined vision for this new design included the qualities outlined below (as reported in *30*).

A vision for excellence in transportation design includes the following qualities:

- The project satisfies the purpose and needs as agreed to by a full range of stakeholders. This agreement is forged in the earliest phase of the project and amended as warranted as the project develops.

- The project is a safe facility both for the user and the community.
- The project is in harmony with the community and preserves environmental, scenic, aesthetic, historic, and natural resource values of the area.
- The project exceeds the expectations of both designers and stakeholders and achieves a level of excellence in people's minds.
- The project involves efficient and effective use of resources (time, budget, community) of all involved parties.
- The project is designed and built with minimal disruption to the community.
- The project is seen as having added lasting value to the community.

A vision of the process that would yield excellence includes the following characteristics:

- Communicate with all stakeholders in a manner that is open, honest, early, and continuous.
- Tailor highway development to the circumstances. Employ a process that examines multiple alternatives and that will result in consensus on approaches.
- Establish a multi-disciplinary team early, with disciplines based on the needs of the specific project, and include the public.
- Seek to understand the landscape, the community, and valued resources before beginning engineering design.
- Involve a full range of stakeholders with transportation officials in the scoping phase. Clearly define the purposes of the project and forge consensus on the scope before proceeding.
- Tailor public involvement to the project. Include informal meetings.
- Use a full range of tools for communication about project alternatives (e.g., visualization).
- Secure commitment to the process from top agency officials and local leaders.

As seen in this vision statement, early consideration of environmental issues, problem definitions, and identification of environmentally sensitive alternatives are basic points of departure for CSS. Involving individuals representing a range of disciplinary skills and including substantive public involvement throughout the process are also key characteristics of a CSS process. As noted in *NCHRP Report 480: A Guide to Best Practices for Achieving Context-Sensitive Solutions,* "CSD/CSS means involving social, economic, and environmental considerations as a meaningful part of the solutions-generating process, not as additional or after-the-fact steps." A process for considering environmental issues during transportation systems planning probably will have very similar characteristics.

Transportation Planning and the Environment

A recent TRB study, whose purpose was to define a transportation-environmental strategic research program, identified six areas of needed research (*32*). These areas included: human health, ecology and natural systems, environmental and social justice, emerging technologies, land use, and planning and performance measures. As noted in that section of the report devoted to planning, "the methods and tools used by engineering and environmental professionals for integrating environmental considerations into various aspects of transportation decision-making are quite rudimentary, having originated in the major highway construction era of the 1950s and 1960s."

In fact, the strong relationship between the construction and operation of the transportation system and the resulting effects on the natural environment have led to various approaches for considering environmental issues in transportation planning. One of the first major research efforts on this topic, sponsored by the National Cooperative Highway Research Program, culminated in NCHRP Report 156, *Transportation Decision-Making, A Guide to Social and Environmental Considerations* (*33*). The three major findings of this research were that

1. The overall process through which social, economic, and environmental considerations are brought into transportation planning and decision-making is as important as the particular techniques used for predicting effects.
2. Issues of social equity must be explicitly recognized and taken into account in transportation decision-making.
3. Different groups of people can be expected to have different interests and different priorities.

This report was one of the first to note the "disconnect" between the level of data analysis and impact prediction that occurred during project development and that which was undertaken during system planning. This was primarily due to the longer time horizon for transportation systems planning (and, therefore, the greater uncertainty associated with the predictions of effects), the spatial nature of the types of effects that are often spread over large expanses of a metropolitan area, the complex analysis challenge of determining system effects that can occur indirectly over time or geography, and the localized characteristics of some impact categories (such as noise) that might not be available when systems planning occurs.

Although many articles and books have developed "new" approaches to transportation systems planning, very few have specifically examined the role that environmental considerations should play in this process, other than as part of evaluation. European literature, which will be examined in more detail in the following section, has devoted more atten-

tion to this issue (see, for example, *34, 35*). But even in this literature, the primary attention given to environmental factors is a discourse of how transportation systems affect the natural and built environment, with a recommendation that such issues should be more closely linked. Very little attention has been given to how such links should occur and what techniques could be used in analysis and evaluation.

One of the most recent books on transportation systems planning begins the process of thinking about how such connections should be accomplished (*36*). This book views transportation as one system that relates to, and is part of, many other systems. This perspective leads to important planning questions reflecting the interaction among transportation and other systems that help an urban area function, as well as between transportation and higher-level systems, such as ecological or economic systems. In particular, transportation system effects on the ecosystem are highlighted as an important emerging issue in transportation planning. The links between the construction, operation, and maintenance of transportation facilities and the natural environment must often be considered from the broader perspective of the spatial and temporal links that characterize such processes.

This book also examines the difference between what was referred to as a "traditional planning process" and a process that is concerned with sustainability. Table 2 shows the key differences between the two. Some of the key differences that are relevant to this research are the importance of ecology and systems theory for understanding the scale of effects; the focus of technical analysis on the relationship between the transportation system and ecosystems, land use, economic development, and social health; the use of societal costs to assess the value of environmental assets that are degraded or lost due to system development; and the importance of issues relating to biodiversity and economic development.

As noted by the authors, the characteristics of planning oriented toward sustainable development clearly will evolve to reflect new understandings of the relationships between the human and natural environments. However, the planning characteristics shown in Table 2 are significant because those who practice a more traditional approach to transportation planning have a very different mindset than those interested in viewing transportation planning more broadly. The basic scientific foundation for the two approaches is different, thus leading to the use of tools and techniques for analyzing environmental impacts that vary significantly. The types of strategies that result from both planning processes and the type of information that is produced to inform such decisions will also be very different.

The challenge for a future characterized by increasing environmental challenges could very well be in building a bridge between traditional planning, as practiced by almost every transportation agency in the United States, to planning that more seriously considers environmental impact.

International Practice

The consideration of environmental factors has been a common characteristic of much infrastructure planning in other countries. In particular, the concepts of strategic environmental assessment (SEA), sustainable transportation planning, and environmental management systems are important approaches that relate environmental factors to systems-level planning for transportation and other civil infrastructure.

Strategic Environmental Assessment (SEA)—SEA is considering potential environmental effects early in the strategic investment decision-making process. Strategic, rather than project-level, decisions are those that concern policies, plans, and programs. SEA is applied to earlier and higher levels of decision-making where opportunities to avoid and mitigate potential environmental impacts can have greater dividends in time saved and/or improved project characteristics.

Conducting environmental impact assessments at all decision-making levels (policy, plan/program, and project) began seriously in Europe in the 1970s. In 1973, the European Commission's (EC's) first environmental action program emphasized the importance of a comprehensive environmental assessment of all plans to prevent environmental damage. In 1996, after a long development period, the EC adopted the SEA proposal, *Proposal for the Assessment of the Effects of Certain Plans and Programs on the Environment*. The SEA proposal addressed the deficiencies in existing approaches for evaluating and documenting environmental impacts and established the minimum requirements for ensuring a proper environmental assessment at strategic decision-making levels (*37*). To date, SEAs have been performed for various sectors, such as transportation, other civil infrastructure, energy, and land use. These SEAs have been performed at various application levels, including regional, national, and international contexts. The European experience with SEA is arguably the most significant and advanced in the world, and thus can provide useful precedents, methodologies, and lessons learned to the United States. The Organization for Economic Co-operation and Development (OECD) guidelines for conducting an environmentally sustainable transportation study are shown in Table 3.

The practical experience with SEA, which has been growing steadily since the mid-1990s, can be found in most of the member states of the European Union (EU). SEA is already an official part of planning procedures within some countries, and is practiced even in the absence of legislation. A recent report by the EC, *Strategic Environmental Assessment in the Transport Sector: An Overview of Legislation and Practice in EU Member States* (*38*), provides a comprehensive assessment of current transportation-related SEAs in the European Union. A survey was conducted of two groups of countries, those that have legal requirements for SEA for transport policies, plans, and programs, and those that have

TABLE 2 Traditional transportation planning process compared to process oriented toward sustainable development

Characteristic	Traditional Process	Process Oriented toward Sustainable Development
Scale	• Regional and network level	• Local, state, national, and global perspective
Underlying "Science"	• Traffic flow theory • Network analysis • Travel behavior	• Ecology • Systems theory
Focus of Planning and Investment	• Accommodate travel demand • Promote economic development • Enhance system safety • Catch up to sprawl	• Efficient use/management of existing infrastructure • Provide transportation capacity where appropriate (from ecology perspective) • Redevelopment of development sites • Reduce demand for single-occupant vehicles • Reduce material consumption and throughput
Government Economic Policies	• Promote new development on new land • Focus economic policy on productivity • Do not include secondary and cumulative impacts in policy analysis	• Promote reuse and infill development • Fully integrate economic policy with environmental policy • Include secondary and cumulative impacts as part of policy decision analysis
Timeframe	• 15–20 years planning • 4–8 years for decision-maker interest (elections)	• Short (1–4 years) • Medium (4–12 years) • Long (12– --- years)
Focus of Technical Analysis	• Trip-making and system characteristics between origins and destinations • Air-quality conformity • Benefits defined in economic terms	• Relationships between transportation, ecosystem, land use, economic development, and community social health • Secondary and cumulative impacts
Role of Technology	• Promote individual mobility • Meet government-mandated performance thresholds to minimize negative impacts • Improve system operations	• Travel substitution and more options • Benign technology • Total life-cycle perspective to determine true costs • More efficient use of existing system
Land Use	• Considered as a given based on zoning that accommodates autos • Separated from transportation planning	• Integral part of solutions set for providing mobility and sustainable community development • Infrastructure funding tied to sound land use planning • Increased density and preservation of open space/natural resources
Pricing	• Subsidies to transportation users • True "costs" to society not reflected in price to travel	• Societal cost pricing including environmental cost accounting • Value, that is, transportation priced as utility
Types of Issues	• Congestion • Mobility and accessibility • Environmental impact at macroscale • Economic development • Little concern for secondary/cumulative impacts • Social equity (increasingly)	• Global warming and greenhouse gases • Biodiversity and economic development • Community quality of life • Energy consumption • Social equity
Types of Strategies	• System expansion/safety • Efficiency improvements • Traffic management • Demand management (from perspective of system operating more smoothly) • Intelligent transportation systems	• Maintenance of existing system • Traffic calming and urban design • Multimodal/intermodal • Transportation–land use integration • Demand management (from perspective of reducing demand)/nonmotorized transportation • Education

Source: Characteristics for process oriented toward sustainable development synthesized from Newman and Kenworthy, 1999 (*15*), Maser, 1997 (*19*), and Haq, 1997 (*35*).

TABLE 3 OECD environmentally sustainable transport (EST) guidelines

GUIDELINE	DESCRIPTION
Guideline 1.	Develop a long-term vision of a desirable transport future that is sustainable for environment and health and provides the benefits of mobility and access.
Guideline 2.	Assess long-term transportation trends, considering all aspects of transport, their health and environmental impacts, and the economic and social implications of continuing with business as usual.
Guideline 3.	Define health and environmental quality objectives based on health and environmental criteria, standards, and sustainability requirements.
Guideline 4.	Set quantified sector-specific targets derived from the environmental and health-quality objectives, and set target dates or milestones.
Guideline 5.	Identify strategies to achieve EST and combinations of measures to ensure technological enhancement and changes in transport activities.
Guideline 6.	Assess the social and economic implications of the vision, and ensure that they are consistent with social and economic sustainability.
Guideline 7.	Construct packages of measures and instruments for meeting the milestones and targets of EST. Highlight 'win–win' strategies incorporating, in particular, technology policy, infrastructure investment, pricing, transport demand and traffic management, improvement of public transport, and encouragement of walking and cycling; capturing synergies (e.g., those contributing to improved road safety), and avoiding counteracting effects among instruments.
Guideline 8.	Develop an implementation plan that involves well-phased application of packages of instruments capable of achieving EST taking into account local, regional, and national circumstances. Set a clear timetable and assign responsibilities for implementation. Assess whether proposed policies, plans, and programs contribute to or counteract EST in transport and associated sectors using tools such as Strategic Environmental Assessment (SEA).
Guideline 9.	Set provisions for monitoring implementation and for public reporting on the EST strategy; use consistent, well-defined sustainable transport indicators to communicate the results; ensure follow-up action to adapt the strategy according to inputs received and new scientific evidence.
Guideline 10.	Build broad support and cooperation for implementing EST; involve concerned parties, ensure their active support and commitment, and enable broad public participation; raise public awareness and provide education programs. Ensure that all actions are consistent with global responsibility for sustainable development.

Source: OECD, 2000 (*40*).

practical experience with SEA in the transport sector, but no legal requirements. The report found that the existence of legislation promotes consistency and greater influence in SEA application. In addition to the benefits of early detection and mitigation of environmental effects, SEA was found to provide a more efficient approach to both policy development and implementation. The report also identified some obstacles in the successful implementation of SEAs, such as lack of expertise and lack of institutional collaboration.

Another recent EC publication on transport SEAs is *Strategic Environmental Assessment of Transport Corridors: Lessons Learned Comparing the Methods of Five Member States* (*39*). This study analyzed five SEAs of multimodal transport corridors, and found that an SEA can be more effective if initiated at the earliest stages of planning. The report demonstrates that SEAs are feasible for transport corridor assessment, and that flexibility is important for adoption. It concludes that SEAs are vital in the effort to promote multimodal approaches and optimize the combination of infrastructure and noninfrastructure solutions.

From a legislative perspective, the EC has adopted COM 511 (*41*), the directive on the assessment of plans and programs on the environment. In 1999, this directive was further defined to extend existing, project-level environmental assessment approaches to the planning and programming level (*42*). The directive requires early consideration of environmental impacts in decision making, which, in essence, is SEA. The directive pertains to a range of public plans and programs in areas such as transport, energy, waste, water, industry, tourism, telecommunications, town and country planning, and land use. The EC's *Case Studies in Strategic Environmental Assessment* (*43*) provides an overview of the status of SEA legislation in the EU member states and includes three case studies in which SEA principles were integrated into existing decision-making procedures at the strategic level.

In broader work on SEA, a 2001 report by the EC (*44*) examines the benefits, challenges, and methods for integrating environment factors into decisions concerning plans, policies, and programs. A collection of SEAs is studied in Partidário and Clark (*45*), with a focus on the use of SEA to

promote sustainability. Therivel and Partidário (*46*) analyze the strengths and challenges of SEA, and detail case studies of SEA from around the world. Partidário (*47*) reviews practical approaches for SEA efforts and identifies key issues raised by practitioners. Therivel (*48*) examines several existing and then-emerging SEA systems in European countries.

Numerous guidebooks have been developed that outline the principles, processes, and methods that could be tailored to different applications (*49*). A large portion of SEA literature provides useful guiding principles and frameworks for the application of SEAs, along with specific methodologies. A report by the EC (*50*) provides detailed guidance and methods for SEA for transport infrastructure plans. This report examines principles and processes of SEA, such as levels of planning (network, corridor, and project), steps to conduct an SEA, and methods of impact assessment for the transport sector. An earlier publication by the EC (*51*) set out methods to incorporate environmental issues into the definition and preparation of regional plans and programming documents in the context of the EU's structural funds process.

The key factors identified for a successful SEA in all of these guidance materials include the following:

- Legislative Support—The most successful SEA generally occurs where there is a legal obligation requiring its performance.
- Transparency—SEA needs to be a clear process that allows environmental considerations to be highlighted.
- Early Consideration—Successful SEAs have been at the start, rather than the end, of a process of integration and may serve as a catalyst for developing further guidance and training.
- Alternative Options versus Option Alternatives—A successful SEA assesses the effects of alternative options rather than option alternatives.
- Public Participation—Widespread involvement of stakeholders, policymakers, and the wider public is crucial for a successful SEA.
- Open Communication—A successful SEA is an active, participatory, and educational process for all parties, in which stakeholders are able to influence the decision maker, and the decision maker is able to raise awareness of the strategic dimensions of the policy, plan, or program.
- Information Accessibility—A successful SEA involves the wide use and dissemination of baseline and assessment information.
- High-Quality Assessment—A successful SEA depends on high quality and rigorous application of assessment methodologies, whether qualitative, quantitative, or both.
- Systematic Process—An SEA needs to be a systematic process involving different institutions in a common reporting framework.
- Independent Review—An independent body that can review or audit the assessment process and content is needed to provide sufficient incentive to carry out an SEA and promote accountability.

The EU's experience with SEA points to the importance of legislation in elevating environmental consideration to the systems level of planning and the subsequent effect of the environment as a criterion in identifying and selecting plan alternatives. Guidelines for the application of SEA are included in Appendix A, which is contained in *NCHRP Web-Only Document 77*.

Sustainable Transportation Planning—Although sustainability was discussed in an earlier section, sustainable transportation planning has received such attention in the international literature that it is important to describe those aspects of the literature that relate to this topic.

The United Nations World Commission on Environment and Development defines sustainable development as "development that meets the needs of present without compromising the ability of future generations to meet their own needs." (*52*) A sustainable process or condition is one that can be maintained indefinitely without progressive diminution of valued qualities inside or outside the system in which the process operates or the condition prevails. (*53*)

A review of the international literature indicated that Canada, the Baltic Region, New Zealand, the City of San Francisco, and the UK are noted for their work to incorporate sustainability in long-range transportation planning. OECD and the World Bank also are noted for integrating sustainability and systems-level planning (*54*).

- In Canada, Transport Canada (as well as several other organizations, e.g., Environment Canada, National Round Table of the Environment and the Economy, Ontario Round Table on Environment and Economy, Transportation Association of Canada and Victoria Policy Institute) is involved in the development of performance measures for systems-level decision making. In response to a legislative requirement, Transport Canada outlined its Sustainable Development Strategy in 1997, setting the direction for integrating environmental concerns with safety and efficiency in developing policies and programs and carrying out its day-to-day operations (*55*). Two years later, Transport Canada adopted a Sustainable Development Action Plan (SDAP), which outlined eight sustainability challenges that articulate the agency's sustainable development goals. In partnership with other agencies and various stakeholders, Transport Canada is presently involved in developing performance measures, collecting data, and developing analysis tools to monitor and advance its progress toward sustainability (*56*).
- Baltic 21 is a multicountry process of regional cooperation and environmental improvement involving countries bordering the Baltic Sea. The effort focuses on seven sectors of crucial importance in the region:

agriculture, energy, fisheries, forestry, industry, tourism, and transportation. Sustainable transportation indicators have been developed as part of the monitoring effort toward meeting the objectives of sustainability set out in the Baltic 21 agreement. The proposed set of indicators is based on outcome-oriented indicators linked to specific goals.

- In June 1999, the New Zealand Ministry of the Environment published *Proposals for Indicators of the Environmental Effects of Transport*. The main purpose of the document was to provide the basis for agreement on the use of a core set of indicators to measure the environmental effects of transportation decisions. The proposal identified the following factors as major components of a framework for performance assessment: root causes of transport activity; indirect pressures; direct pressures, and state or effects indicators.
- The OECD has developed a framework of indicators for integrating environmental concerns into transportation policies. The OECD model has been adopted by most members of the European Union, and by some international organizations that deal with environmental information, as the most appropriate way to structure environmental information. Details on the OECD model are presented in the Appendix A, which is available as *NCHRP Web-Only Document 77*. Table 4 lists the sustainability indicators related to transportation policies.
- In 1996, the City of San Francisco developed a sustainability plan with transportation as one of 15 major elements given priority. The city identified seven major transportation and land-use goals and developed a set of four transportation indicators to monitor progress toward these goals. An extensive community consultation, which involved 400 volunteers, was used in developing

TABLE 4 OECD's framework of sustainability indicators

Environmentally Significant Trends by Sector	
1. *Overall Traffic Growth and Mode Split* • Passenger traffic trends by mode (private cars, buses and coaches, railways, air) in passenger-kms • Freight traffic trends in vehicle-kms/road traffic trends in vehicle-kms • Trends of airport traffic, number of movements • Trends in tonnage handling in national harbors	2. *Infrastructure* • Capital expenditure, total and by mode 3. *Vehicles and Mobile Equipment* • Number of road vehicles (autos, commercial vehicles): total, gasoline, diesel, others
Environmental Impact	
1. *Resource Use* • Total final energy consumption of the transport sector (share in total, per capita, by mode) in tonnes of oil equivalent 2. *Air Pollution* • Transport emissions (CO_2, NOx, VOC, CO, etc) share in total, per capita, by mode) • Emissions per vehicle-km: CO_2, NOx, VOC, CO, etc. 3. *Water Pollution* • Tonnage of oil released through accidents and discharges during current operations	4. *Noise* • Population exposed to noise greater than i65 dB(A) from transport 5. *Waste* • Tonnage of transport-related waste • Tonnage of hazardous waste imported or exported 6. *Risk and Safety* • Number of people killed or injured • Tonne-kms of hazardous materials transported
Economic Considerations	
1. *Environmental Damage* • Environmental pollution damage relating to transport 2. *Environmental Expenditure* • Total expenditures on pollution prevention/clean-up • Research and development expenditures on quiet, clean, energy-efficient vehicles • Research and development expenditures on clean transport fuels	3. *Taxation and Subsidies* • Direct subsidies • Direct and indirect subsidies • Total economic subsidies • Relative taxation of vehicles and vehicle use 4. *Price Structure* • Trends in gasoline (leaded, unleaded), diesel, and other fuel prices and public transport prices in real terms 5. *Trade and Environment* • Indicator not yet developed

Source: Transport Canada, 1999 (*55*).

the plan. The plan formulation was dependent on work done for the European Union's Agenda 21 Implementation Plan.
- The Department of the Environment, Transport, and Regions of the United Kingdom has developed indicators of sustainable development grouped around 21 main issues, one of which is transportation. Following the June 1992 commitment made at the Earth Summit in Rio de Janeiro, Brazil, in 1994 the U.K. government published its *Strategy for Sustainable Development*. One of the commitments made at the Earth Summit was the development of a set of indicators that would help to assess whether the country's development was becoming more sustainable, and also whether U.K. government was meeting its objectives as set out in the Sustainable Development Strategy.
- The World Bank, the world's largest source of economic development assistance, maintains a large information base that includes environmental, economic, demographic, and other information, and has an extensive range of activities involving the development of indicators for sustainability. Examples of these are the Environmental Performance Indicator Project, which discusses indicator frameworks, selection criteria for environmental project indicators and issues to consider for various areas; the Indicators-on-the-Web Project, which provides managers with ideas for environmental performance indicators at the project and national levels; and, the Development Goals Project, which aims to develop a set of indicators to measure progress toward sustainable development.

International experience with strategic environmental assessment (SEA) and sustainable transportation planning indicates that environmental considerations in transportation planning are being elevated to the national agenda increasingly. At least two important messages emerge from these international experiences: (1) the passage of relevant legislation is an enabler for effective consideration of the environment in planning and (2) development of performance measures lends more credibility to the entire process of considering the environment in planning. Hence, the EU agencies with more effective SEAs have adopted legislation to validate and support these assessments. Several countries that have adopted sustainability goals have begun initiatives to develop ways to measure their progress toward these goals. Although both initiatives are still relatively new, as they evolve they will continue to offer pertinent lessons for others in incorporating environmental factors earlier in planning.

Environmental Management Systems—An environmental management system (EMS) is a framework for continuously improving measurable environmental outcomes that result from decisions made by agencies (*56*). Outcomes are defined as the results, effects, or consequences of making decisions and taking action. The International Standards Organization's (ISO) 14001 standard for an EMS consists of five main elements:

- Environmental Policy—Establishes overall policy related to laws and regulations for continuous improvement of environmental quality, requiring the attainment of targets and objectives with a periodic audit of the EMS.
- Planning—Addresses all environmental aspects of an organization's activities, operations, products and services that affect the environment—based on establishment of objectives, targets and time schedule for meeting targets, consistent with policy.
- Implementation and Operation—Monitors and measures environmental performance and assesses progress in achieving environmental objectives and targets.
- Checking and Corrective Action—Addresses nonconformance and provides preventive and corrective action.
- Management Review—Assesses the suitability, adequacy, and effectiveness of EMS over time and addresses needed changes to all elements of the system.

For transportation agencies, an EMS would relate closely to the activities undertaken in planning, programming, project development, operations, and maintenance for any mode of transportation. In particular, it would most likely interface closely with other management systems that are already in place in many transportation organizations, such as those relating to pavement management, bridge management, congestion management, safety management, maintenance and construction management, and project tracking.

One of the best sources for information concerning the potential application of EMS procedures in transportation agencies is found in the *Environmental Information Management and Decision Support System—Implementation Handbook* (*58*). This report comes from an NCHRP project that was initiated to respond to the need of state transportation agencies and metropolitan planning organizations for systems to manage environmental information and to support decision making. The project objective was to develop a concept and implementation approach for an Environmental Information Management and Decision Support System (EIM & DSS) that addresses all levels of decision making—planning, programming, project development, operations, and maintenance—for all modes of transportation. This implementation handbook describes the EIM & DSS concept and provides guidance to state DOTs and MPOs on developing and implementing such systems.

This NCHRP project concluded from interviews with state DOT officials that an EMS that is ISO 14001 compliant is not sufficient to meet their decision-making needs. However, the value gained from the ISO 14001 EMS concept was considered to be in its focus on explicitly creating environmental policies, objectives, and targets, and measuring the effects of decisions on these objectives and targets.

Literature Summary

The literature presented in the previous sections covers a wide range of topics that suggest the importance of incorporating environmental considerations early in systems planning. The basic messages that result from this literature search include the following:

1. Transportation and environmental professionals approach problems in very different ways. The underlying scientific concepts and the resulting analysis methods can lead the problem-solving search in various directions. The meaningful incorporation of environmental considerations into transportation systems planning will require transportation professionals to rethink the relationship between transportation investments and the environment.
2. The "systems" perspective is a key point of departure for examining environmental impacts and understanding the relationships between the construction and operation of the transportation system, ecological systems, and the built environment. This perspective encourages agencies to incorporate systemic environmental concerns, such as air quality and watershed effects, into transportation planning.
3. The European literature suggests that other countries are further advanced than the United States in integrating environmental concerns into transportation systems planning. However, this experience has not resulted in significantly different approaches to alternatives definition, nor to a fundamentally new way of making investment decisions. Europe has, however, made significant advances in monitoring environmental health and using this information to inform planning and decision-making.
4. The United States has made important, yet relatively targeted, progress in examining environmental and community factors earlier in project development. This is most notable in the context-sensitive solutions movement that has emerged in the past decade in many state and regional transportation agencies. The success of moving projects forward in a way that results in both meeting safety and mobility objectives while at the same time meeting community and environmental group desires for a more sensitive design represents an important evolutionary step forward for transportation agencies.
5. Although the concept of linking environmental considerations to transportation systems planning is not new, the relatively recent development of powerful and accessible computer-based tools and data management techniques has greatly increased the capability of doing so. This is particularly true in identifying areas of sensitive environmental resources through the use of geographic information systems (GIS).
6. The evolution toward system planning that incorporates environmental considerations in a meaningful way must look at all aspects of this process. The traditional approach of including environmentally oriented criteria for plan or project evaluation alone is not sufficient to result in meaningful early assessment of environmental impacts.

LAWS, POLICIES, AND REGULATIONS

Federal and state laws and regulations often provide an important motivating factor for considering environmental factors in transportation planning and decision making. Respondents to the project survey, and many of those interviewed for the case studies, pointed to such laws and regulations as being the most important reason for environmental considerations being incorporated into transportation planning and decision making. This section reviews some of the more important federal laws and regulations that relate to transportation and environmental quality, and provides examples of similar state laws.

Federal Laws

Almost every respondent to the project surveys and to questions posed during the case study visits credited Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Transportation Equity Act for the 21st Century (TEA-21) for making planning more open and sensitive to broader issues. This section will begin with an overview of the environmental sections of TEA-21 and of the regulations that implemented the ISTEA provisions. Note that since no planning regulations were promulgated for TEA-21, the law itself and those parts of the ISTEA regulations not superseded by TEA-21, were in force since 1991 when ISTEA was passed.

TEA-21 and ISTEA linked environmental issues with transportation planning in the following ways:

1. Consolidating 23 planning factors required in ISTEA for state and metropolitan planning into seven, including one stating the need to "protect and enhance the environment, promote energy conservation, and improve quality of life";
2. Coordinating state planning with "planning needs to be coordinated with planning conducted by federal, state, and local environmental resource planning that substantially affects transportation actions";
3. Promoting public access and input into state transportation planning and for influencing key decisions;
4. Coordinating metropolitan transportation planning with the state implementation plan (SIP) in nonattainment or maintenance areas; and encouraging the development of transportation control measures;

5. Coordinating NEPA and transportation planning requirements for highway/transit projects among the many different agencies involved with the environmental analysis that occurs during project development;
6. Encouraging environmental streamlining by coordinating environmental review for highway construction projects;
7. Executing a planning program to "plan, develop, and implement strategies to integrate transportation and community and system preservation plans and practices that, among other things, will reduce the effects of transportation on the environment"; and
8. Promoting that "to the fullest extent possible, all environmental investigations, reviews, and consultations be coordinated as a single process, and compliance with all applicable environmental requirements be reflected in the environmental document required."

These requirements provide an important policy context for environmentally sensitive transportation planning.

The number of federal laws and regulations that could influence transportation planning is quite extensive. However, as noted by the respondents to the surveys, there were some federal laws and executive orders (other than ISTEA and TEA-21) that have had a more important effect for considering environmental factors in transportation planning than others. These include the following:

- The National Environmental Protection Act (NEPA) of 1969 required federal, state, and local governments to use systematic approaches to incorporate the protection of the natural and human environment within project development. NEPA also established the national commitment to preserving the environment as a goal of national policy.
- The Clean Water Act Amendments (CWA) of 1997 established the basic structure for regulating the discharge of pollutants into waters of the United States. Section 404 of the Clean Water Act established a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. Activities that are regulated under this program include fills for development and infrastructure development such as highways and airports. The basic premise of the program is that no discharge of dredged or fill material can be permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded.
- The Clean Air Act (CAA) Amendments of 1990 addressed air quality standards, motor vehicle emissions, and alternative fuels, toxic air pollutants, acid rain, and stratospheric ozone depletion. The law designated the states as being responsible for nonattainment areas; deadlines for attainment were established for each source based on the severity of the pollution. This legislation also raised automobile emissions standards and set a definite timetable for reductions in order to tighten control in this area. Along with federal transportation legislation, the Clear Air Act established the process for conformity assessment that requires transportation plans, programs, and projects to conform with the state implementation plan (SIP) for the state.
- The Endangered Species Act was passed in 1973 and reauthorized in 1988. This legislation regulated a wide range of activities affecting plants and animals designated as endangered or threatened. By definition, an endangered species is an animal or plant listed by regulation as being in danger of extinction. A threatened species is any animal or plant that is likely to become endangered within the foreseeable future. The Endangered Species Act provided a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service of the Department of the Interior maintains a list of endangered and threatened species.
- Title VI of the Civil Rights Act of 1964 stated that no person in the United States on the ground of race, color, or national origin, should be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance. This law is the foundation for the issues relating to environmental justice.
- Executive Order 12898 of 1994, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, required each federal agency to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse health or environmental effects of its activities on minority and low-income populations.

Many additional laws and regulations have provided important access into transportation planning for environmental issues. A good reference for the federal laws, regulations, and guidance that relate to the consideration of environmental factors in transportation decision-making can be found at www.fhwa.dot.gov/environment.

State Laws

States also have enacted laws or adopted policies and regulations to promote the consideration of environmental factors in transportation planning. The selected state laws presented below characterize the nature of the range of state legislation that currently exists in the Untied States. Appendix B, contained in *NCHRP Web-Only Document 77,* provides a much more detailed description of state laws as they relate to the relationship between transportation and consideration of environmental factors.

- *California*—The California Environmental Quality Act (CEQA) is one of the most influential state environmental laws in the United States. Regional transportation plans (RTPs) and any subsequent revisions, amendments, or updates to the plan must be in compliance with the law, and the regional planning agency must prepare and certify an environmental document before adopting an updated plan. A program or master environmental impact report (EIR) is typically prepared for the RTP. An EIR must be prepared if the proposed action will have a significant effect on the environment. In the EIR, consideration of alternatives that would avoid or reduce significant environmental effects is required. A negative declaration or mitigated negative declaration may be prepared if no significant environmental impacts are identified, or if all identified potentially significant effects will be mitigated below the level of significance. The CEQA environmental document must address specific issues, the number and scope of which are determined by the potential environmental impacts.
- *Georgia*—Title 32 (32-2-3) of the Georgia Code requires the Department of Transportation to develop a comprehensive, statewide 20-year transportation plan that must include "the total environment of the community and region including land use, state and regional development goals and decisions, population, travel patterns, ecology, pollution effects, esthetics, safety, and social community values."
- *Maine*—Maine's Sensible Transportation Policy Act (STPA) sets the framework for Maine DOT's planning and programming. The STPA resulted from a 1991 citizen-initiated referendum that mandated public participation in transportation decisions. It requires the analysis of alternatives before major highway investments are made.
- *Maryland*—The Maryland Smart Growth and Neighborhood Conservation Act and Executive Order became effective in 1997. This initiative directs growth to areas where it is most environmentally suitable while protecting some of the state's most ecologically and environmentally valuable landscapes. It calls for transportation investments that satisfy current and projected travel demands while supporting smarter growth patterns. Maryland's Transportation Performance Act, passed in May 2000, requires the Maryland DOT to apply performance measurements to the Maryland Transportation Plan and the state's Consolidated Transportation Program or capital improvement program.
- *Minnesota*—As per Minnesota state statutes (Chapter 174.01, Subdivision 2 [1994]), one of Minnesota's 14 transportation goals is "to ensure that the planning and implementation of all modes of transportation are consistent with the environment and energy goals of the state."
- *Oregon*—Oregon has 19 state planning goals of which transportation is one element. These planning goals include guidance to "protect and enhance the environment, promote energy conservation, and improve quality of life."
- *Pennsylvania*—In January 1999, the governor issued Executive Order 1999-1 requiring all Commonwealth agencies to identify laws, regulations, practices, and policies that advance the Commonwealth's land-use objectives. Furthermore, Acts 67 and 68, signed into law in 2000, amended the municipal planning code to allow multimunicipality planning for the first time. All counties are required to have a comprehensive land-use plan under the new regulations. State agencies are allowed to consider municipality and county plans as well as zoning when they make decisions to permit and fund projects.
- *Washington*—Transportation planning in Washington must comply with the State Environmental Policy Act (SEPA). As part of this compliance, state transportation plans are required to identify and document potential affected environmental resources. The plans are exempt from the requirement for an environmental impact statement (EIS). However, actions to implement the plan(s) are subject to further, detailed analysis under SEPA. Also, the 2001 Washington State Legislature passed the Environmental Permit Streamlining Act, which established the Transportation Permit Efficiency and Accountability Committee. Although the committee's primary aim is to develop permit-streamlining processes, the law requires the committee to work within the structure of existing environmental laws and regulations.
- *Wisconsin*—Wisconsin DOT is required to complete a System-Plan Environmental Evaluation (SEE) as per Wisconsin Administrative Rule TRANS 400, which implements the Wisconsin Environmental Policy Act as it relates to DOT planning activities. The rule has been applied to several statewide modal plans, resulting in a systems-level environmental evaluation.

SURVEY OF DOTS, MPOS, AND STATE ENVIRONMENTAL RESOURCE AGENCIES

To gain a better understanding of the current state-of-the-practice in linking environmental factors and transportation planning, web-based surveys were administered to state DOTs, MPOs, and state environmental resource agencies. Although respondent-specific questions were incorporated into each survey, similar questions allowed for comparisons on key topics. (The survey instruments are found in Appendix C, which is contained in *NCHRP Web-Only Document 77*). Some surveys were pretested by state transportation planning officials, and the feedback from these pretests was incorporated into the final survey instrument. An electronic

mailing was sent to 685 survey respondents to request their participation in the web-based survey. Those not responding to this initial effort were contacted through a second electronic mailing, which was followed with telephone calls to identified respondents who still had not completed the survey.

The survey was sent to 51 members of the American Association of State Highway and Transportation Officials (AASHTO) who represented each state DOT and Washington, D.C.; 340 members of the Association of Metropolitan Planning Organizations (AMPO); and 293 members of environmental resource associations—the State and Territorial Air Pollution Program Administrators (STAPPA), the Association of Local Air Pollution Control Officials (ALAPCO) and the Environmental Council of the States (ECOS). A total of 42 responses were received from the state DOTs (82% response rate); 45 responses from MPOs (13% response rate); and 13 responses from environmental resource agencies (4% response rate).

Although special efforts were made to obtain responses from environmental resource agencies, the response rate was quite low. The study team found that many resource agency officials had not considered how to better integrate environmental considerations into transportation systems planning and, in many cases, did not know what the system planning process was. Therefore, these respondents felt there was little they could offer to the survey.

While the low MPO response rate is cause for some concern, these concerns are offset by the fact that of the 293 MPOs asked to participate in the survey, some represented very small urban areas. The 45 responses from MPOs included the largest MPOs in the country, and reflect the environmental concerns that would most likely be found in large metropolitan areas. This bias toward large MPOs is not considered a threat to the validity of the research results because large metropolitan areas typically face the widest range of environmental problems. Smaller metropolitan areas encounter environmental issues similar to those faced by larger MPOs, although on a lesser scale. Because of the ability of large MPOs to confront the full range of environmental issues, as well as their ability to draw upon greater resources in addressing these issues, the survey should adequately represent the current state-of-the-practice in environmentally sensitive planning. The following sections summarize the results of the survey effort.

Key Findings from the Surveys

The survey findings indicate that 38% of the state respondents and a similar percentage of MPO respondents thought that environmental considerations were important (rated 4 or 5 on the survey question) in the development of their latest transportation plan. This percentage increased to 45% for state DOTs and 52% for MPOs when asked how important environmental factors are likely to be in the update of the plan 10 years in the future. Most state respondents thought that environmental factors were somewhat important for both the last update as well as for the future update of the plan. For MPOs, most responses fell into the "more important" category.

Generally, there also seemed to be a consensus that incorporating environmental factors earlier in planning leads to better decisions and shortens the time for project implementation. Several DOTs were able to identify specific examples where incorporating environmental factors earlier in planning had resulted in tangible benefits.

The 12 areas detailed below summarize the major results of the survey effort. A more detailed summary of the key findings, as well as detailed reports from the three surveys, are included in Appendix C, which is contained in *NCHRP Web-Only Document 77.*

1. The most considered environmental factors in current transportation planning are air quality, land use, socioeconomic considerations, and environmental justice.

- DOTs considered air quality to be the most important factor in the most recent plan update as well as likely being the most important factor in the update of the plan 10 years hence. MPOs considered land use to be the most important factor both in the most recent plan and in the pending 10-year update of the plan. Environmental resource agencies considered air quality to be the most important factor for DOTs and MPOs, both for the most recent plans and for plan updates 10 years in the future.
- DOTs identified land use, socioeconomic considerations, and environmental justice as the next most important factors in planning in the most recent and 10-year updates of the plan. MPOs identified air quality, socioeconomic considerations and environmental justice as the next most important environmental factors.

2. The most widely used tools for considering environmental factors in transportation planning are data trend analysis, geographic information systems (GIS), environmental-impact-specific models, overlay maps, and focus groups.

- According to the DOT respondents, the most commonly used tools for environmental assessment are data trend analysis, GIS, environmental-impact-specific models, socioeconomic impact assessment, surveys, and focus groups.
- According to the MPO respondents, the most commonly used tools are data trend analysis, GIS, overlay maps, and environmental-impact-specific models.
- According to the environmental resource agency respondents, the most commonly used tools are environmental-impact-specific models, overlay maps, data trends, and focus groups.

3. There is general agreement that only part of the data needed for considering environmental factors in transportation planning is available.

- Sixty-six percent of the responding DOTs, 51% of the responding MPOs, and 57% of the responding environmental resource agencies (i.e., most each group) were of the opinion that only part of the data needed for considering environmental factors in transportation planning is currently available.

4. The most readily available types of data within agencies relate to air quality, socioeconomic, noise, energy consumption, storm water runoff, and erosion.

- According to the DOTs, the most readily available in-house data are air quality and socioeconomic data.
- According to the MPOs, the most readily available in-house data relate to noise, energy consumption, storm water runoff, and erosion.
- According to the environmental resource agencies, the most readily available types of data in MPOs and DOTs relate to air quality, erosion, and water quality.

5. The most readily available types of data from outside agencies are environmental justice, hazardous wastes, historic properties, water quality, biological, and climate.

- According to the DOTs, the most readily available data from outside the agency relate to environmental justice, hazardous wastes, and historic properties.
- According to the MPOs, the most readily available data from outside the agency relate to climate, water quality, biological, community cohesion, and historic properties.
- According to the environmental resource agencies, the types of data most readily available to transportation planning agencies relate to air quality, water quality, erosion, wetlands, and storm water runoff.

6. Most DOTs and some of MPOs use performance measures that include environmental factors in transportation planning. Most states and MPOs use performance measures in transportation planning.

- Approximately 59% of the responding DOTs and 36% of the responding MPOs use performance measures that include environmental factors for transportation planning.
- Approximately 12% of the states and 43% of the MPOs use performance measures that do not include environmental factors.

7. DOTs and MPOs have a relatively high level of interaction with each other and with environmental resource agencies, the governor's office, environmental advocacy groups, and public interest groups in transportation planning.

- Approximately 46% of DOTs stated that they interact with MPOs, environmental resource agencies, the governor's office, environmental advocacy groups, and public interest groups (other than environmental groups) in transportation planning. The DOTs interact most closely with MPOs.
- Approximately 79% of MPOs stated that they interact with DOTs, environmental resource agencies, the governor's office, environmental advocacy groups, and public interest groups (other than environmental groups) in transportation planning. The MPOs interact most closely with the U.S. Department of Transportation.
- Approximately 74% of the environmental resource agencies indicated that they interact with DOTs, MPOs, other environmental resource agencies, public interest groups (other than environmental groups), and the governor's office in transportation planning.

8. Competing priorities that detract from environmental issues and a lack of appropriate planning analysis tools were identified by DOTs, MPOs, and environmental resource agencies as the most significant obstacles to considering environmental factors in transportation planning. Lack of data and lack of regulations were perceived as less important obstacles to considering environmental factors in transportation planning.

- Most DOT respondents (76%) selected "competing priorities that distract from environmental issues" as an obstacle to considering environmental factors in transportation planning; 53% of the DOT respondents indicated that a lack of appropriate planning analysis tools was an obstacle.
- Most MPO respondents (64%) indicated that "competing priorities that distract from environmental issues" was an obstacle to considering environmental factors in transportation planning; 58% of the MPO respondents indicated that the lack of appropriate analysis tools was an obstacle as well.
- Most sustainability environmental resource agency respondents (85%) also saw "competing priorities that distract from environmental issues" as an obstacle to considering environmental factors in transportation planning; 38% of the environmental resource agency respondents perceived the next most important obstacle was a lack of appropriate analysis tools.

9. Most DOT and MPO respondents had taken action to promote the consideration of environmental factors before the project development stage.

- Most (88%) of the DOT respondents had taken action to promote the consideration of environmental factors before the project development stage.
- Almost two-thirds (62%) of the MPO respondents had taken action to promote the consideration of environmental factors before the project development stage.
- Most DOTs had defined purpose and need early in planning and entered into agreements with environmental resource agencies.
- Most MPOs had defined purpose and need early in the process and used environmental experts to identify sensitive areas.

10. Most DOTs, MPOs, and environmental resource agencies believe that the most important benefit for considering environmental factors before the project development stage is that it results in better decisions. In addition, MPOs also believe that an equally important benefit is that it shortens the time to project implementation.

- For DOT respondents, other important benefits included improving the agency image, reducing the level of potential public controversy, and engaging environmental resource agencies earlier.
- For MPO respondents, other important benefits included linking planning better with project development, reducing the level of potential public controversy, and helping to develop a constituency for a project.
- For environmental resource agency respondents, other important benefits included linking planning to project development, engaging environmental resource agencies earlier, and shortening the time to project implementation.

11. Respondents varied in their ability to identify specific examples in which considering environmental factors before project development had resulted in benefits.

- Just over 50% of the DOT respondents, 22% of the MPO respondents, and 23% of the environmental resource agency respondents could identify specific examples in which considering environmental factors before project development resulted in benefits.

12. Most of the MPO respondents (73%) indicated that they believed implementing agencies in their area would be supportive of addressing environmental concerns earlier in project development.

Figures 2 through 6 show the differences between the DOT and MPO responses for key survey questions. The survey indicates that there is notable variation in the ways in which different agencies are considering environmental factors in transportation planning. Typically, DOTs and MPOs place great emphasis on air quality and environmental justice issues in transportation planning, and use tools such as data trend analysis, GIS, air quality impact models, overlay maps, and focus groups as part of their analysis. This is not surprising given the emphasis these concerns have received in recent years. Planning agencies generally consider data availability an issue in addressing environmental factors in planning. In addition, they are hindered by the lack of appropriate analysis tools and too many competing objectives that detract from environmental considerations.

Many DOTs and MPOs are including environmental performance measures in planning. Most DOTs and MPOs seem to have taken at least one action to incorporate environmental factors before the project development stage. There seems to be general agreement that there is a high level of interaction among implementing agencies, and MPOs seem optimistic that implementing agencies would be supportive of incorporating environmental factors earlier in planning. There also seems to be broad consensus that incorporating environmental factors earlier in planning generally leads to better decisions. Several agencies gave examples where incorporating environmental factors earlier resulted in tangible benefits.

In general, the survey suggests that DOTs and MPOs recognize the importance of environmental considerations in transportation planning, but that the state-of-the-practice is oriented toward environmental-impact-specific issues. Not surprisingly, both DOT and MPO respondents identified air quality and environmental justice as those issues receiving the most attention. These issues have been the focus of most recent federal legislation and regulatory actions. Very few examples were found where environmental issues were considered from a systems perspective and linked closely with the development of transportation plans. Some examples were found where agencies, especially state DOTs, have implemented actions to streamline project development. As seen in the survey response, a major reason for considering environmental factors earlier was considered to be better decisions.

SUMMARY AND IMPLICATIONS OF IMPORTANT FINDINGS

The literature points to several theoretical bases for addressing the environment in transportation planning at a systems level. The idea of cities as ecosystems with finite carrying capacities presents a simple and broadly understood basis for integrating environmental considerations with planning and for tracking how transportation development decisions are impacting the environment over time. The concept of sustainability also is increasingly important in transportation planning. Sustainability refers to economic and social change to improve human well-being while reducing the need for environmental protection.

The importance of legislation in advancing environmental considerations in planning for infrastructure is found in both

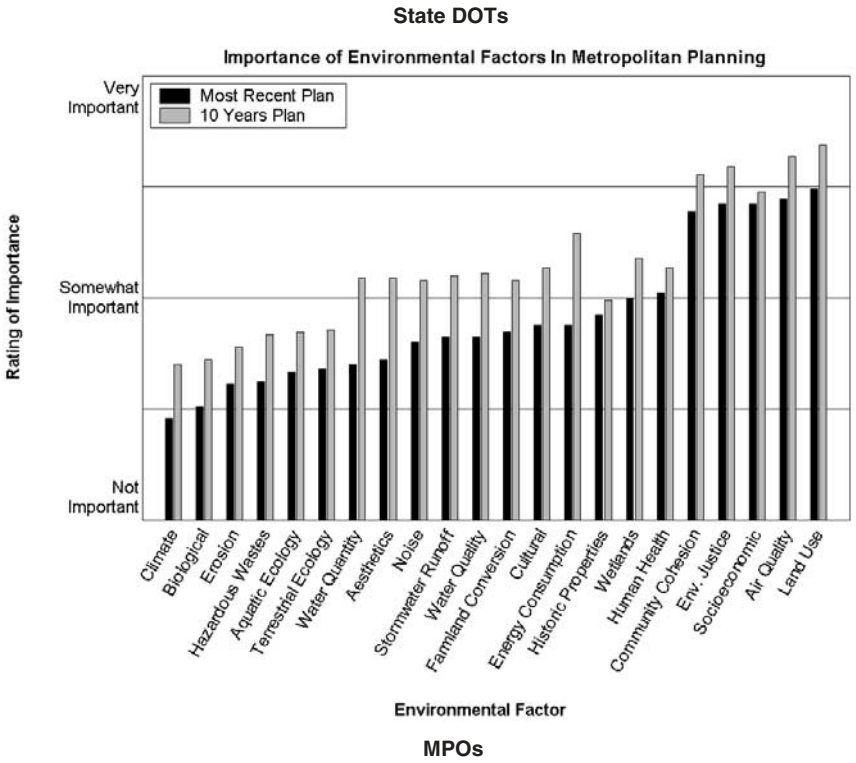


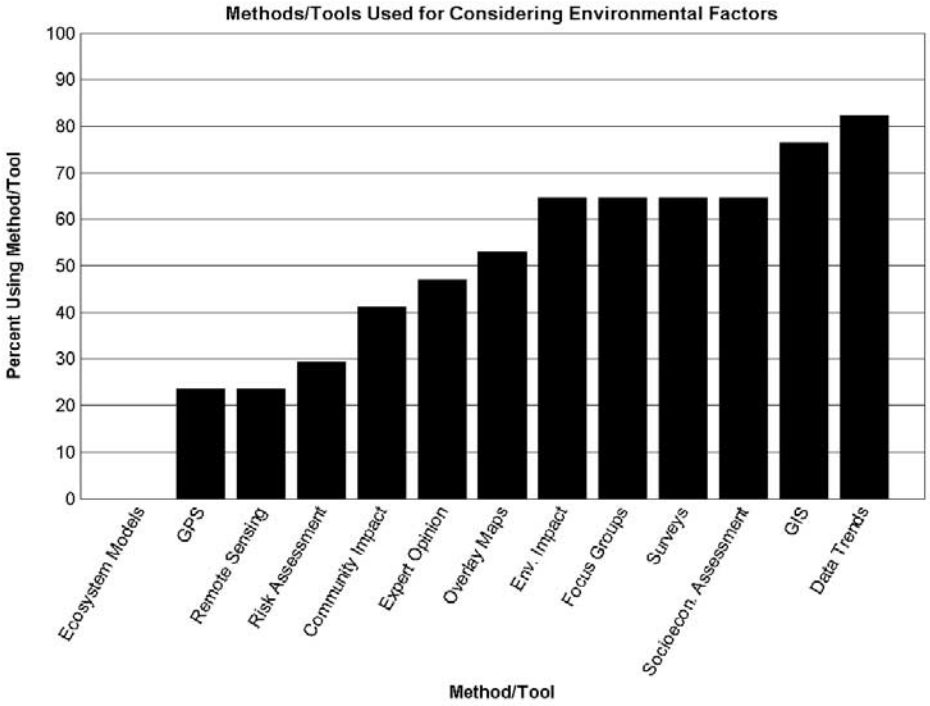
Figure 2. Importance of environmental factors, state DOTs and MPOs.

domestic and international experiences. States that have passed strong environmental legislation, not surprisingly, have made greater progress than their counterparts without similar legislation. A similar finding was made for countries in the European Union: those who had passed legislation on Strategic Environmental Assessments (SEAs) had made more strides with the application and effectiveness of SEAs. The fact that some states have passed laws that explicitly link environmental considerations to transportation planning and decision making is indicative of a growing awareness of the importance of this issue and a desire to institutionalize requirements to address it.

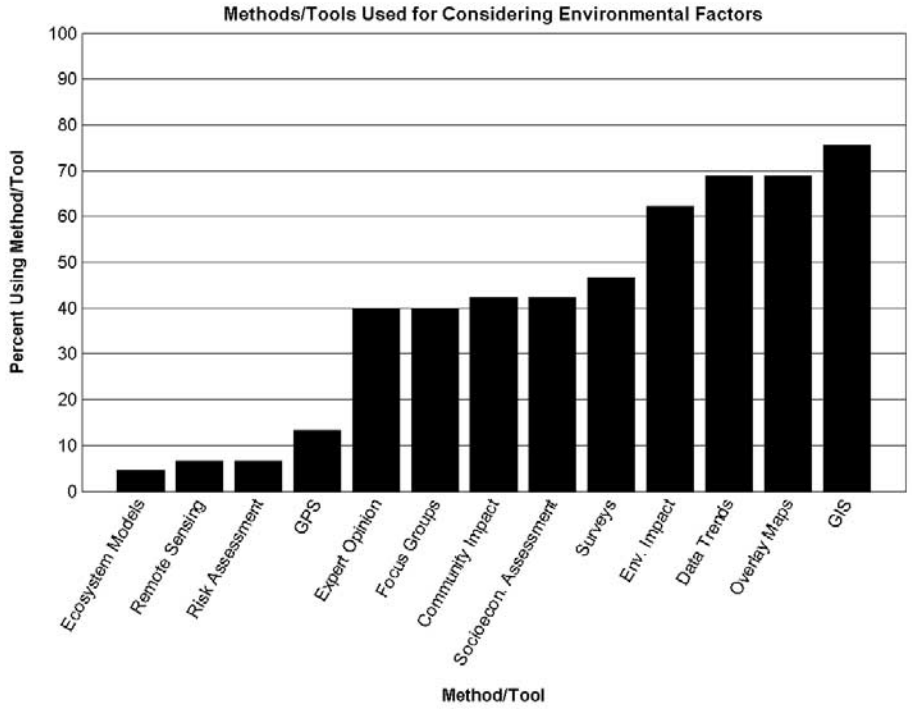
Both domestic experiences with transportation planning and international experiences with sustainable transportation activities highlight the importance of performance measurement as a tool for assessing an agency's progress toward environmental or sustainability goals. The literature shows that performance measurement is one of the first steps agencies take to develop credibility in the environmental area.

Although the survey results indicate a general consensus on the importance of environmental considerations in transportation planning, they also show that different agencies have adopted various approaches and priorities to address the environment during planning. Thus, it is unlikely that there will be a universal approach that fits the needs or perceived priorities of all agencies. It is interesting to note that agencies tend to agree that earlier environmental considerations should result in better decisions. However, agencies also tend to be constrained by other competing priorities, indicating that some form of incentive (e.g., devoting additional resources to this goal) may be necessary to foster increased integration of environmental considerations with transportation planning. Not surprisingly, the United States and countries in the European Union that have passed legislation to promote environmental considerations in planning have given this issue a high priority and allocated appropriate resources to address it.

The next chapter presents a transportation planning framework and the important steps needed to consider environmental factors earlier. As noted in the results of the survey, although the application of this framework could result in faster project development procedures, the primary intent is to produce better decisions. In this case, "better" means investment decisions that meet the important transportation goals of a community, but do so in a way that enhances the capacity and functionality of the surrounding environment while preserving those quality-of-life characteristics valued by the local community.

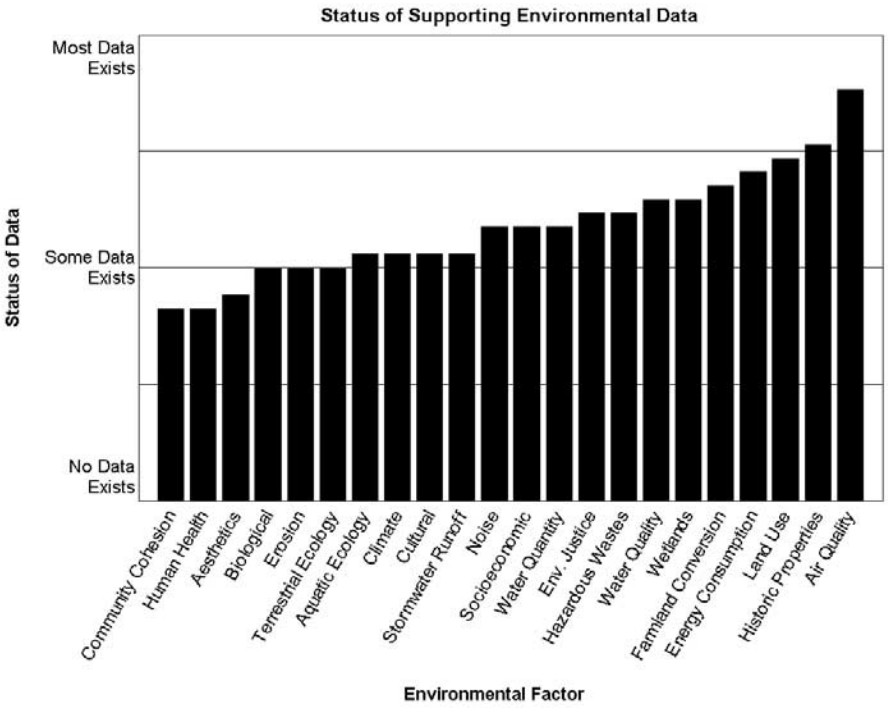


State DOTs

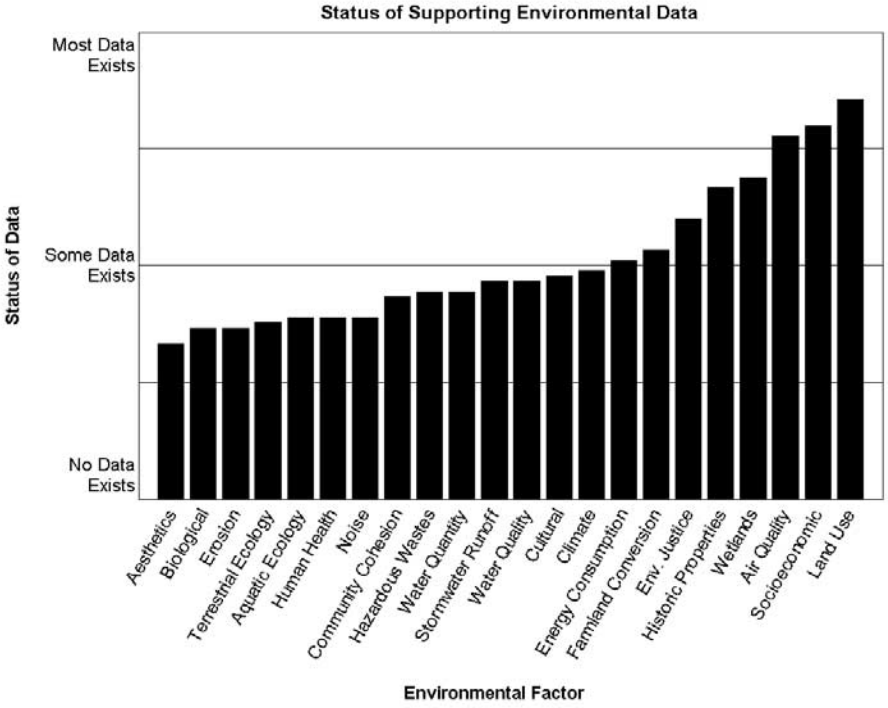


MPOs

Figure 3. Most important methods and tools for environmental consideration, state DOTs and MPOs.

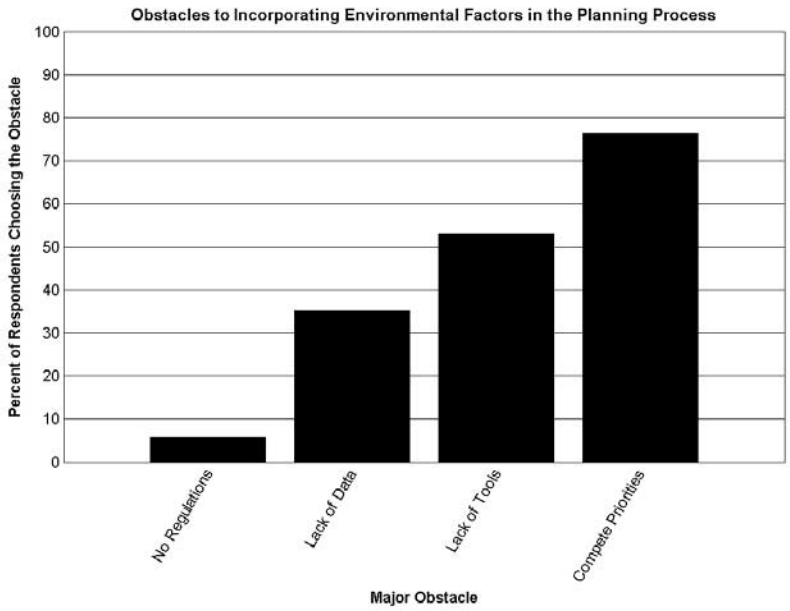


State DOTs

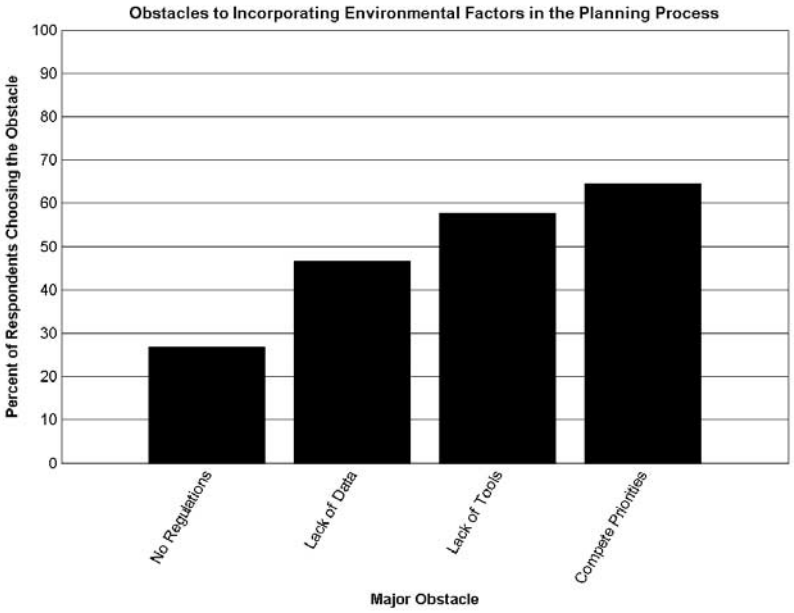


MPOs

Figure 4. Existence of data for consideration of environmental factors, state DOTs and MPOs.

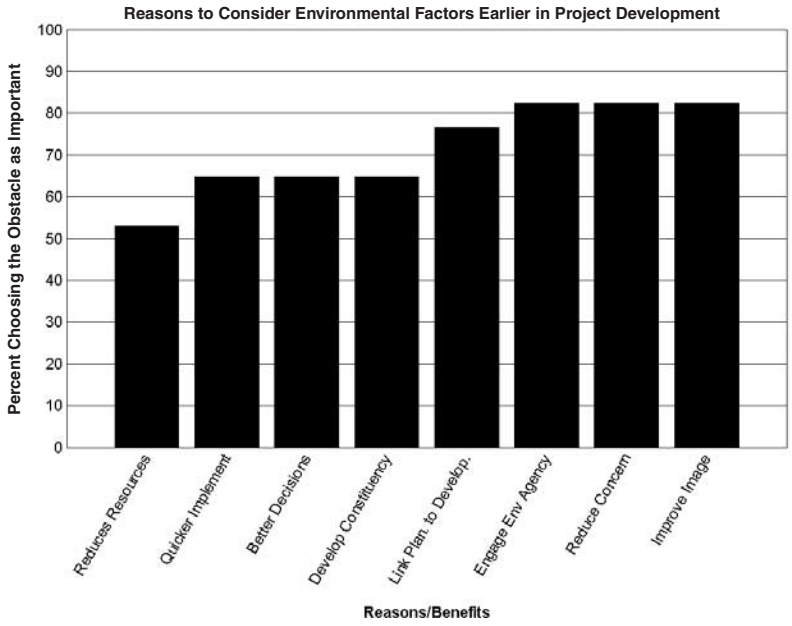


State DOTs

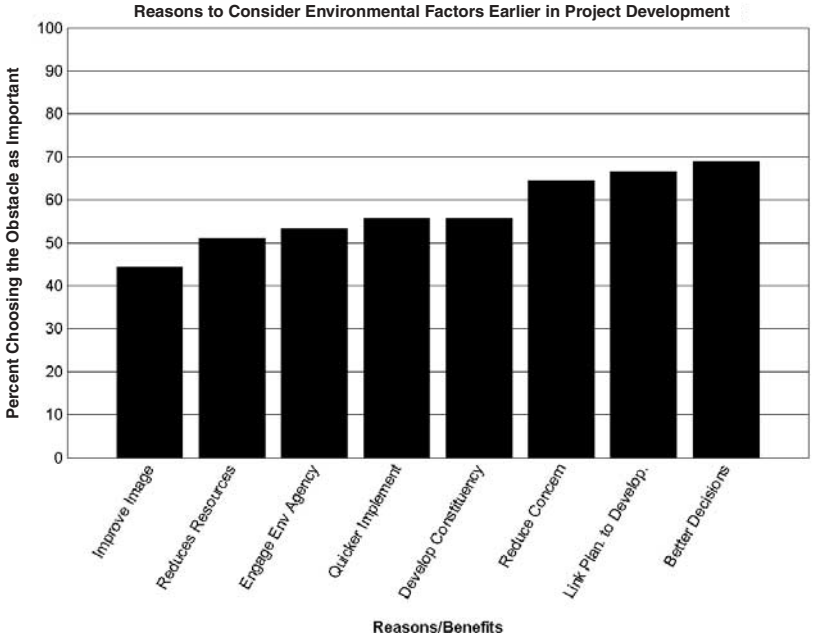


MPOs

Figure 5. Obstacles to incorporating environmental factors into transportation planning, state DOTs and MPOs.



State DOTs



MPOs

Figure 6. Reasons for considering environmental factors earlier in project development, state DOTs and MPOs.

CHAPTER **3**

INCORPORATING ENVIRONMENTAL CONCERNS INTO TRANSPORTATION PLANNING AND PROJECT DEVELOPMENT

INTRODUCTION

This chapter presents a conceptual framework of transportation systems planning and project development that illustrates where environmental considerations can be incorporated into planning and what strategies can be used to provide greater sensitivity to environmental concerns. The first section of this chapter describes the conceptual framework. Subsequent sections use the results of the case studies conducted for this project to illustrate how some states and MPOs have incorporated environmental considerations into each step of system planning and project development.

An important step in systems planning, and thus a component of the conceptual framework, is analyzing alternatives. This step is heavily dependent on data collection and interpretation. In addition, analysis uses models or other tools to understand how changing the characteristics of the transportation system might affect system performance and otherwise affect the natural and built environment. Because many distinct analysis tools and methods could be used to incorporate environmental factors into systems planning, this topic will be covered in Chapter 4.

The conceptual framework is defined in this chapter in general terms that make it possible to describe the basic steps for planning and project development in both statewide and metropolitan-level applications. Clearly, different components of such a framework might receive different levels of emphasis in each type of application. For example, metropolitan transportation systems planning tends to be much more dependent on network modeling activities than most examples of statewide transportation planning. Although several states have developed models that forecast future travel flows on the state's transportation system, most state planning activities have not included this level of complexity in the process.

Another important distinction between metropolitan and statewide transportation planning applications is that a state DOT has a responsibility not only for statewide transportation planning, but also for project development. Metropolitan planning organizations (MPOs) are primarily responsible for transportation systems planning, and project development is left to other agencies. This is an important institutional issue in that the challenge of influencing systems planning and project development will likely relate to which organizations are responsible for each.

CONCEPTUAL FRAMEWORK

By its very nature, a conceptual framework is a simplification of what could be a very complex process. For example, the framework outlined in this chapter presents systems planning and project development as an orderly, somewhat rational series of steps that logically follow one another. An illustration of this framework shows the process as starting with ideas (e.g., developing a vision) and ending with a solution to identified problems (e.g., projects programmed and designed). In reality, planning and project development are much more complex, with many different activities possibly occurring concurrently. Additionally, in a typical planning context, many of the steps outlined in the framework might have already occurred and be irrelevant to a particular situation at a specific time. Even with these caveats, a conceptual framework that identifies important components of a process and how they relate to one another can be beneficial in guiding the discussion of how this process can be modified.

The conceptual framework that has guided this research is shown in Figure 7. The development of this framework has relied heavily on two recent contributions to the literature, both of which emphasize different parts of the framework. First, Meyer and Miller's (*36*) book on urban transportation planning provides the key point of departure for the systems planning components of this framework. Second, project development borrows heavily from *NCHRP Report 480: A Guide to Best Practices for Achieving Context-Sensitive Solutions* (*30*).

Systems planning begins with the creation of a ***vision***. The definition of a vision portrayed in Figure 7 reflects the interaction between desired states of prosperity, environmental quality, and social equity/quality of life. These three factors have been used purposely to define the key definitions of sustainable development. This vision can consist of general statements of desired end-states, or can be as specific as a defined land-use scenario. Usually, the vision for metropolitan planning tends to be more specific than the vision created for state-level planning. The "visioning process" relies on extensive public outreach and is often one of the most interactive steps of the systems planning process.

Once a vision has been defined, planning needs more specific information on what this vision means in terms of both desired transportation system performance, as well as the

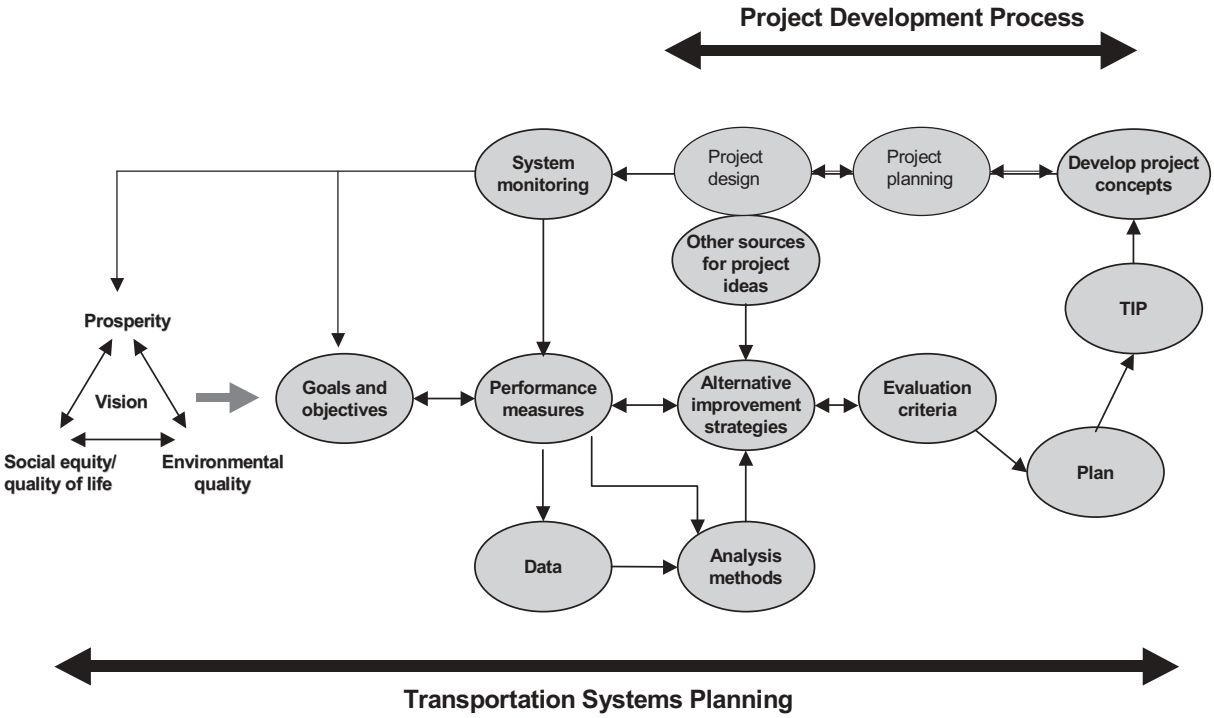


Figure 7. Conceptual framework of transportation system planning and project development.
Source: Meyer and Miller, 2001 (*36*).

desired characteristics of those aspects of community life affected by transportation, such as environmental quality or economic development. This is usually accomplished by defining ***goals and objectives*** that provide overall direction to the planning process. These goals and objectives not only serve the purpose of helping to define what the purposes of planning are but, later in planning, they lead to the identification of criteria that are used to evaluate different transportation system options and alternatives.

Goals and objectives can also lead to the identification of ***system performance measures***. The use of measures to monitor the performance of the transportation system and of other systems deemed important to decision-making is a relatively new phenomenon to the transportation field (see, for example, *59, 60*). The primary purpose of these measures is to target key data collection (and resulting information needs) on those aspects of performance that decision makers determine to be of most importance for their state or region. For example, many performance measures have been defined that monitor whether congestion, average speeds, system reliability, and mobility options have changed over time. Very few transportation-systems-level examples exist of measures that relate to such things as environmental quality, economic development, and quality of life (*61*).

Key to understanding the problems and challenges likely to be faced in the future is the ability to collect and analyze data. ***Analysis*** primarily focuses on understanding how a transportation system and its components work and, consequently, how changes to that system will alter its performance. Analysis also focuses on the relationships between transportation system performance and other topics such as environmental quality, economic development, and quality of life. The analysis step includes the identification of alternative strategies or projects that meet the objectives of the study. Analysis tools, ranging from simple data analysis to complex simulation models, are used to produce the information that feeds the next step of the process, which is evaluation.

Evaluation is synthesizing information on the benefits, costs, and effects generated by analysis so that judgments can be made concerning the relative merits of alternative actions. As noted by Meyer and Miller (*36*), evaluation should have the following characteristics:

- Focus on the decisions being faced by decision makers.
- Relate the consequences of alternatives to goals and objectives.
- Determine how different groups are affected by transportation proposals.
- Be sensitive to the time frame in which project effects are likely to occur.
- In the case of regional transportation planning, produce information on the likely effects of alternatives at a level of aggregation that permits varying levels of assessment.
- Analyze the implementation requirements of each alternative.

- Assess the financial feasibility of the actions recommended in the plan.
- Provide information to decision makers on the value of alternatives in a readily understandable form and a timely fashion.

One of the most common ways of making sure that the results of evaluation are linked closely to the needs of decision makers is through the definition of evaluation criteria that reflect important decision-making concerns. These criteria provide important guidance to planners and engineers about what type of data and analysis tools must be available in order to produce the desired information. The result of evaluation is the development of ***recommended strategies*** or a ***plan.***

In the United States, the actual program of action, referred to as the transportation improvement program (TIP) for a metropolitan area and the state transportation improvement program (STIP) for a state, is connected to the plan through ***programming***. Programming is matching actions that have surfaced through evaluation as being the most desirable with available funds. When funds are insufficient to satisfy all of the funding needs, some form of priority-setting occurs. This priority-setting can take many forms from pure politics to the use of systems analysis tools to assigning priority weights to different feasible actions.

Once a project or action has been programmed for implementation, that project must be further refined in terms of design and operation, as well as to better understand likely effects. Such refinement is called ***project development***. The three major steps in project development include developing project concepts, planning the project in finer detail than what would ordinarily occur in systems planning, and preliminary and final engineering. Project development takes various forms depending on the scope and magnitude of the project and expected effects. When significant environmental impacts are expected, for example, project development will include an analysis whose steps are well laid out in rules and regulations.

The final component of the framework is ***system monitoring***. Note in Figure 7 that system monitoring provides a feedback loop to the definition of goals and objectives and the use of performance measures. Poor system performance can lead to further planning analysis to better understand the dynamics of the underlying problem and might lead to the identification of new goals and objectives.

The system planning framework shown in Figure 7 is very different from more traditional constructs. First, and perhaps most significantly, system planning as shown encompasses a broad set of activities. Many books on transportation planning have focused almost exclusively on analysis and evaluation, with the visioning process, program and/or project implementation, and system monitoring (i.e., assessing how well the system is performing) occurring outside the planners' purview. The conceptual framework for this research adopts a much broader perspective of what constitutes systems planning.

Second, a relatively new addition to systems planning is the use of performance measures, shown in Figure 7 as a central concept in the overall planning process. Given the important link between planning and decision making, performance measures should focus on the information of greatest concern to decision makers. Performance measures should reflect the ultimate outcomes of transportation system performance, including, for example, the level of mobility for disadvantaged populations, pollutant levels from mobile sources, and economic development gains. Performance measures not only define data requirements and influence the development of analytical methods, but they become a critical way of providing feedback to decision-making on the results of previous decisions.

Third, a major focus of systems planning is the consideration of alternative strategies, which could include projects in the conventional sense, but also may include many different types of actions designed to influence travel behavior and system performance. For example, travel demand management (TDM) strategies, such as variable work hours, rideshare programs, and parking pricing, have become important options in many metropolitan areas for reducing transportation demand. Likewise, many intelligent transportation system (ITS) actions are not really "projects" as much as they are efforts to better coordinate the actions of those responsible for system operations. And also included in the strategies concept are actions that can be undertaken individually or in concert with specific projects aimed at reducing or avoiding environmental impacts. Thus, the conceptual framework shown in Figure 7 provides for a much wider consideration of actions and strategies than what is usually considered in the systems planning process.

A final characteristic of the planning framework proposed here is the periodic feedback provided by system monitoring to the original vision definition, goals statement, and identification of performance measures. Analysis and evaluation are undertaken not only to assess the consequences of a decision, but also to better understand the definition of the problem, which may require changing this definition based on preliminary analysis results. System monitoring serves as a major source of information on the performance of the transportation system and is an important indicator of system deficiencies or opportunities for improvement.

A very important context for the consideration of environmental factors in transportation systems planning is found in the community development decision-making process. A community develops in response to various influences, ranging from market and economic factors that affect the location of households and firms to changing levels of accessibility afforded by a transportation system. Land-use decisions incorporate various influences, often reflecting the market demand for community development and the political

structure established for making land-use decisions. Such decisions can be substantially constrained by both the inability of a transportation system to provide needed levels of accessibility and by environmental limits on the ability to provide water and support human activity on environmentally sensitive land. Land-use decisions drive transportation demand; they can shape the natural environment and alter it in such ways that infrastructure delivery becomes challenging (e.g., creation of park lands or protected habitats). In addition, land-use decisions such as corridor preservation or transit-oriented development can help create opportunities that support more effective and efficient transportation services.

Historically, transportation projects and, in some cases, plans as well, have been developed with community and environmental issues relegated to an evaluation issue. This may prompt questions such as: How does the proposed project or plan affect the land use and environmental characteristics of the adjacent land? What form of mitigation is necessary? However, the premise of this study is that environmental concerns need to be integrated closely with community planning, and that transportation planning needs to be better integrated with both environmental concerns and community planning. By providing a broader context, projects could be identified that provide dual benefits, not only enhancing a community's environmental quality, but also satisfying a transportation need.

Several case studies in this chapter illustrate how some communities have linked community planning, environmental assessment, and infrastructure provision. The triangle on the left side of Figure 7 represents this integration. One of the most important challenges to the transportation profession in the next several decades is to evolve into a more integrated approach toward community development that both recognizes environmental constraints and provides infrastructure supportive of the community vision.

The conceptual framework shown in Figure 7 represents a simplification of the systems planning and project development approach to transportation decision making. For this research, the important questions become: (1) To what extent and in what way can environmental factors be incorporated into each of the steps shown in this figure? and (2) Are there steps in systems planning where such factors can be considered earlier such that better and timelier decisions will result?

CASE STUDIES

Although the survey results presented in Chapter 2 did not find many examples of agencies that have effectively incorporated environmental concerns into transportation systems planning, there were several noteworthy examples. These examples ranged from changing an organizational culture so that environmental consequences were considered in every action taken by agency staff to identifying new tools and methods that allowed decision makers to visualize likely effects at the systems planning stage of decision making.

Case studies of selected DOTs and MPOs were undertaken in order to better understand the examples where linking environmental factors and transportation planning was found. The case studies were selected on the basis of the level to which survey respondents indicated that efforts had been made to consider environmental factors in systems planning, or where strategies to expedite project development by moving environmental tasks earlier into planning had been implemented. In some cases, such as the Cape Cod Commission or the Tahoe Regional Planning Agency, both the literature and survey respondents pointed to each area as one where environmental concerns have played a dominant role in planning.

These case studies represent the activities and efforts of agencies at a particular point in time, in this case, primarily during the summer and fall of 2002. Changes in agency administration and personnel can strongly influence how a process evolves, possibly changing its direction significantly. Nonetheless, the best-case practice represented by these case studies reflects the challenges and opportunities that have been faced by transportation planners, engineers, and decision makers in evolving toward a more environmentally sensitive decision-making process.

Each of the case studies focused on several key characteristics of the planning and environmental process found in that institutional environment. In particular, each case study described long-range transportation systems planning being used for that jurisdiction, the environmental goals and objectives that had been articulated for this process, any legislation or regulations that guided actions by agency staff, and the tools or methods that had been developed and/or used to analyze or evaluate environmental consequences in the planning process. Case studies were undertaken in the following locations:

- States
  - California
  - Florida
  - Maryland
  - Minnesota
  - North Carolina
  - Oregon
  - Pennsylvania
  - Washington
  - Wisconsin
- Metropolitan/regional areas
  - Atlanta (Georgia)
  - Cape Cod (Massachusetts)
  - Eugene (Lane County, Oregon)
  - Portland (Oregon)
  - San Francisco Bay Area (California)
  - Seattle (Washington)

- Southern California Council of Governments (Los Angeles, California)
- Tahoe Region (Nevada)
- Toledo Metropolitan Area Council of Governments (Ohio)

Vision

In the context of this research, vision has two meanings. A vision can be a statement of desired end states and/or directions that describe what a community wants to achieve in the future or an organizational philosophy or mission statement that outlines an organization's approach to achieving its mandate. With respect to this latter concept, state legislation and/or regulation can have an important influence on how an agency incorporates environmental considerations into transportation planning.

An important distinction needs to be made between a vision statement that simply lists general principles accepted by everyone (but have very little influence on actual results) and concepts that lead to very specific actions and activities aimed at achieving the vision. In the context of this research, a vision means articulating statements concerning environmental quality and preservation that are implemented in subsequent planning activities, leading eventually to investment decisions that reflect a concern for environment quality. As will be seen in the following examples, this distinction can have an important influence on the types of strategies that are considered in the planning process.

California Department of Transportation

The California Department of Transportation (Caltrans) is responsible for developing the transportation plan for the state of California. Developing this plan is accomplished in coordination with the California Transportation Commission (CTC) and 45 regional transportation planning agencies (RTPAs). Sixteen of the RTPAs are MPOs and 29 are nonurban planning agencies. Since the mid-1970s, state law has required these regions to prepare regional transportation plans (RTPs) that focus on the specific challenges each is facing, and that are designed to assist local and state decision makers in shaping California's transportation future. According to state law, the California Transportation Plan must be consistent with the plans developed by other entities in the state, such as cities, counties, special districts, private organizations, tribal governments, and state and federal agencies. State law specifically prohibits the California Transportation Plan from being project specific. Caltrans also develops and disseminates guidelines for regional transportation planning to the RTPAs and MPOs so that the regional transportation plans are consistent with federal and state transportation planning requirements.

The transportation challenge facing California is formidable. California has the world's fifth largest economy, with much of the economic wealth dependent on a functioning transportation system (e.g., California is the nation's leading global gateway for Pacific Rim trade with an estimated 37 percent of the value of all U.S. and foreign trade—an amount over $200 billion—passing through California's ports). Over 11 million people will be added to the current state population of 34 million by the year 2020, significantly stretching the capability of the transportation system to meet travel demands.

To prepare for this future, Caltrans has developed a state transportation plan that outlines the goals, policies, and strategies needed to meet the expected challenges. In developing this plan, extensive public involvement was used to formulate a vision of the state's transportation system that could guide the selection of strategies. The vision of California's future transportation system is one where California has a safe, sustainable transportation system that is environmentally sound, socially equitable, economically viable, and developed through collaboration; it provides for the mobility and accessibility of people, goods, services, and information through an integrated, multimodal network. (*62*)

Key concepts in this vision include the following four elements:

1. California is one of the few states that declares sustainability as a key guiding principle as part of its statewide transportation plan. Sustainability was defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs. When applied to transportation, it means ensuring that environmental, social, and economic considerations are factored into decisions affecting transportation activity." (*62*)
2. The term "environmentally sound" is used to describe a transportation system that "is part of an enhanced, ecologically healthy environment, and is developed with appropriate safeguards to protect open space, agricultural and sensitive lands, critical habitats, wildlife, water and air quality, and to minimize noise and visual effects."
3. A socially equitable transportation system is one where the burdens and benefits resulting from transportation investment are fairly distributed. In addition, targeted populations, such as low-income groups, the young and elderly, people with disabilities, and other disadvantaged individuals in rural and urban areas are to have access to safe and reliable transportation.
4. The vision specifically includes the concept of collaboration. This pertains not only to the participation of numerous stakeholders and groups that are normally involved in the development and implementation of the transportation plan, but also to the needed collaboration with the environmental community and especially with environmental permitting agencies.

Maryland Department of Transportation

In 1992, Maryland's General Assembly enacted the Maryland Economic Growth, Resource Protection, and Planning Act. This act established seven guiding visions for growth in Maryland. In addition, it required all local plans to comply with the act's provisions, mandated that state and local capital projects be consistent with local plans, and established an Economic Growth, Resource Protection, and Planning Commission. The visions were aimed at placing all county and municipal plans within the broader context of state goals for fostering economic development and environmental quality. In particular, the visions emphasized that

1. Development be concentrated in suitable areas,
2. Sensitive areas be protected,
3. In rural areas, growth be directed to existing population centers and resource areas be protected,
4. Stewardship of the Chesapeake Bay and the land is a universal ethic,
5. Resources be conserved, including reducing resource consumption,
6. To assure achievement of (1) through (5) above, economic growth be encouraged and regulatory mechanisms streamlined, and
7. Funding mechanisms be put in place to achieve these visions.

The Maryland State Highway Administration (SHA) has adopted an organizational perspective that supports state laws as they relate to smart growth and environmental preservation. In particular, Maryland's SHA has articulated the following four principles to guide the agency's activities as they relate to the environment:

1. Meet or exceed all environmental laws and regulations applicable to SHA activities;
2. Incorporate and integrate smart growth, environmental protection, and enhancement measures in planning, design, construction, and operations;
3. Protect and enhance all aspects of the natural and human environment whenever possible, using available state-of-the-art practices; and
4. Support advancement in environmental protection technology through innovation and technology transfer.

To provide organizational support for these principles, Maryland's SHA has hired staff specialists in such environmental areas as wetlands, streams and floodplains, noise abatement, storm water management, water quality, air quality, historic resources, archaeology, access for people with special needs, landscape architecture, socioeconomic impact assessment, erosion and sediment control, plant and wildlife ecology, forest creation, safety, hazardous waste management, and pedestrian access and bicycle compatibility.

New York State Department of Transportation

The New York State Department of Transportation (NYSDOT) has been a national leader in inculcating an environmental ethic into its organizational culture. In 1998, in response to the governor's desire for more active state involvement in environmental quality, NYSDOT launched an "Environmental Initiative" to change its way of doing business. The department moved away from a perspective of dealing with environmental issues simply as complying with regulations, to one where project construction and maintenance were viewed as an opportunity for improving the local environment, even if such efforts were not required as part of project approval.

New York State law has historically provided strong environmental protection of the lands surrounding state-funded transportation projects. Recently, however, state law was modified to allow NYSDOT to undertake environmental enhancement projects off of a project's right-of-way. Article 2 of the State Highway Law, for example, gives the NYSDOT Commissioner the authority to acquire "property for recreational, natural, and scenic areas along, but not necessarily contiguous to, state highways. . . . that shall lend itself to restoration, preservation or enhancement as a recreational, natural, or scenic area or provides visual access from highway to such area." The law further authorizes the Commissioner to spend state highway dollars to improve these areas.

One of the ways NYSDOT has incorporated environmental factors more seriously into its operations has been by changing departmental policies and procedures. The most important policy with respect to the Environmental Initiative is the NYSDOT Environmental Policy (*63*) that was issued in 2000. Key statements from this policy include the following:

- As New York State's largest public works agency, the Department of Transportation has an obligation to the people of New York State to preserve, protect, and enhance the environment.
- It is the policy and practice of the Department to
  - Plan, design, construct, and maintain facilities that meet transportation needs while proactively protecting, conserving, restoring, and enhancing important natural and man-made resources. Again, project permit and mitigation requirements are only a start.
  - Seek opportunities to cooperatively advance federal, state, and local environmental policies, programs, and objectives as part of the department's work through close and systematic coordination with the public and concerned agencies and groups.
  - Demonstrate leadership by piloting the development and implementation of improved methods for environmental protection and enhancement.
  - Employ safe and appropriate context-sensitive design measures to ensure that project designs reflect community values as understood through proactive outreach with local stakeholders.

  - Assist municipalities and others with their environmental projects by allowing them to include their work as "betterments" in department projects so that their investments can benefit from the economies of scale associated with larger projects.

These policy goals have been incorporated into the standard operating procedures of the agency, which are known as Engineering Instructions.

NYSDOT officials felt strongly that changing the mindset of transportation employees who have traditionally viewed the environment as "something to overcome" is the key to successfully integrating environmental considerations into decision making. At NYSDOT, this meant changing the procedures and standard operating procedures of the organization, and constantly reinforcing the message at all levels of the organization.

North Carolina Department of Transportation

The North Carolina DOT has adopted an organization-wide strategy for incorporating environmental stewardship into all aspects of its operations. The general impetus for this initiative came from the adoption of a 1999 *Strategic Plan for Transportation* that incorporated several goals that related to human and natural environmental stewardship. DOT leadership adopted an Environmental Stewardship Policy that outlined the key characteristics of what environmental stewardship meant for DOT employees. As noted in this policy environmental stewardship encompasses . . . (providing an integrated transportation system that enhances the state's well-being) . . . and is reflected in the day-to-day operations by

- Safeguarding the public's health by conducting DOT's business in an environmentally responsible manner,
- Demonstrating DOT's care for, and commitment to, the environment, and
- Recognizing that DOT's customers expect the agency to provide mobility and quality of life that includes the protection of the natural resources and the cultural and social values of their community.

This vision of what environmental stewardship meant to the DOT was implemented through various organizational changes designed to emphasize a continual commitment to enhancing environmental quality. These changes included appointing the first DOT's Deputy Secretary for Environment, Planning, and Local Government Affairs; the creation of an environmental committee of the state's Board of Transportation; the appointment of a Board member with specific responsibility for representing environmental issues; incorporating environmental stewardship as part of the DOT's strategic plan; and the creation of a DOT Office of Environmental Quality.

To establish a consistent vision among its many different partner agencies, the DOT entered into formal agreements with such agencies as the U.S. Army Corps of Engineers and the state's Department of Environment and Natural Resources. The major purpose of these agreements was for joint efforts to set a common mission of furthering transportation projects while preserving the environment. The resulting "Process Improvement Memorandum of Agreement" among the three agencies committed each agency to work cooperatively to improve the process of "developing quality permit applications, issuing environmental permits, and mitigation that support timely delivery of transportation programs while minimizing disruption to the natural and human environment."

Portland, Oregon

The state of Oregon enacted land-use laws in 1973 requiring every city and county to have a long-range plan that addressed future growth and that achieved three objectives. These plans were to (1) meet the expectations established by state and local comprehensive plans; (2) establish urban growth boundaries, which must contain an adequate supply of developable land to accommodate the expected growth in a 20-year period; and (3) protect natural resources (*64*). The state's land use goals were developed by the Land Conservation and Development Commission (LCDC). The administrative arm of the LCDC, the Department of Conservation and Land Development (DCLC), reviews and approves local comprehensive plans, a procedure known as "acknowledgement."

In 1992, Portland voters approved a home-rule charter that directed Portland Metro, the region's MPO, to make regional growth management its primary mission. This charter required Metro to adopt a future vision capturing a long-range statement of the region's *outlook* and *values* as well as a comprehensive set of regional policies on land use, transportation, water quality, natural areas and other regional planning mandates. The region's transportation system plan was to integrate goods and people movement with the desired community vision of surrounding land use. Metro used an extensive public outreach effort to help identify the outlook and values of the region by asking basic questions on livability that were later used to prioritize community values.

Public response placed a premium on several quality of life characteristics, including the following that relate to environmental quality (*64*):

- A sense of community,
- Quiet neighborhoods with easy access to shopping, schools, jobs, and recreational opportunities,
- The preservation of natural areas, forests, and farmlands,
- The "feel" of the region with open spaces, scenic beauty, and a small-town atmosphere,

- Preservation of individual community's character and assets, and
- A balanced transportation system providing a range of choices, including transit, walking, biking, and cars.

Based on these desired regional characteristics, Portland Metro developed a 2040 Growth Concept that was to serve as a blueprint for regional growth. The 2040 Growth Concept complies with state land-use goals and is the basis for all of Metro's subsequent planning activities. It embraces "land use and transportation policies that will allow Metro and the metropolitan area's cities and counties to manage growth, protect natural resources, and make improvements to facilities and infrastructure while maintaining the region's quality of life." Important elements of this concept include (1) maintaining clearly defined boundaries and characteristics of the different communities in the region; (2) promoting thriving central cities, regional and town centers, station communities (i.e., areas of development centered around a light rail or high-capacity transit station with shops and services that are accessible to people using all modes of transportation); and (3) designating lands that will remain undeveloped.

Portland Metro's approach to defining a vision is very much tied to the community's desires for quality of life and future development. Oregon's strong growth management laws and a public ethic of supporting effective regional planning have resulted in an integrated approach to decision making that is unique in the United States. Many of the most significant environmental challenges facing the region are linked to land-use and development decisions. By focusing on these decisions and by putting in place strategies such as urban growth boundaries, the Portland region is attempting to preempt future environmental problems by making smart decisions today. The community-led definition of a consensus vision was the beginning of such an effort.

Puget Sound (Seattle), Washington

The Puget Sound Regional Council (PSRC) is the transportation and growth planning coordinating agency for the central Puget Sound region of the state of Washington. PSRC's Vision 2020, the region's adopted growth management, economic, and transportation strategy, guides both the region's long-range transportation planning, as well as the short-range prioritization of projects and financial strategies. Vision 2020's primary goal is to create diverse, economically and environmentally healthy communities framed by open space and connected by a high-quality, multimodal transportation system that provides effective mobility for people and goods.

Vision 2020 was based on an analysis of five alternative growth and transportation strategies, including: no action, implementing existing plans, focusing development in major urban centers, focusing development in multiple centers, and allowing growth to disperse throughout the region. The process used in developing Vision 2020 is indicative of the important role that public outreach has in providing a sense of what type of future the public desires. Figure 8, for example, indicates the results of four major public involvement activities and how each activity led to a public expression of desirable futures for the Seattle region. This public process also led

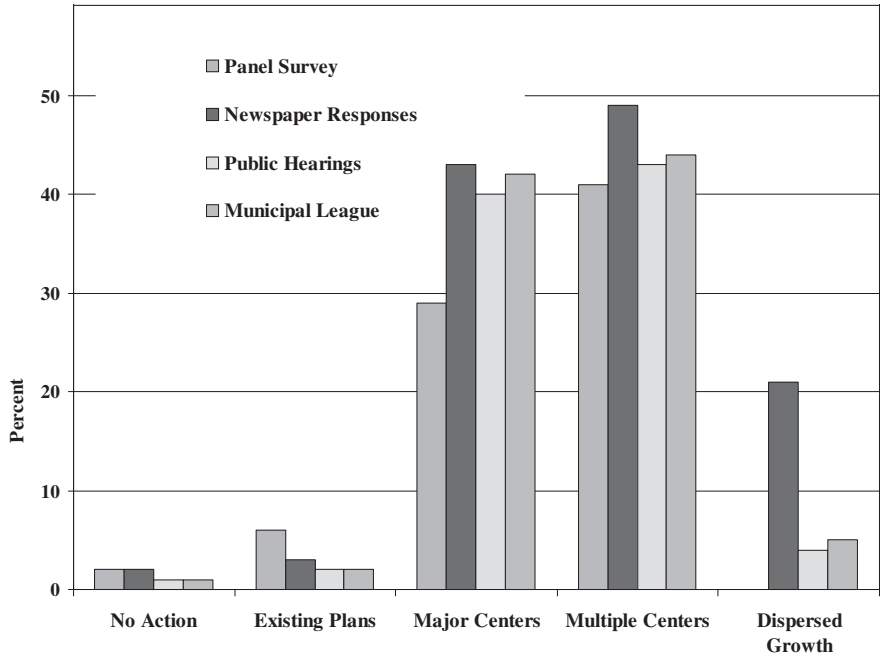


Figure 8. Public expression of support for alternative visions in Seattle.
Source: Puget Sound Regional Commission, 1990 (*65*).

to the identification of the following five strategies that were to guide planning and decision making in the region:

1. Create a regional system of central places framed by open space.
2. Strategically invest in various mobility options and demand that management support the regional system of central places.
3. Maintain economic opportunity while managing growth.
4. Conserve environmental resources.
5. Mitigate potential adverse effects of concentrating development by early action.

The main theme that surfaced from the Vision 2020 effort was that land use and quality of life should come first. Transportation investment should then be targeted to achieve whatever goals are associated with both issues. In addition, the public supported conserving environmental resources by thinking about such issues early in planning (*65*). Like Portland, the Seattle region has been known for its approach to environmental preservation and mitigation of project construction. The vision for the region, and the planning that followed, heavily considered environmental factors in the systems planning process.

Washington State Department of Transportation

The Washington State Department of Transportation (WSDOT) is responsible for developing the state's long-range transportation plan. This plan is largely a policy document that sets policy for all transportation agencies in the state. One of the guiding visions for WSDOT is growth management, which has a particularly strong legislative foundation and widespread public support in the state. The Washington State Environmental Policy Act (SEPA) requires all cities and counties to develop a growth management plan. All urbanized areas must have growth boundaries. In 1990, the state legislature passed a Growth Management Act (GMA) that required all cities and counties to plan for the transportation infrastructure needed for anticipated growth and to deny additional development if local infrastructure was not available. These concurrency requirements were aimed at tying growth to the ability of municipalities to provide the necessary supporting infrastructure.

WSDOT has been proactive in fostering environmental stewardship and sustainable transportation in its program of activities. A section of the most recent Washington Transportation Plan (WTP) is entitled "Environmental Challenges and Opportunities." Dedicated to the identification of transportation-related environmental challenges and opportunities, it states that "Environmental concerns must now be incorporated early into planning and project development to ensure minimal effects to the environment and effective mitigation for unavoidable effects." (*66*)

WSDOT's seven core principles of management for operating and improving the state's transportation systems include environmental responsibility alongside other principles of leadership, safety, delivery and accountability, communications, business practices, and excellence and integrity. The environmental responsibility principle states: "Our work shall incorporate the principles of environmental protection and stewardship into the day-to-day operations of the department as well as the ongoing development of the state's transportation facilities" (*66*).

WSDOT has adopted an Environmental Policy Statement that acknowledges the state's vital interests in protecting and preserving natural resources and other environmental assets and its citizens' health. The policy calls for the implementation of an Environmental Management System (EMS) that embraces all of WSDOT's program functions as well as the establishment of performance indicators on environmental stewardship that would be reported regularly to the public. WSDOT also has an Environmental Affairs Office that focuses on the environmental linkage to long-range transportation planning.

Wisconsin Department of Transportation (WisDOT)

Wisconsin is one of the few states that require an environmental analysis of state transportation plans, and is a good example of the challenges that might be faced when attempting to assess the environmental impacts of system plans and policies at a very broad level of application.

The state administrative rule governing this analysis is known as TRANS 400, which implements, for transportation actions, the Wisconsin Environmental Policy Act adopted in 1971. Key concepts of TRANS 400 include

Purpose: ". . . to implement the Wisconsin environmental policy act by establishing the policy by which the department will consider environmental effects of its major actions on the quality of the human environment. . . .

Policy: "The department shall strive to protect and enhance the quality of the human environment in carrying out its basic transportation mission and shall consider pertinent environmental factors consequential to any proposed action. . . .

Actions: "A System-Plan Environmental Evaluation (SEE) may be prepared in the case of proposals contained in system plans, if it is concluded they are major and significant new proposals. . . . (and) that if the plan recommendations are implemented, there will be subsequent project or site-specific environmental reviews.

SEE Content: ". . . it is recognized that, in most cases, the analysis of transportation alternatives, including multimodal analyses where appropriate,

will be qualitative, reflecting the broad level of generality of system plans. Therefore, by necessity, a SEE shall be more conceptual, qualitative, and general than is common with the individual project environmental reviews. A SEE, prepared as an integral part of a system plan, may address the following matters

(a) The range of environmental effects, including the effects on sensitive land and water resources of systems plans;
(b) In non-attainment areas, the range of air quality effects which might be expected from system plan recommendations;
(c) The range of system plan effects on energy consumption;
(d) The relation of system plans to adopted regional development goals and plans, including potential effects of transportation on land use and land use on transportation demand;
(e) The range of anticipated effects of system plans on traffic congestion;
(f) The range of anticipated effects of system plans on economic development;
(g) The qualitative comparison of the costs of system plans and expected benefits; and
(h) The range of effects of system plans on communities."

The most important benefit of the TRANS 400 process, as identified by WisDOT officials, was the early involvement of other agencies and interest groups in the environmental issues associated with transportation investment. For example, the early involvement of the Department of Natural Resources, the state's environmental agency, was considered a positive result of the SEE process. Coming to agreement early in planning on (1) the goals of the study; (2) how environmental factors were to be incorporated into the planning process; and (3) developing a sense of what types of results were expected was considered by WisDOT officials as a very important factor in the success of the planning effort.

Goals/Objectives and Performance Measures

Visions need to be translated into explicit statements of goals, objectives, and system performance measures. Goals and objectives provide specific guidance to the planning process. Performance measures are even more specific in that they target the key dimensions of transportation and other system performance that are of interest to decision makers. Goals and objectives should be strongly linked to the types of actions that result later in the process. Thus, environmental goals and objectives should have some influence over the identification of strategies and on the type of information that will be used by decision makers to choose among the many strategies examined during analysis.

Cape Cod, Massachusetts

Cape Cod is one of the nation's most environmentally sensitive areas. Given ecological habitats unique to the United States, including the largest single source aquifer in the United States, the Cape Cod's tremendous population growth over the past 20 years has resulted in significant concerns about the future of this national resource. As noted in the 2001 Regional Policy Plan, "portions of Cape Cod's sole source aquifer have been contaminated by incompatible uses, discharges of hazardous materials and excessive development densities; traffic congestion has worsened steadily, approaching gridlock conditions in some locations during the summer months; thousands of acres of shellfish beds have been closed due to pollution; open space and scenic vistas have been lost to residential subdivisions, and the architectural quality and economic viability of the Cape's historic villages have been undermined by commercial sprawl." (*67*)

In response to what residents considered to be ominous trends in population growth, the Cape Cod Commission was established in 1990 to guide the development on the Cape while preserving natural and undeveloped areas. The commission reviews and regulates developments of regional impact (DRI), recommends designating areas as "districts of critical planning concern," and prepares and oversees the implementation of a regional land-use policy plan. The regional policy plan, updated every five years, establishes broad goals that are to guide the development of more specific policies and plans, such as Cape Cod's transportation plan. In addition, the plan includes minimum performance standards that future development is required to meet.

The 2001 update of the regional policy plan adopted a different emphasis from that found in previous plans. Although previous plans outlined standards of environmental protection and desired public investment, the new plan is based on the concept of the "capacity" of Cape Cod to handle new population. In this case, capacity was related to water supply, transportation, natural systems, and municipal fiscal resources. As noted in the plan, "the 'ecological footprint' made by sprawl ultimately limits the population that can be accommodated within the Cape's capacity constraints." Part of this approach is to protect sensitive resources such as quality ground and surface water, wetlands, and plant and wildlife habitats. One way of doing this was to establish minimum performance standards that regulated how development should occur. The policy plan goals and corresponding performance standards shown in Table 5 illustrate how environmental considerations are integrated into this plan.

TABLE 5 Sample policy goals and performance standards, Cape Cod

Goal	Example Minimum Performance Standard
Encourage growth and development consistent with the Cape's carrying capacity.	New development shall be located and designed to promote redevelopment and infill.
Protect open space and minimize environmental and community impacts.	All residential and commercial subdivisions of land shall cluster the proposed development. Development shall be directed away from Significant Natural Resource Areas.
Maintain the overall quality and quantity of the Cape's ground water.	All development shall not exceed a 5 ppm nitrogen loading standard for impact on ground water.
Preserve and restore the quality and quantity of inland and coastal wetlands.	Wetland alteration shall not be permitted except when there is a finding of no feasible alternative.
Preserve and enhance the availability of open space and provide wildlife habitats.	Development shall provide permanently restricted upland open space in proportions defined in the Plan.
Reduce and/or offset expected increase in motor vehicle trips.	All development shall implement adequate and acceptable measures to reduce by 25% expected increase in summer site traffic on a daily basis. Development shall consider and accommodate the needs of bicyclists, pedestrians, and other users.
Maintain travel times and level of service on regional roads and intersections.	Development shall not be allowed if the project is estimated to add new traffic such that within 5 years generally accepted warrants for road and intersection widening are expected to be met at any location within historic districts, on scenic roads, or if natural resources are to be affected.
Encourage energy conservation and improved energy efficiency.	Carpooling, mass transit, bicycling, and walking shall be encouraged as an alternative; where appropriate, bikeways and footpath connections between commercial and residential uses shall be provided.
Encourage development that respects the traditions and distinctive character of historic village centers and outlying areas.	For new development outside designated growth centers, the footprint of an individual structure shall not exceed 10,000 square feet.

Source: Cape Cod Commission, 2001 (*67*).

Eugene/Lane County, Oregon

The Eugene-Springfield metropolitan area is the second largest metropolitan area in the state of Oregon, consisting of metropolitan Lane County and the cities of Eugene and Springfield. The region has an estimated 275,000 people and is anticipating significant population and employment growth over the next decade (the region's population is expected to grow by 41% over the next 12 years).

The Lane Council of Governments (LaneCOG), the region's MPO, is a voluntary association of 25 local governments and agencies. Because state law requires there to be a strong linkage between state goals, local comprehensive planning, and other jurisdictional plans, LaneCOG's transportation plan is closely allied with land-use and environmental goals expressed in the general plan for the metropolitan area (*68*). Given that transportation decisions are subsidiary to land use decisions, the objective of regional transportation planning is to offer several transportation choices for meeting travel needs in the most efficient and environmentally friendly manner, consistent with previously determined land use decisions.

The region's transportation plan, called TransPlan, was designed to meet two major goals

- Provide an integrated transportation and land-use system that supports choices in travel modes and development patterns that will reduce reliance on the auto and enhance livability, economic opportunity, and the quality of life; and
- Enhance the metropolitan area's quality of life and economic opportunity by providing a transportation system that is balanced, accessible, efficient, safe, interconnected, environmentally responsible, supportive of responsible and sustainable development, responsive to community needs and neighborhood effects, and economically viable and financially stable.

TransPlan included a performance and monitoring program to assess how TransPlan performs over time. Key performance measures included the following:

- Demographic variables such as population and employment, congestion, vehicle miles traveled (VMT);
- Trip length variables such as internal VMT per capita, average trip length and percent of person trips under one mile, mode shares for all trips;
- Environmental variables such as average fuel efficiency and carbon monoxide (CO) emissions;
- Land-use measures such as acres of zoned nodal development, percent of dwelling units built in nodes, and percent of new total employment in modes; and
- System characteristic measures such as percent of roadway miles with sidewalks, percent of roadways in fair or better condition, percent of households within quarter-mile of a transit stop, transit service hours per capita, percent of households with access to 10-minute transit service, percent of employment with access to 10-minute transit service, and bikeway miles and fatalities.

These data are collected for the transportation system and compared with projections that come from the regional plan.

The Eugene/Lane County experience with tying transportation planning to land-use and quality-of-life goals is not surprising given the tradition of planning found in most communities in Oregon. What is particularly interesting is the list of performance measures that are being used to monitor the progress being made by implementing projects and strategies from the transportation plan. Included in this list of performance measures are environmental variables, measures of land-use density, and transit accessibility. The system performance measures in this community closely reflect the concern to preserve the natural environment. Transportation systems planning is designed with this as a basic point of departure.

Maryland Department of Transportation

Maryland has several laws that promote a strong consideration of environmental factors in transportation planning.

- As noted previously, in 1992 Maryland enacted the Economic Growth, Resource Protection, and Planning Act, which established seven guiding visions for growth in Maryland, all geared toward ensuring that local plans were consistent with state goals.
- In 1997, Maryland's Smart Growth and Neighborhood Conservation Act and Executive Order directed growth to areas where it was most environmentally suitable, while protecting some of the state's most ecologically and environmentally valuable landscapes. This legislation called for transportation investments that satisfied current and projected travel demands while supporting smarter growth patterns.
- The 2000 Transportation Performance Act required the Maryland Department of Transportation (MDOT) to apply performance measurements to the long-range transportation plan and the consolidated transportation program (or capital improvement program). Beginning with the *2002 State Report on Transportation,* an *Annual Attainment Report of Transportation System Performance* accompanied the long-range plan and consolidated transportation program. Also, to prevent the adverse effects of storm water runoff, the state of Maryland developed 14 performance standards that must be met at all development sites.

In response to such state laws, the MDOT established policies that support the early consideration of environmental factors in systems planning. For example, two of the 10 goals of the 2002 Maryland Transportation Plan (MTP) are related to the environment, as follows:

- Develop transportation investments and facilities that support smart growth, and
- Provide responsible stewardship of natural, community, and cultural resources.

Two other goals indirectly affect the environment

- Protect the current investment in the state's transportation system before investing in system expansion (which induces sprawl); and
- Provide people with transportation choices for convenient, accessible, and effective mobility to key destinations (which effects congestion and air quality).

Each goal has at least one policy objective that provides more detailed information about the actions that the department will take to accomplish the goal. For example, the three policy objectives for smart growth are

- Direct transportation funding to priority funding areas and support the Governor's Smart Growth Executive Order;
- Design and coordinate transportation projects, facilities, programs, and services to reinforce local land-use plans and economic development initiatives that support smart growth principles; and
- Work with local communities to increase their understanding of smart growth principles and opportunities to incorporate smart growth into local plans and visions.

There is one policy objective for responsible environmental stewardship: Minimize effects on, and strive to enhance, Maryland's resources.

The environmental factors included in Maryland's system planning are considered at a strategic policy level.

Collectively, the goals and policy objectives may be viewed as guiding principles for Maryland's transportation planning process.

Similar to the experience in New York, Maryland transportation officials stated that it was very important to emphasize the significance of environmental considerations at the beginning of planning and project development in order to guide infrastructure and policy decisions away from environmentally unsatisfactory results. Maryland's State Highway Administration has assumed a national leadership role in fostering context-sensitive solutions in project development. This could not have occurred if policy sensitivity to environmental quality was not an organizational standard. In addition, Maryland's very strong growth management law has provided a context within which environmental quality can be linked to community development goals and objectives.

Minnesota Department of Transportation

The Minnesota Department of Transportation (Mn/DOT) has a long history of statewide transportation planning that is recognized nationally as being at the forefront of planning and methodology. For example, with the passage of ISTEA, Mn/DOT refined its statewide transportation planning to incorporate several new concepts (the most important being the use of performance measures to monitor progress of the statewide, district, and business plans of the agency) as well as the identification of and the targeting of resources on a statewide system of interregional corridors. Both concepts are considered key elements to the approach for updating the statewide transportation plan that is underway.

Mn/DOT's planning and programming consists of several key elements.

- Strategic plan—Defines Mn/DOT's mission and vision for meeting customers' needs.
- Statewide transportation plan—A policy document that outlines the directions and policies that are to be used in achieving the strategic plan and in attaining desired performance goals.
- Modal plans, district long-range plans, interregional corridor plans—More specific plans covering system and service deficiencies, these plans identify the improvements needed to meet goals.
- Capital programs—Programs of capital and service improvements needed over the next 2 to 10 years.
- State transportation improvement program (STIP)—The 1-to 3-year capital program for state investments.

One of the goals for Mn/DOT mandated by state law is "to ensure that the planning and implementation of all modes of transportation are consistent with the environment and energy goals of the state." Accordingly, Mn/DOT has given considerable attention to environmental considerations when transportation policies, plans and performance measures are being developed.

A recent update of the statewide plan focused on better linking Mn/DOT's vision with the policies/goals that were to guide the development of the plan. Table 6 shows how Mn/DOT officials viewed this linkage. Three strategic directions were identified: safeguard the transportation system that exists, make the network operate better, and make Mn/DOT work better. Ten policies or goals were established to guide investment decisions. Environmental protection is found in the strategic direction category of "make Mn/DOT work better."

One of the more innovative aspects of Minnesota's statewide planning activities is the use of performance

TABLE 6 Mn/DOT plan policy link with strategic directions

Strategic Directions	Safeguard What Exists	Make the Network Operate Better	Make Mn/DOT Work Better
Plan Policies	1. Preserve essential elements of existing transportation systems. 2. Support land-use decisions that preserve mobility and enhance the safety of transportation systems. 3. Effectively manage the operation of existing transportation systems to provide maximum service to customers.	4. Provide transportation options for people and freight. 5. Enhance mobility in interregional transportation corridors linking regional trade centers. 6. Enhance mobility within major regional trade centers. 7. Ensure the safety and security of the transportation systems and their users.	8. Continually improve Mn/DOT's internal management and program delivery. 9. Inform and involve all potentially affected stakeholders in transportation plans and investment decision processes. 10. Protect the environment and support community values.

Source: Minnesota Department of Transportation, 2000 (*69*).

measures to monitor the change in important characteristics of transportation system performance and other important effect categories. In the mid-1990s, Mn/DOT adopted a "family of measures" concept that reflected a range of effects and outcomes that could be affected by transportation system performance. The initial list of outcomes and measures included six items.

- Time-directness—To meet customer expectations, a predictable travel time for length of trip is maintained by monitoring
  - Number of freeway miles congested,
  - Average travel time and distance, and
  - Percentage of Minnesotans satisfied with trip time.
- Safety—Incidents and crash rates are minimized to Mn/DOT's current and potential ability to influence infrastructure, partnerships/education, full range of solutions, and driver behavior. Data gathered includes
  - Motor vehicle crash rates and fatal crashes by roadway design type,
  - Percentage of Minnesotans feeling safe while driving in work zones, and
  - Percentage of Minnesotans satisfied with the safety of roadways.
- Condition of infrastructure—An infrastructure that meets customer expectations is maintained by monitoring
  - Pavement quality index,
  - Bridge structural rating, and
  - Bridge functional rating.
- Access/basic levels of service—Services are provided to meet personal travel and shipping needs by measuring
  - Percentage of Minnesotans with satisfactory transit options,
  - Posted bridges and bridge load carrying capacity,
  - Miles of trunk highway spring weight restrictions, and
  - Percentage of Minnesotans satisfied with travel information.
- Environment—Mn/DOT is a proactive, responsible, environmental steward that checks

  Percentage of residential areas in incorporated areas exposed to excessive noise and
  - Number of wetland acres impacted and replaced by Mn/DOT.
- Socioeconomics—To ensure that transportation investments will yield the highest possible economic return to the region and are tempered by an evaluation of community values and social effects, Mn/DOT measures
  - Total VMT and freight ton miles,
  - Maintenance and construction expenditures per VMT, and
  - Percentage of highway funds going to construction.

In 2000, Mn/DOT shifted the focus of its performance measurement. A primary measurement framework now emphasized four strategic objectives: interregional corridors, multimodal investment, program delivery, and information dissemination. Many of the measures developed in the 1990s were still used in this new framework. In fact, many became even more important in that performance targets were now set for many of the measures.

A draft set of outcome measures for the policies shown in Table 6 includes similar types of measures as those described above. It is interesting to note in the environmental area that, instead of performance measures, Mn/DOT officials are considering the use of indicators to monitor environmental system conditions and performance. Indicators are defined as "a set of consistent trend data reported over time that provides important historical or predictive information on a changing condition of strategic importance." Monitoring key environmental condition indicators gives an indication of whether these conditions are improving or worsening. However, such changes might not be directly related to departmental activities.

An Mn/DOT advisory committee has identified the following five areas where indicators are considered appropriate:

- *Air*—Air quality, fleet emissions;
- *Water*—Water quality, water quantity, wetlands and erosion control;
- *Land*—Habitat/wildlife, special parks/wildlife and recreation areas, vegetation quality/sustainability;
- *Community and quality of life*—Context-sensitive solutions, environmental justice, noise; and
- *Operations*—Construction sustainability, maintenance waste materials management.

Mn/DOT officials are still developing a final set of indicators for these categories. An example of the type of indicators being considered includes "ambient concentrations of pollutants and greenhouse gases" for air quality.

The Mn/DOT example illustrates one of the most extensive efforts in the United States by a DOT to develop and use performance measures in its management of the statewide transportation program. Environmental stewardship is part of the list of measures that provide such guidance. In addition, Mn/DOT is considering the use of environmental indicators to provide reference points of progress in meeting statewide and regional goals in environmental quality.

Pennsylvania Department of Transportation

The Pennsylvania Department of Transportation (PennDOT) developed a long-range multimodal transportation plan for 2000 to 2025 based on an extensive public involvement program to identify the critical issues or major themes that reflect the state's transportation needs and desires. PennPlan, as the plan is called, is a cooperative venture involving PennDOT; MPOs; local development districts (LDDs); county planning commissions; and local, state, and federal

environmental resource and regulatory agencies such as the Environmental Protection Agency, the Department of Environmental Protection, the U.S. Department of Agriculture, State Historic Preservation Service, and the U.S. Army Corps of Engineers; as well as the general public.

This process resulted in the identification of 10 goals that have been translated into 30 tasks or objectives, each with targets to measure the state's progress toward success. Through an annual achievement report, PennDOT systematically monitors and reports on the implementation of the plan objectives and progress toward meeting targets. PennPlan includes all modes of transportation: highways, public transit, passenger rail, freight rail, air, water, bicycle, and pedestrian facilities, as well as the intermodal connections between these modes. The plan is usually updated when there is a change of administration, (i.e., usually on four-or eight-year cycles).

PennDOT conducted extensive public surveys in developing its vision for the 2025 plan. In addition, PennDOT reviewed the transportation plans of the state's metropolitan and rural transportation planning organizations. From this information, 10 statewide goals for transportation planning emerged. Of the 10 goals, one emphasized improving the environment. Four other goals indirectly related to preserving or improving the environment, including

- Make transportation decisions that support land-use objectives,
- Develop transportation alternatives and manage demand,
- Provide smooth and easy connections between transportation alternatives, and
- Inform and involve the public and improve customer service.

Some of PennDOT's 30 objectives were directly related to the environment, including

- Develop and implement a program to analyze environmental impacts in conjunction with the PennPlan corridor analysis program;
- Consistently meet the requirements of the Clean Air Act, and achieve compliance with all relevant environmental laws and regulations;
- Incorporate strategies identified under the Pennsylvania Greenways Partnership Commission Action Plan and the 21st Century Commission Report into the project development and design processes;
- Promote the enactment of airport hazard zoning ordinances;
- Increase urban and rural transit systems ridership;
- Reduce dependence on single-occupancy vehicles;
- Promote telecommuting as an alternative to traditional work travel; and
- Implement the objectives contained in the Statewide Bicycle and Pedestrian Master Plan.

PennDOT has developed one or more performance measures for each objective, as well as quantitative targets to be met within designated time frames. Table 7 shows examples of such performance measures and targets for selected objectives. Each year, PennDOT reports on its progress toward achieving the preset targets or objectives. It also provides an assessment of whether it is on track with meeting the overall objective at the end of the allotted time frame.

TABLE 7 Sample PennPlan objectives, performance measures, and targets

Objective	Performance Measure	Target
Develop and implement a program to analyze environmental impact in conjunction with the PennPlan corridor analysis program (#5)	Number of environmental impact analyses completed	Two analyses completed per year
Increase urban and rural transit systems ridership (#17)	Percentage increase in transit ridership, using 1997 as the base year	Ridership increased by: 9% (2003) 16% (2010) 26% (2020)
Reduce dependence on single-occupancy vehicles (#17)	Increase vehicle occupancy rate (VOR)	VOR increased by: 5% (2003) 10% (2010) 20% (2020)
Promote telecommuting as an alternative to traditional work travel (#22)	Increase telecommuting as reported in the national censuses, with 2000 census as base	Telecommuting increased by: 15% (2010) 22% (2020)
Implement the objectives contained in the Statewide Bicycle and Pedestrian Master Plan (#29)	Number of objectives implemented	100% of short-term objectives implemented by December 31, 2001 100% of mid-term objectives implemented by December 31, 2004 75% of long-term objectives implemented by December 31, 2010

Source: Pennsylvania Department of Transportation, 2001(*70*).

Southern California

Southern California is the largest metropolitan area in the country. Encompassing 38,000 square miles, and home to more than 17 million people (approximately one half of California's population), Southern California has one of the largest concentrations of employment, income, business, industry, and finance in the world.

The Southern California Association of Governments (SCAG) is the MPO for six Southern California counties and 184 cities. Like many of the larger MPOs in the country, SCAG faces several challenges and opportunities in providing effective transportation services and infrastructure in such a multijurisdictional environment. While Southern California is one of the most prosperous and productive metropolitan areas in the world, the metro area is currently grappling with urban congestion and air quality issues. Projected growth over the next two decades has the potential to exacerbate these already critical issues

SCAG's Regional Transportation Plan has identified six regional goals and several corresponding supporting policies (*71*). One of the goals states that the plan will "ensure that transportation investments are cost effective, protect the environment (including air quality), promote energy efficiency, and enhance the quality of life." In addition, two other goals reinforce priorities that will protect the environment

- Encourage land-use and growth patterns that enhance the livability of our communities and maximize the productivity of transportation investments, and
- Develop regional transportation solutions that complement the subregional transportation systems and the land-use plans of communities within the subregions.

SCAG also has adopted a performance-oriented approach toward systems planning and decision making. Environment-oriented measures that SCAG monitors on a periodic basis include

- Measures for vehicle emissions and particulate matter,
- Mobility measures that capture such system attributes as the average work trip travel times and percent of P.M. peak travel in delay,
- Accessibility measures that capture such user-based attributes as work opportunities within 45 minutes of door-to-door travel time and average transit access time,
- Equity measures that capture various benefits and burdens by income and racial groups,
- Reliability measures that capture average on-time arrivals per mode, and
- Cost-effectiveness measures that capture return on total investment.

Other measures being considered include livable communities and transportation sustainability measures. In addition, SCAG publishes an annual state-of-the-region report that tracks a series of indicators related to major issues in the region. The report includes user-based, as well as system-based, indicators. An annual state-of-the-commute survey collects information on commuters' travel behavior and attitudes toward their commutes (e.g., traffic congestion and alternative travel modes), as well as demographic characteristics of commuters in the six-county region.

Lake Tahoe Region

Like Cape Cod, the Lake Tahoe Region is among the most environmentally sensitive areas in the United States In the 1960s, after many years of rapid growth and public concern about the effect of this growth on the natural environment, the states of California and Nevada created a bi-state compact, later ratified by the U.S. Congress, that formed the Tahoe Regional Planning Agency (TRPA). TRPA was the first multistate environmental planning agency formed in the United States. One of the innovative aspects of this compact was that the starting point for urban and infrastructure planning was first to define environmental thresholds that reflected the capacity of the natural environment to support development. Only then would infrastructure investments be considered that resulted in environmental performance within the threshold values.

TRPA was also given regulatory powers to distribute new residential and commercial development in the region in such a way as to meet environmental targets. In the 1980s, when TRPA first began to develop the comprehensive plan and environmental program for the region, TRPA board members used these powers to declare a 32-month moratorium on new land development until the plan was developed. Only recently did the U.S. Supreme Court declare that the moratorium was not considered a "taking of private property" and thus subject to compensation.

A regional plan, adopted in 1987, outlined the goals for the region, including a Code of Ordinances to regulate land use, density, rate of growth, land coverage, excavation, and scenic impacts. The regional plan also included a comprehensive monitoring program that followed progress in meeting threshold values in the following categories: water quality, soil conservation, air quality, vegetation, fisheries, wildlife, scenic resources/community design, recreation, and noise.

All other planning efforts (e.g., that relating to the regional transportation plan) are targeted to meet environmental carrying capacities. For example, the following goals were identified for the regional transportation plan. Note the prominence given to environmental capacity in the overall transportation strategy as follows:

- It is the goal of the Regional Transportation Plan to fulfill the requirements of the Tahoe Regional Planning Compact;
- It is the goal of the Regional Transportation Plan to attain and maintain the Environmental Threshold

Carrying Capacities and federal, state, and local transportation standards;
- It is the goal of the Regional Transportation Plan to establish a safe, efficient, and integrated transportation system which reduces reliance on the private automobile, provides for alternative modes of transportation, and serves the basic transportation needs of the citizens of the Tahoe Region, supports the economic base of the region in the movement of goods and people, and minimizes adverse effects on man and the environment;
- It is the goal of the Regional Transportation Plan to provide for the reactivation of the Tahoe Transportation District to enable the TTD to fulfill its role as defined by the Tahoe Regional Planning Compact; and
- It is the goal of the Regional Transportation Plan to research potential funding sources as referenced in the RTP-AQP Capital Improvement Program and as referenced in the Lake Tahoe Transportation Summit Final Report, dated June 20, 1991.

As noted earlier, TRPA monitors progress toward achieving environmental capacities by measuring a selected set of environmental indicators. These indicators are shown in Table 8. The Tahoe Regional Planning Compact requires that

TABLE 8 Measures of environmental benefit for Lake Tahoe Region

Indicator	Unit of Benefit
Air Quality	
Carbon monoxide	Improved level of service
Ozone	Hydrocarbon, NOx emissions
Particulates	Stationary burning dust control
Visibility	Dust control; SO_2 emissions
US–50 traffic volume	Park/US–50 volume reductions
Air quality/wood smoke	Wood heater emissions/burn time
Vehicle miles traveled	VMT reduced
Atmospheric nutrient loading	NO_3 emission reductions
Fisheries	
Lake habitat	Acres improved
Other habitat	Acres improved
Stream habitat	Miles improved to excellent
Stream habitat	Miles improved to good
Stream habitat	Miles improved to marginal
In-stream flow	Base flow maintained
Noise	
Single event (aircraft)	dBa improved
Single event (other)	dBa improved
Community	CNEL dBa improved
Recreation	
High quality rec experience	Unitless
Multi-use trails	Miles paved
Multi-use trails	Miles unpaved
OHV trails	Miles acquired
Dispersed recreation	Acres acquired
Capacity for general public	Capacity
Winter day use	PAOTs
Summer day use	PAOTs
Overnight use	PAOTs
Soil Conservation/SEZ	
Impervious cover	Square feet of land coverage
Disturbed land	Acres revegetated
Hard coverage	Acres retired
Roadway	Miles obliterated
Soft coverage	Acres retired
Sensitive land	Acres acquired
Naturally functioning SEZ	Acres restored

(*continued*)

TABLE 8 (*Continued*) Measures of environmental benefit for Lake Tahoe Region

Scenic Resources	
Travel route ratings—roadway units	Units > 15 in attainment + points
Travel route ratings—Shorezone units	Units > 7 in attainment + points
Scenic quality ratings	Maintain/improve numerical ratings
Public recreation area ratings	Maintain/improve numerical ratings
Community design	Consistency with standards/guides
Vegetation	
Relative abundance and pattern	Area/location
Prescribed burns	Acres treated
Forests	Acres mechanically treated
Revegetation	Acres revegetated
Uncommon plant communities	Species cover/area
Sensitive	Number of population sites
Special species	Acres protected
Wildlife	
Special-interest species	Number of population sites
Critical wildlife habitat	Acres acquired/improved
Habitats of special significance	Acres improved/acquired
Forest habitat	Acres improved/acquired
Meadow habitat	Acres improved/acquired
Riparian habitat	Acres improved/acquired
Water Quality	
Turbidity	Reduced sed/nutr discharge
Pelagic Lake Tahoe winter clarity (Secchi depth)	Reduced sed/nutr discharge
Pelagic Lake Tahoe winter clarity (CIP)	Acres treated; source control
Winter clarity—(% of private properties BMPs)	Miles of road BMP
Pelagic Lake Tahoe winter clarity (road BMPs)	Miles improved
Pelagic Lake Tahoe winter clarity (trail BMPs)	Miles improved
Pelagic Lake Tahoe winter clarity (slope stable)	Acres improved
Pelagic Lake Tahoe winter clarity (runoff treated)	Miles conveyance treated
Phytoplankton PPR	< N.P. Fe discharge
Tributary water	Percent of watershed treated
Runoff volume	Percent of runoff treated
Runoff water	Acres intervening treated
Groundwater	Volume runoff infiltrated
Other lakes	Maintain 1991 study level

Source: Tahoe Regional Planning Agency, 2003 (*74*).

TRPA assess the progress toward these indicators at least once every 5 years.

Toledo, Ohio

The Toledo Metropolitan Area Council of Governments (TMACOG) is a voluntary association of local governments in Northwest Ohio and Southeast Michigan responsible for intergovernmental cooperation and planning. Planning responsibilities include the adoption of areawide plans and policies for transportation, land use, water quality, and the environment.

To establish a direction for the 2025 regional transportation plan, the TMACOG Transportation and Land Use Committee adopted a statement of goals and objectives based on a vision statement for the region's transportation system that was developed at annual regional meetings of transportation stakeholders (*72*). The four goals were

- Enhance the region's economic competitiveness in the worldwide economy,
- Be an integrated intermodal transportation system,
- Be a sustainable system, and
- Enhance the region's quality of life.

Table 9 shows 12 supporting objectives for the established goals. These goals and objectives provide an interesting example of how goals can be given different levels of importance in the decision-making process. As shown, two goals, those relat-

TABLE 9 Goals and objectives for the TMACOG Transportation Plan

Type of Goal	Goal	Supporting Objectives
Primary or driving	1. Our transportation system must enhance our region's economic competitiveness in the global economy.	-Maximize job potential through transportation improvements that support economic development including revitalizing the regional core (Toledo CBD). -Maximize economic efficiency and safety for movement of goods and people. -Enhance "connections" into interregional and international transportation systems. -Maintain the existing system.
	2. Our transportation system must be "an integrated intermodal transportation system."	-Minimize delays for movement of goods and people. -Maximize ease of intermodal transfers. -Enhance viability of nonhighway modes to achieve balanced system and provide for choice of modes for many trips (both freight and passenger).
Filter or screening	3. Our transportation system must be a "sustainable system."	-Minimize negative environmental impacts on open space, natural areas, wetlands, floodplains, etc. -Maximize achievement of long-term environmental objectives (e.g., air quality goals, reduction of fossil fuels used).
	4. Our transportation system must "enhance the region's quality of life."	-Fulfill environmental objectives as described in 3 above. -Maximize reasonable access to jobs and services for all citizens of our region without regard to age, income, race, or disability, especially those in environmental justice target areas. -Help create safe and pleasant living environments in the region and avoid disproportionate impact on minority and poverty areas targeted for environmental justice issues.

Source: Toledo Metropolitan Area Council of Governments, 2000 (*72*).

ing to economic competitiveness and the intermodal nature of the transportation system, are considered to be primary or "driving" considerations in the decisions for selecting projects and strategies. Two other goals are considered to be "screening" goals, that is, goals relating to concerns about the effects associated with transportation system performance. The concept of sustainability is also incorporated into the environmental goal, where it is defined primarily as an effort to minimize the environmental impact of the transportation system.

The Analysis Process

As noted earlier, a more detailed discussion of the analysis tools and methods that could be used for environmental assessment at the systems planning level will be presented in Chapter 4. However, three concepts merit attention at this point. The first is the effort of identifying environmentally sensitive and critical areas very early in systems planning so that decision makers know at the beginning of the process where important natural and community resources are located.

The second concept is the range of alternative strategies that can be considered as part of the planning and project development process. Transportation agencies focus their efforts on identifying transportation alternatives, with little thought given early in the process to the type of strategies that might be needed to enhance the environment. As shown in this section, a wide range of strategies can be considered as part of project development and planning that are aimed at improving environmental quality in general.

The third concept is the definition of an "environmental alternative" as one of the alternatives to be examined as part of the analysis of alternatives. An environmental alternative is defined in a way that purposely avoids environmentally sensitive areas. This might mean redirecting investment to other parts of a study area, possibly substituting one form of transportation for another (e.g., meeting travel demand through transit or telecommunication substitution for automobile travel), or reducing travel demand through travel demand management (TDM) strategies.

These three concepts are very much related because the goal of an environmental alternative is to avoid sensitive environmental areas as much as possible, or at least to mitigate negative effects. Such an effort relies on an analyst's ability to locate sensitive environmental resources.

Identifying Environmentally Sensitive Areas and Resources

The consideration of environmental factors early in systems planning requires that analysts be able to identify where possible effects could occur. With the advent of geographic information systems (GIS), which will be discussed in more detail in Chapter 4, the development of databases that include spatially located environmental resources is quite feasible. Using these databases, agencies examining effects at the system, or corridor, levels can conduct "red flag" analyses to identify significant environmental resources located in a particular study area that could be a barrier to implementing a transportation improvement. The following examples illustrate the concept of identifying such environmentally sensitive areas.

Cape Cod, Massachusetts The Cape Cod Commission has identified a long list of regionally important resources that may be vulnerable to damage from development. These resources include: water recharge areas, wetlands, ponds, floodplains, habitat areas, conservation lands, open space, historic resources, regional facilities, and water supply/distribution systems. All of these critical resources have been mapped on a GIS. In addition to simply identifying resources of regional importance, Cape Cod Commission staff use the GIS to recommend the creation of Districts of Critical Planning Concern that possess "significant natural, coastal, scientific, cultural, architectural, historic, economic, or recreational resources or values of regional, statewide, or national significance." Four such areas have been designated, all focusing on groundwater, natural resource, and wildlife habitat protection. Additional development restrictions have been imposed in these areas.

The GIS capability was used with great results when the regional transportation plan was being developed. Given the policy of preserving environmentally sensitive areas, transportation officials began planning by identifying where such areas existed on Cape Cod. The final plan included a figure that showed important natural resources, including unfragmented forested habitat, bodies of water, a 350-foot buffer around vernal pools, wetlands, water supply areas, wetland wildlife habitats, and priority sites for rare species, ecological communities, and critical upland areas. Also identified were National Register Historic Districts and regional/local historic districts. Figure 9 shows the significant natural resource areas on Cape Cod. This type of information becomes an important input into the early stages of transportation planning.

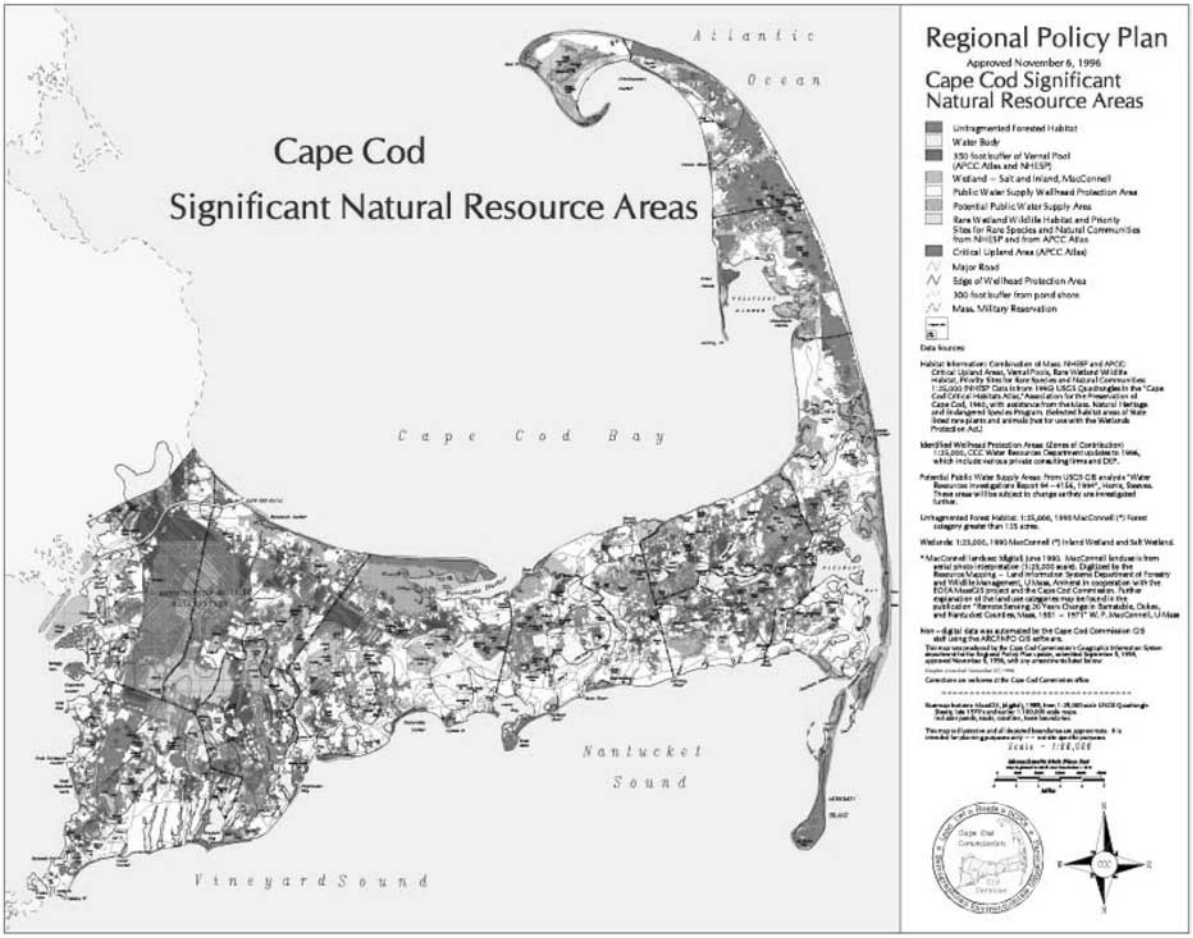


Figure 9. Environmentally sensitive areas mapped using GIS, Cape Cod.

Florida Department of Transportation The Florida Department of Transportation (FDOT) has been a national leader in the use of GIS databases for planning and project development activities. FDOT has developed an environmental screening approach used during system planning that, with the aid of a GIS database, shows all of the environmental resources in a proposed study area. Called the Environmental Screening Tool, this Internet-accessible GIS application allows all agency representatives that are part of planning to access the same information. Environmental resource agencies have agreed to use the system to provide their comments on the scope and magnitude of likely environmental impacts that will be found in particular areas, or are related to specific projects. The GIS database is housed at the University of Florida, which has been developing a comprehensive environmental resource database for many years.

With this capability, participants can conduct simple analyses to determine which environmental resources are likely to be affected by investments in a study area, as well as the likely significance of these effects. In addition to allowing individual GIS analyses, the Environmental Screening Tool collects and reports the comments of each participant, and provides read-only information for the public. This tool will be further described in Chapter 4.

North Carolina Department of Transportation (NCDOT) In 2002, NCDOT spearheaded the Ecosystem Enhancement Program, a multiagency effort to reduce environmental impacts, streamline project development, and implement the most environmentally beneficial mitigations available for ecosystems that were to be affected by transportation projects. In addition to NCDOT, the agencies involved with this partnership included the state's Department of Environment and Natural Resources and Wildlife Resources Commission, U.S. Army Corps of Engineers, Environmental Protection Agency, and Fish and Wildlife Service. The motivation for this cooperative effort was an expected significant increase in wetland (6,000 acres) and watershed (over one million feet of streams) effects that would occur over the next seven years with many new state highway projects to be built on new alignment.

The intent of this effort was to disassociate compensatory ecosystem mitigation from permit approval processes and project reviews. Unavoidable influences to ecosystems would be offset by developing a statewide program of compensatory ecosystem mitigation projects that would be in place before project-level influences were identified. This effort, in essence, would result in a net increase in wetland and riparian functions in the affected watershed, as well as in the state.

According to NCDOT officials, the benefits of this program are

- Compensatory mitigation is removed from the critical path of transportation project development by having such replacement functions already constructed before project development;
- Project effects and proposed mitigation can be "bundled" to deal with cumulative effects in a comprehensive watershed perspective;
- Given a watershed-level approach, the greatest ecological benefit will accrue with the comprehensive nature of the compensatory mitigation;
- NCDOT will be able to provide a proactive approach toward environmental stewardship that is consistent with the goals of other state and federal agencies; and
- Less staff time will be needed for project-level permit approval processes.

The basic analysis approach to developing adequate compensatory watershed mitigation is the use of a watershed assessment methodology that will define the loss of ecosystem function that might occur with different types of transportation project construction. This methodology will be used to develop watershed restoration plans. These plans will be based on standard protocols for establishing goals and objectives for each watershed, as well as identifying desired mitigation strategies. It is expected that the watershed assessments will be integrated into a state GIS layer that can then be used by NCDOT planners in the early stages of project planning.

Riverside County, California The Riverside County Integrated Project (RCIP) is one of the best examples of land-use planning, environmental assessment, and transportation infrastructure. Riverside County, one of the fastest growing counties in California and in the United States, is expected to double in population (from 1.5 to 3 million) in the next 15 to 20 years. This surge in population was expected to place significant pressure on the county's environmentally sensitive habitats, especially with the need to add new transportation infrastructure to meet future demand. In 1999, county officials, in cooperation with federal and state counterparts, initiated a planning effort designed to integrate land use, transportation, and conservation planning before infrastructure- and project-specific plans were developed. Instead of the traditional approach of mitigating effects after project planning had occurred, the RCIP was an effort to put such planning into a much broader context that would not only result in better project decisions, but also in decisions that could be expedited to implementation.

RCIP consisted of several elements as follows:

- An updated General Plan for that portion of the county expected to face the most development pressures.
- A Multi-Species Habitat Conservation Plan (MSHCP) that focused on reserving habitat for 146 species.
- A Community and Environmental Transportation Acceptability Process (CETAP) that identified four future transportation corridors targeted for further environmental assessment. A two-tiered environmental process has been used to reserve necessary right-of-way for future transportation services. (This program

element was selected by U.S. DOT as a priority project for its program in environmental stewardship and transportation infrastructure project reviews.)
- A Special Area Management Plan (SAMP), which is a targeted planning effort aimed at aquatic resource protection that can be used by resource permitting agencies in their review of development permits. (It is expected that this effort will result in a U.S. Army Corps of Engineers expedited regulatory permit program.)

The critical environmental assessment effort in the RCIP is the development of the MSHCP, created to serve as an official Habitat Conservation Plan (HCP) pursuant to the Natural Communities Conservation Plan Act of 2001. The purpose of this plan was to "enhance and maintain biological diversity and ecosystem processes while allowing future economic growth." (*73*) The MSHCP is creating a conservation area of over 500,000 acres focusing on 146 species. Once adopted, the MSHCP will require no further species surveys for 75% of the 1,146 species covered by the plan.

Three goals were defined for plan recommendations

1. **Biological Goal**—Conserve targeted species and their habitats.
2. **Economic Goal**—Improve the future economic development in Riverside County by providing an efficient, streamlined regulatory process through which the county can proceed. The plan will develop a clearly defined blueprint detailing where future development should and should not occur.
3. **Social Goal**—Provide for permanent open space, community edges, and recreational opportunities that contribute to maintaining community character.

The County Board of Supervisors also specified policy directions for developing and implementing plan recommendations. These directions included the following:

- Minimize the need for new local ordinances;
- Use existing state environmental processes to the extent possible;
- Include a range of incentives to facilitate land assembly;
- Produce a product that would not require endangered species permits for future infrastructure development in the conservation area;
- Provide for up to 10,000 acres of uncultivated land to be cultivated in the plan time horizon;
- Include measurable goals and criteria easily administered by local jurisdictions; and
- Provide implementing mechanisms that minimize the potential for wildlife agencies to suspend the county's permit as a result of local jurisdiction action on an individual project, and minimize the role of wildlife agencies in future project decisions.

Approximately $30 million has been spent to date on the development of the RCIP and early implementation. The effort has included most of the important environmental, planning, and transportation agencies at the federal, state, and local levels. Critical to the success of this multiagency, multijurisdictional effort was the existence of a local political champion, who initiated the idea and nurtured it through the institutional approval structure. The success of the effort was apparent in 2002 when county voters approved an initiative to tax themselves to fund both transportation and habitat conservation projects. The many different elements of the RCIP that make it unique, and successful, are shown in Figure 10.

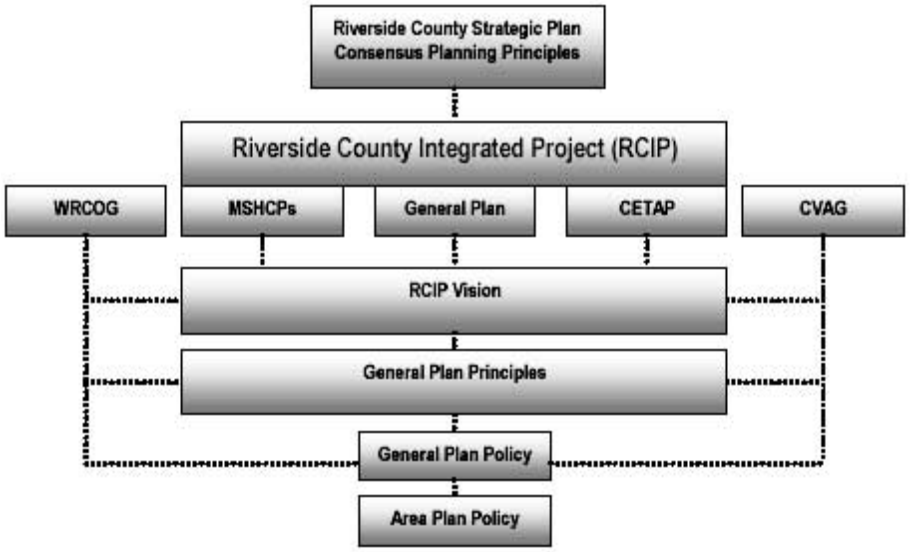
A Range of Strategies

The analysis for a typical major transportation investment decision usually focuses on a few alternatives. However, as seen in the following two cases, the types of strategies that can be considered by transportation agencies to mitigate or enhance environmental quality can range widely.

New York State Department of Transportation (NYSDOT) NYSDOT has emphasized the enhancement of the natural environmental as part of project construction and implementation for many years. The types of environmental initiative actions that have been incorporated into NYSDOT's standard operating procedures are not the type of alternatives that can necessarily replace the need for mobility or safety improvements, but they do represent an organizational commitment to go beyond the usual project requirement for mitigation. These actions are designed not to simply reduce environmental effects, but to enhance the quality of the environment surrounding a project.

NYSDOT has also made a strong commitment to a context-sensitive solutions program that emphasizes the consideration of many of the types of strategies shown below as part of the community-based design process. Consideration of these strategies, which occurs very early in the project planning process, becomes a significant part of the community effort to enhance the surrounding environment, not just mitigate project effects. There are three types of NYSDOT environmental initiative actions (*63*)

1. Examples of practices or features that should be incorporated into NYSDOT capital and maintenance projects, as appropriate
   - The practice of context-sensitive design;
   - Street ambience enhancements (e.g., benches, decorative paving, etc.);
   - Restoration of historic highway related features (e.g., lighting, stone walls, guide rails, etc.);
   - Measures to retain the integrity of historic parkways and bridges;
   - Increased wildflower plantings;



CETAP: Community and Environmental Acceptability Process
CVAG: Coachella Valley Advisory Group
MSHCP: Multiple Species Habitat Conservation Plan
RCIP: Riverside County Integrated Project
WRCOG: Western Riverside Council of Governments

Figure 10. Integrated environmental, community, and transportation planning in Riverside, CA.
Source: Riverside County, 2002 (*73*).

- Additional landscaping to enhance the appearance of noise barriers;
- Increased landscape plantings to improve roadside appearance and streetscapes;
- New or rehabilitated fishing access and trail-head parking areas;
- New or rehabilitated boat and canoe launch sites;
- New or rehabilitated historic markers and interpretive signing;
- Increased signing of important waterways and watersheds;
- New or rehabilitated scenic overlooks;
- Retrofits of existing highway drainage systems with created wetlands and storm water management facilities;
- Soil bioengineered stream banks;
- Plantings, boulders, deflectors, and other techniques to improve fisheries habitat;
- Culverts for wildlife crossings;
- New or rehabilitated wildlife viewing sites;
- Wildlife habitat improvements;
- Mitigation and enhancement for past wetland effects;
- Restored and enhanced wetlands;
- Acquisition of endangered species habitat;
- Acquisition for preservation of regionally important wetlands and upland habitat;
- Acquisition of scenic easements;
- Improvements to highway entrances of public parks, wildlife management areas, and historic sites; and
- Replacement of fixed-time traffic signals with vehicle-actuated signals.

2. Examples of some of the practices and programs that should be considered to improve NYSDOT's current environmental performance
   - Continue to identify improved ways to use deicing materials and abrasives;
   - Improve efforts to sweep/collect/recycle the roadside abrasives in the spring;
   - Continue efforts to reduce herbicide use;
   - Clean up wastes previously generated at DOT projects and facilities;
   - Encourage and implement transportation demand management, transportation system management, and Intelligent Traffic System practices;
   - Encourage alternatives to single-occupant vehicle commuting;
   - Expand Ozone Alert Day initiatives;
   - Promote alternative fueled vehicles;
   - Increase support for mass transit;

- Pilot and promote the use of recycled tires in highway embankments, glass, plastics, and aggregate in pavements, and plastic, rubber, and aggregate in noise walls;
- Preserve historic structures; and
- Promote state bike routes and greenways.

3. Examples of technology transfer and data sharing activities with other local, state, and federal resource and highway agencies to advance environmental stewardship in the transportation industry
   - Provide and/or participate in joint training;
   - Share standard details, specifications, and best management practices;
   - Share guidance manuals and handbooks;
   - Conduct joint research and share results;
   - Exchange GIS data sets;
   - Identify agency points of contact and subject matter experts;
   - Exchange staff phone numbers and e-mail addresses; and
   - Participate and present at relevant state and national conferences.

Tahoe Regional Planning Agency (TRPA) The types of strategies considered as part of TRPA's planning and enforcement program are likely the widest ranging in the United States (*74*). The environmental strategy for the region is defined in a document called the environmental improvement program (EIP). The EIP is viewed as the implementation strategy for the TRPA regional plan. The EIP, which identifies capital projects targeted at improving the condition of environmental resources, includes transportation projects (the 2001 update of the EIP identified $908 million in project needs over 10 years; $1.3 billion over 20 years). The EIP also includes strategies relating to research and study needs, program and technical assistance, and operations and maintenance costs.

In addition to the range of strategies found in the EIP, TRPA's regulatory authority allows it to allocate residential and commercial units for new development, employ mitigation fees for expected effects on water and air quality, and conduct environmental threshold evaluations to determine the level of regulatory activity that might be necessary. TRPA has divided the region into 175 plan areas and has prepared a statement for each on how that area should be regulated with respect to development and environmental improvement. A sample statement would include the following sections:

- Plan designation (including land use designation, the type of environmental management strategy that is being applied to the area, and any special designations under the TRPA authority),
- Description of the plan area,
- Planning statement (a concept of what planning purpose this area serves, e.g., it could be a receiving area for transfer of residential development from elsewhere in the region),
- Planning considerations (special planning aspects for the area, e.g., senior citizen housing should be encouraged),
- Special policies (any special considerations that need to be acknowledged up front),
- Permissible uses,
- Maximum densities,
- Maximum community noise equivalent levels,
- Additional developed outdoor recreation facilities, and
- Applicable environmental improvement programs.

By developing a statement for each plan area, TRPA has helped frame the types of alternatives and strategies that can be considered by local officials and the public. In some cases, the range of alternatives is large because the environmental carrying capacity of the plan area can handle various projects. In others, the number of alternatives is limited, reflecting the concept that environmental quality must come first, and little disturbance in an area is allowed.

Defining an Environmental Alternative

The concept of an environmental alternative implies that planning for future infrastructure must account for environmental consequences, and attempt to avoid these consequences as much as possible. While there are few examples of such an approach in the United States, the public's growing concern for environmental quality could make the adoption of an environmental alternative an important part of planning in the future. Two examples of such an approach were found in this research.

Georgia Regional Transportation Authority, Atlanta, GA The Georgia Regional Transportation Authority (GRTA) was created in 1999 by the state legislature and governor to provide leadership in meeting the air quality challenges in all nonattainment areas in the state of Georgia. At the time of GRTA's creation, this meant only the Atlanta metropolitan region. GRTA was provided not only with bonding authority to construct transportation facilities in the region, but it also had planning powers and was able to disapprove local land-use decisions for developments of regional effect. One of GRTA's first activities was to initiate major planning studies of portions of the Atlanta region where development pressures and deteriorating transportation system performance were contributing to poor air quality. One of these areas was the northern portion of the region, which had experienced one of the fastest growth rates for comparable areas in the United States over the past decade. With a population of over 1.3 million and employment of 800,000, this northern area was considered the economic center of the region.

The study began with an effort to identify strategic themes through an extensive public participation effort. Different transportation and land-use scenarios were

defined to emphasize the characteristics of each theme. One of the themes was the desire to preserve and enhance the environmental quality in the study area, as well as the region. Accordingly, the study defined an environmental scenario that consisted of transportation infrastructure and service improvements, land-use/development policies, and policies targeted at reducing travel demand. Other scenarios included meeting transportation needs, promoting growth in existing urban centers, emphasizing transit service, promoting equity in transportation investment and resulting burdens, and implementing all of the plans prepared by local communities (regardless of their relationship to the regional plan).

Figure 11 shows the environmental scenario that resulted from the analysis process. In the southern part of the study region, future growth was clustered along existing transportation corridors and around existing urban areas to avoid influencing environmentally sensitive areas. The northern part of the study area was targeted for managed growth, which used such strategies as conservation subdivision ordinances, cluster housing, and higher densities to minimize effect on the natural environment. Increased emphasis was placed on transit investment to support high-density development sites, and major freeway corridors included high-speed, high-capacity transit services in dedicated rights-of-way.

The environmental scenario showed the smallest effect on the 10 environmental criteria that were part of the evaluation process. Common elements of each of the scenarios, including many elements from the environmental alternative, were combined into three system alternatives that proceeded into more detailed analysis.

Lake Tahoe Region One of the earliest examples of an environmental alternative occurred in 1989 with the development of the Truckee Meadows-Washoe County regional plan in the Lake Tahoe Region (*75*). This plan, mandated by state legislation, required city and county master plans to comply with the development and environmental goals for a region. One of the first steps in developing the regional plan was to establish community consensus on future development patterns for the region, as well as on desired environmental quality and community quality of life. The evolution toward an agreed-upon urban form included consideration of different alternatives, each of which focused on a theme that emerged from a comprehensive public outreach effort. The best and most desirable elements of each alternative were then combined into a recommended urban growth concept for the region.

Major alternatives included the following:

1. *Current Trends Concept*: This alternative illustrated the consequences of continuing the development trends that had occurred over the past decades. These trends resulted in the continued decline of existing centers, the degradation of environmental quality, increased traffic congestion, increased fiscal stress associated with governments trying to "keep up" with demands, and the loss of open space.
2. *Capital-Driven Concept*: This alternative focused on fiscal efficiency for government programs and the

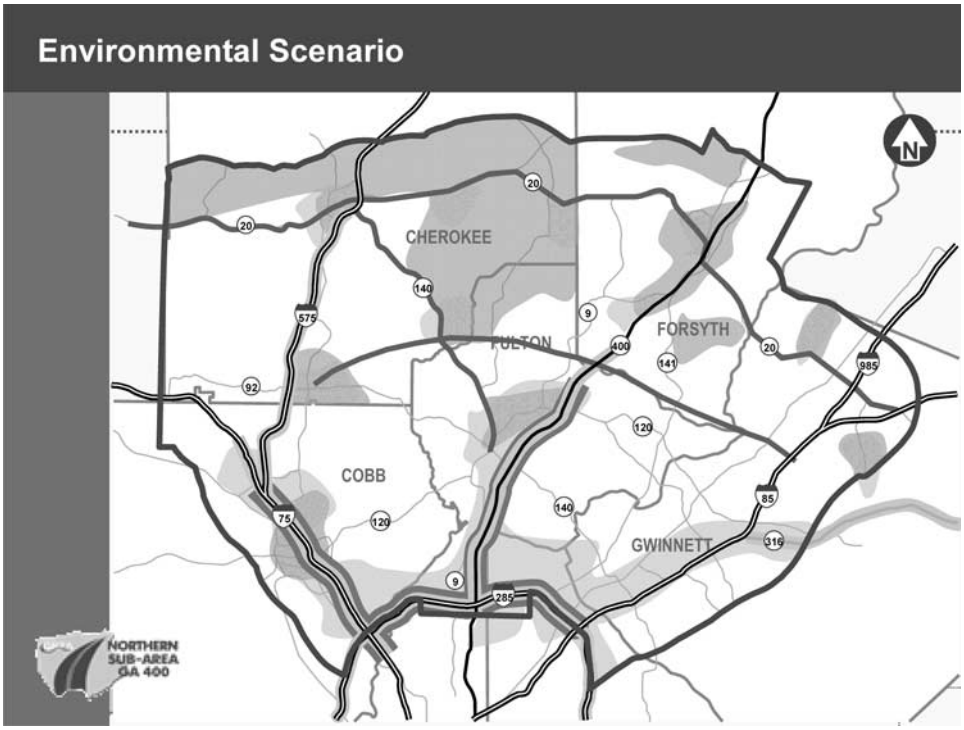


Figure 11. Environmental scenario in Atlanta.

phasing of new infrastructure. Existing infrastructure was to be used as much as possible, thus directing new development into existing urban areas.

3. *Quality-of-Life Concept*: This alternative examined how infrastructure and service policies, including land acquisition, zoning, tax incentives, development controls, environmental controls, and capital improvements could be applied to meet desired performance targets for regionally important issues such as air quality and traffic congestion
4. *Critical Areas Concept (or the Environmental Alternative)*: This alternative focused on preserving sensitive environmental areas (such as floodplains, aquifer recharge areas, and wetlands) while still providing areas for future growth. Infrastructure expansion and government policies were used to channel future development into parts of the region that could support new growth without significantly harming environmental resources.

Figure 12 shows the critical areas and the current trends concepts. Note that the biggest difference between the two is the location of urban area boundaries, which is a surrogate for the provision of the infrastructure that will support future development.

The Evaluation Process

One of the most important linkages between transportation planning and decision making is the use of evaluation criteria to define performance categories that are of interest to decision makers. For projects with possible effects on environmentally sensitive resources, the criteria of greatest interest to decision makers often relate to federal and state environmental assessment requirements. To a lesser extent, other environmental and quality-of-life effects that decision makers feel are important to their decision are also considered. For example, the types of environmental impacts that are evaluated by FDOT as part of its environmental screening include:

- Social resources
  - Land use,
  - Community cohesion,
  - Community impact assessment,
  - Economic resources,
  - Safety,
  - Mobility,
  - Civil rights,
  - Relocations,

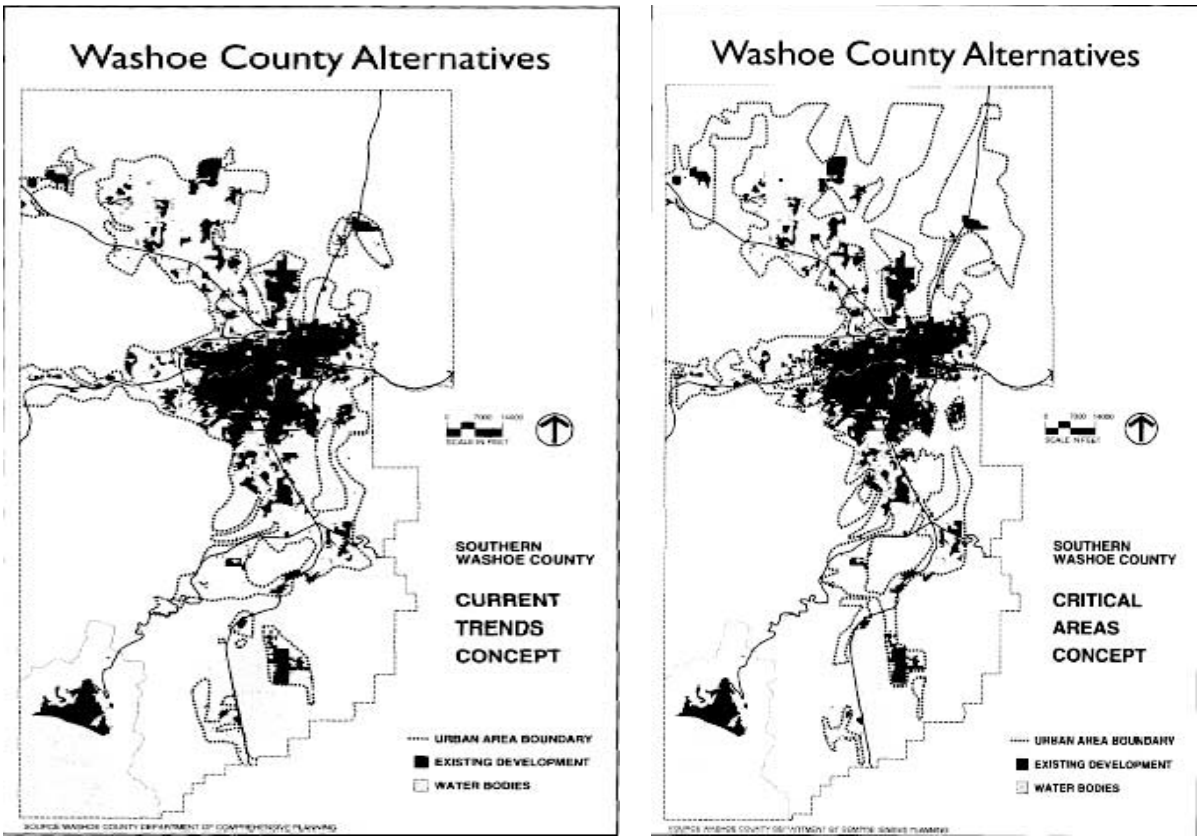


Figure 12. The environmental alternative in Washoe County, NV.
Source: Freilich, 1999 (*75*).

  - Noise, and
  - Air quality.
- Natural environmental resources
  - Wetlands,
  - Wildlife and habitat,
  - Water quality and quantity,
  - Aquatic preserves,
  - Outstanding Florida waters,
  - Sole-source aquifers,
  - Wild and scenic rivers,
  - Floodplains,
  - Coastal zone consistency,
  - Coastal Barrier Islands, and
  - Contaminated sites.
- Cultural Resources
  - Section 4(f) lands,
  - Historic sites/districts,
  - Archaeological sites, and
  - Recreation areas.

Not all of these impact categories would be necessary in the evaluation process, but because this screening tool is designed for use in all parts of the state, the state database must have data that relates to each of these categories.

The use of environmental criteria in the evaluation of plans and projects is illustrated by several case studies.

California Department of Transportation (Caltrans) Caltrans has been a national leader in designing environmentally sensitive transportation projects. Caltrans was also one of the first DOTs to enter into memoranda of agreement with environmental resource agencies to expedite project delivery. In recognition of the need for project design to reflect community values as well as to respond to federal and state law, Caltrans has embarked on several innovative project planning efforts that have actively involved a range of stakeholders early in the project planning process. The phrase used to describe the partnering in these joint planning projects is "forming an alliance relationship." (*76*) The intent is to bring diverse interests together in a common forum to frame the issues and develop a common understanding of what the project is intended to accomplish. In addition, for those issues on which there is disagreement, joint analysis of the underlying facts may allow some softening of positions. As noted in conjunction with a freeway project in Monterey County, California, the benefits of these alliance relationships were determined to be

1. Identification of shared values,
2. Joint fact-finding,
3. Collaborative innovation,
4. Indispensability (i.e., wanting to feel like you are an important part of the solution),
5. Decision sustainability,
6. Lasting relationships, and
7. Shared success.

Alliance relationships result in more than just psychological and process benefits. Experience has shown that the need and purpose statements that result from such an effort reflect a more diverse set of values and are accepted more readily by environmental constituencies; project scopes and budgets are more reflective of the types of work that must actually occur; and the participants in the alliance relationship develop a shared ownership over project implementation, that often leads to success.

One of the important steps in this process is defining the evaluation criteria that will be used to assess the relative importance of different alternatives. Part of the alliance relationship effort is to jointly define such criteria and to establish the relative weight that each will have in project planning. Figure 13 shows the results for one freeway project. Participants in project planning were asked to identify what they thought were the most important evaluation criteria associated with the project. Each participant was allowed to assign points to each criterion, and the average of all the assigned points for a particular criterion was used to determine a weight for that factor. As can be seen in Figure 13, only one criterion—accident reduction—was considered more important than minimizing environmental impacts. This result led to efforts to design the project in the most environmentally benign manner possible, while still meeting mobility and safety concerns.

Florida Department of Transportation (FDOT) To implement its policy of enhancing environmental quality, FDOT has adopted several approaches to improve its planning and design procedures. It has

- Adopted a policy on transportation design for livable communities that is intended to promote a more balanced approach toward project design.
- Developed a chapter on this design process that has been incorporated into the FDOT Plans Preparation Manual so that more flexible design standards may be considered.
- Developed and incorporated into its planning activities a nationally recognized approach toward community impact analysis.
- Established an efficient transportation decision-making (ETDM) process that will reduce time, cost, and duplication in the project development process. This is done through the Environmental Screening Tool and by involving agencies and public groups early in the process.

The ETDM process is of particular interest to the evaluation component of transportation planning and decision making. Many different agencies are allowed to judge whether significant environmental resources for particular study areas or project impact areas are likely to be affected. Screening is used early in planning to identify whether additional environmental studies will be likely. According to FDOT's ETDM description (*77*)

PERFORMANCE CRITERIA MATRIX **CALTRANS**
Prunedale Freeway Project

											Total	%
Accident Reduction	A	a	a	a	a	a	a	a	a	a	9.0	20%
Local Circulation	B	b/c	b	b	b	g	h	b	b		5.5	12%
Congestion Level	C	c	c	c	g	h	c	c			5.5	12%
Local vs Thru Traffic	D	d	d	g	h	d	d				4.0	9%
Support of Business	E	e	g	h	e	e					3.0	7%
Support of Mass Transit	F	g	h	f	f						2.0	4%
Environmental Impacts	G	g	g	g							8.0	18%
Emergency Response	H	h	h								7.0	16%
Constructibility	I	i									1.0	2%
Schedule	J										0.0	0%
											45.0	100%

a More important

a/b Equal importance

Figure 13. Evaluation criteria for freeway project planning in California.
Source: Florida Department of Transportation, 2002 *(77).*

The ETDM process creates linkages between land use, transportation, and environmental resource planning initiatives through early, interactive agency and community involvement, which is expected to improve decisions and greatly reduce the time, effort, and cost to affect transportation decisions. Efficiency is gained by two screening events and an efficient permitting process built into the current transportation planning and project development process. The screening events are the "planning" and "programming" screens.

A DOT-led working group concluded that screening had to be conducted by representatives of concerned transportation and environmental resource agencies. This screening is undertaken by an Environmental Technical Advisory Team (ETAT) consisting of 24 signatory agencies. ETAT membership is offered to federal agencies (transportation as well as environmental), state environmental agencies, the MPO within the FDOT district where the plan or project is being proposed, local planning agencies, water management districts, and Native American tribal governments.

For the planning screen, the DOT or MPO proposing a plan uploads plan information and a general needs assessment onto a secure web page and the ETAT is notified when this information is available for review. This information is presented at the systems, or corridor, level. For this level of screening, ETAT members provide information concerning key environmental resources located in the study area that need to be avoided or heavily mitigated if projects are to be proposed near these sites. In addition, secondary and cumulative effects are evaluated to understand land use and other critical systemwide changes that may occur as a result of the project. The planning screen is expected to happen once every 3 years for nonattainment areas and no more than every 5 years for other planning regions.

The programming screen occurs before a project enters the FDOT work program. The ETAT review at this level satisfies the "agency scoping" requirements of NEPA but is much more specific as to the types of effects that are likely to occur for a particular project. In addition, the ETAT identifies the types of technical studies necessary to satisfy federal and state environmental laws. Depending on the scope of the project proposed, ETAT members also may determine that their agency no longer needs to be involved in project development.

After the screening (or evaluation) has been conducted, one of the important tasks in this process is ETAT agencies' acceptance of the Purpose and Need Statement for specific corridors. ETAT members can provide comments or suggest modification to this statement. However, by putting this statement into the process for both the planning and programming screen, as project development begins FDOT expects to save considerable time to come to agreement concerning the definition of purpose and need.

San Francisco Bay Area The Metropolitan Transportation Commission (MTC) is responsible for long-range transportation planning in the San Francisco Bay Area, a nine-county region with a population of over seven million. "Environment" is one of six broad policy goals identified in the 2001 regional transportation plan (RTP), alongside other goals such as mobility (of persons and freight), safety, equity, economic vitality, and community vitality.

The RTP's environmental goal is to plan and develop transportation facilities and services in a way that protects and enhances the environment. Several environmental concerns have historically been issues in the Bay Area, including air

emissions, noise from transportation sources, effects on the Bay and wetlands, visual effects of projects, community disruption, and seismic safety. The RTP identifies several objectives for protecting and enhancing environmental quality, including the following:

- Evaluate the regional environmental effects of the RTP,
- Ensure that project-level effects are addressed and mitigated before MTC approval of state and federal funding,
- Ensure that MTC's plans and programs conform to the federal ozone attainment plan and support reductions in mobile source emissions required in the State Clean Air Plan,
- Support programs directed at improving traffic flow on local streets and freeways to minimize vehicle emissions and excess fuel consumption, and
- Provide alternatives to traveling in single-occupant vehicles and incentives to carpool or take transit.

The MTC is responsible for preparing and adopting an Environmental Impact Report (EIR) for the RTP, a systems-level analysis of the RTP required by the California Environmental Quality Act (CEQA). The intent of the EIR is to assess the range of effects that the proposed measures in the plan are likely to have on regional environmental quality and quality of life. Conducted as a program-level environmental assessment, the EIR evaluates the proposed RTP, identifies any significant adverse regional effects, and proposes measures to mitigate them.

An EIR of the 2001 RTP examined four transportation system alternatives in addition to the proposed system plan in the RTP. The analysis focused on regional, corridor-level, and cumulative effects. The alternatives were evaluated for their influence on air quality, energy, geology and seismicity, biology, water, visual and cultural resources, noise, population, housing and the social environment, and land use. With each alternative, significant effects and mitigation measures were identified for each environmental characteristic. The alternatives were then comparatively evaluated against the proposed RTP using a multiattribute scorecard as shown in Table 10.

The evaluation shown in Table 10 illustrates the type of environmental evaluations that occur at a systems level of planning. Because many of the project-specific effects are not yet known, much of the assessment is subjective. However, as shown in the Florida ETDM process described in the previous section, this subjective assessment could be undertaken by environmental resource agencies that have a great deal of expertise in determining the level and extent of potential effects. This subjective assessment could carry important weight when identifying critical steps needed to address environmental issues during the more detailed planning that follows.

Toledo, Ohio To establish a direction for the 2025 regional transportation plan, the TMACOG Transportation and Land Use Committee adopted a statement of goals and objectives based on a vision statement for the region's transportation system that was developed with input from transportation stake-

TABLE 10 Comparison of alternatives to 2001 regional transportation plan, San Francisco Bay Area

Impact Area	No Project (Alternative 1)	System Management (Alternative 2)	Blueprint 1 Alternative (Alternative 3)	Blueprint 2 Alternative (Alternative 4)
Transportation	4	2	2	1
Air Quality	3	3	3	3
Energy	2	3	4	5
Geology/Seismicity	2	3	4	4
Water Resources	3	3	3	4
Biological Resources	2	2	4	5
Noise	2	2	4	4
Visual Resources	1	2	4	4
Cultural Resources	2	2	4	4
Population, Housing, and Social Environment	2	2	4	4
Land Use	2	3	4	5
Total	25	27	40	43
Average	2.7	2.5	3.6	3.9

Note: 1 = much more favorable; 2 = more favorable; 3 = comparable; 4 = less favorable; 5 = much less favorable.
Source: Metropolitan Transportation Commission, 2001 (*78*).

holders. The committee used these goals—as well as input from the public involvement process—to identify problems, develop possible projects and policies, and evaluate and rank improvements. Transportation leaders identified 250 projects and policy concepts that were considered important to meet identified problems. Committee members organized these potential improvements into four clusters: economic development, congestion, person movement, and goods movement. Based on an original 13 transportation planning objectives, the committee developed 23 measures that would be used to evaluate the system alternatives that corresponded to the four clusters.

Each member of the committee was asked to assign a weight to each objective to capture its relative importance. Then, using an ordinal scale of 0 to 5 for each of the 23 measures, committee members evaluated each cluster of projects on a project-by-project basis. In other words, a multiattribute scorecard was used to rank order the projects in each cluster. The project cluster with the highest cumulative value was selected as the most desired alternative. In this case, the congestion cluster produced the most desirable combination of projects.

Once the congestion cluster was selected, project selection was refined by examining the relative effect of projects from other clusters when added to the set from the congestion cluster. Table 11 shows the environmental attributes used to evaluate the four alternatives to determine how well each cluster of projects contributed to an environmentally sustainable system.

Wisconsin Department of Transportation Wisconsin's legal requirement for a systems-level environmental evaluation (SEE) of all statewide transportation plans created a significant challenge to WisDOT officials. How could one provide substantive information on the likely environmental impacts of plans defined at very high levels of aggregation that focused on the use of alternative policies to influence transportation demand and financing?

The approach adopted for the SEE was conceptually similar to the environmental analysis that might be conducted for a project. For example, in a recent update of the state's highway plan, the SEE compared the environmental consequences of the recommended highway plan alternative to those associated with three other alternatives considered during the planning process. The alternatives included

- Base Case (Alternative 1)—High priority given to pavement/bridge preservation and safety improvements; low priority given to traffic movement and economic development goals.

TABLE 11 Multiattribute scorecard for evaluation of Toledo system alternatives

SCORECARDS FOR EVALUATION OF CLUSTERS
Goal II – Environmentally Sustainable System

YOUR RANKING OF THE CLUSTERS (Use values from 0 to 5)

GOAL	Objectives	Economic Development Cluster	Congestion Cluster	Person Movement Cluster	Goods Movement Cluster
Environmentally Sustainable Systems	Minimize Negative Environmental Impact				
	Maximize Long-Term Environmental Objectives				

HELPFUL EVALUATION INFORMATION — CLUSTERS

Objective	Measure	Base* Condition	Economic	Congestion	Person Movement	Goods Movement
Minimize Negative Environmental Impacts	Change from base condition in tons per day of hydrocarbon emissions produced systemwide	0	0.642	0.999	0.398	0.336
	Acres of farmland, wetlands, open space, and forests damaged or converted		3083	2860	480	3928
	Number of lane miles of pavement as a measure of emission runoff	3863	4306	4208	3911	3928
Maximize Long-Term Environmental Objectives	Total fuel consumed systemwide	483,938	497,931	493,553	478,163	491,698
	Is use of existing transportation facilities maximized to serve needs?	Based on your judgment				

**Note*: Base condition = year 2025 travel conditions if no new projects or policies were completed.
Source: Toledo Metropolitan Area Council of Governments, 2000 (*72*).

- Alternative 2—Priority given to investments in strategic corridors; lower priority given to noncorridor roads.
- Alternative 3—Priority given to all goals for the entire State Trunk Highway System.

The types of environmental criteria considered for each of the system alternatives included: air quality, energy consumption, sensitive land and water resources, indirect land-use effects, economic development consequences, and community and neighborhood effects. For each of the impact categories, the SEE analysis provided a description of the types of mitigation that would be likely to be implemented for the different projects and effects being considered. In each case, previous WisDOT experience with the mitigation strategy was highlighted. Table 12 shows the results of this evaluation.

The level of detail that often accompanies systems-level environmental assessment, especially when the plan consists primarily of policies, and not specific projects, is shown in Table 12. In this case, WisDOT officials attempted to show a subjective assessment of how one system alternative compared to each of the others.

The Project Development Process

The final part of the conceptual framework is the project development process. Traditionally, environmental factors, and the proposal of specific mitigation strategies to avoid or minimize environmental impacts, have been considered in much greater detail during the project development

TABLE 12 Environmental comparison of Wisconsin State Highway Plan alternatives

Impact Category	Plan	Base Case (Alternative 1)	Alternative 2	Alternative 3
Traffic Congestion	Congestion levels under the plan may be lower than under the Base Case, similar to levels under Alternative 2, and marginally higher than levels under Alternative 3.	Congestion under the Base Case would likely be more severe than other scenarios because it gives priority to preservation of existing pavements with no new major highway projects initiated.	Congestion under Alternative 2 would probably be marginally better than under the Base Case, but slightly worse than under Alternative 3 and the plan.	Congestion under Alternative 3 would probably be lower than other scenarios. It would be somewhat lower that under the Base Case, but very similar to congestion with the plan.
Energy	Energy consumption may be slightly less than under the Base Case, almost equal to Alternative 2, and marginally higher than Alternative 3. However, energy consumption levels for all four scenarios are within 1% of each other.	The Base Case energy consumption is within 1% of estimates of other scenarios. With fewer highway projects completed, there will likely be more congestion and somewhat more overall energy consumption.	Alternative 2 is forecasted to result in about the same amount of energy consumption in year 2020 as would the plan.	Alternative 3 requires the least amount of energy consumption in year 2020. Again, energy consumption levels for all four scenarios are within 1% of each other.
Air Quality	The plan is estimated to have total year 2020 emission levels that would be nearly 14% lower than levels estimated for year 2000.	The Base Case is forecasted to provide the smallest overall reduction in emission levels, with projected year 2020 emissions about 12% lower than year 2000 levels.	Alternative 2 is forecasted to provide an overall emission level about 13% lower than year 2000 estimates.	Alternative 3 could result in the most significant overall emission reduction. Year 2020 emissions are projected to be 14% below year 2000 emission levels.
Land Use	Indirect land-use impacts are likely to be greater than under the Base Case, including more commercial development in urban and fringe areas and added rural freeway capacity may encourage development in outlying communities.	Under the Base Case, land development should be less dispersed because of fewer expansions of major roads. The likelihood of new development along interchanges in the urban fringe is small. Similarly, fewer development impacts are likely to occur in the rural areas.	Alternative 2 may result in greater indirect land-use impacts than the Base Case and slightly more than the plan. The greatest difference in indirect land-use impacts is likely to occur in urban areas. Less development will occur near or adjacent to interchanges under this alternative.	Development would probably increase the most under Alternative 3 due to additional bypasses, interchanges, and the funding of most emerging major projects. Development along rural corridors may be encouraged. Additionally, this alternative would convert the most land from farming to transportation uses.

(*continued*)

TABLE 12 (*Continued*) Environmental comparison of Wisconsin State Highway Plan alternatives

Economic Development	The plan could provide significantly better traffic movement and access than would the Base Case. Therefore, economic development benefits associated with improved traffic movement and access are likely to be significantly greater under the plan than under the Base Case.	Overall, the Base Case is likely to provide the least economic development benefit when compared with potential benefits of the plan and Alternatives 2 and 3. Additionally, major projects will not be completed until year 2020, delaying associated economic benefits.	Alternative 2 could facilitate economic development already occurring on the Corridors 2020 system. Additionally, the completion of currently enumerated major projects will probably help serve economic development along new or expanded corridors.	Alternative 3 would probably provide the most potential benefit to economic development by placing the highest emphasis on statewide traffic movement through completing currently enumerated major projects, funding emerging major projects, and constructing the greatest number of bypasses and interchanges.
Community Impacts	Because the plan recommends significantly more improvements than the Base Case, the plan would probably have more potential effects. These include impacts to archeological and historical sites, neighborhood business districts, and additional noise in urban and urban fringe areas.	The Base Case may result in fewer negative urban community and archeological impacts than the plan. However, the Base Case may also offer fewer potential positive urban community impacts such as reducing traffic, and improving safety and access to urban core businesses.	Community impacts under Alternative 2 would be generally similar to those under the plan. The construction of some bypasses and interchanges under Alternative 2 may lead to some community separation.	The types of community impacts under Alternative 3 are generally similar to those under the plan. However, the magnitude of potential impacts under Alternative 3 would probably be greater due to the additional improvements that are included.
Sensitive Land & Water	Under the plan, sensitive land and water would be affected by the conversion of 22,000 to 25,000 acres of land to transportation uses by year 2020.	Under the Base Case, between 8,000 and 11,000 acres would be converted to transportation uses by year 2020. This is the lowest total of the four scenarios.	Under Alternative 2, between 20,000 and 23,000 acres of land would be converted to transportation uses by year 2020.	Alternative 3 calls for between 26,000 and 30,000 acres of land to be converted to transportation uses by year 2020. This would be the most land conversion of the four scenarios.
Total Costs (to 2020)	$20.4 billion	$15.2 billion	$19.4 billion	$23.8 billion
Other Benefits	Mobility would probably be better than under the Base Case, similar to traffic movement under Alternative 2, but worse than under Alternative 3.	In general, there is a slightly lower environmental cost with the Base Case as compared to the other scenarios. Also, delay in completing major projects would delay potential environmental effects.	This alternative results in improved traffic movement on the Corridors 2020 highway system.	This alternative results in improved mobility on the entire State Trunk Highway System.

Source: Wisconsin Department of Transportation, 2000 (*88*).

element of the process than in any other element shown in the conceptual framework. Although this research project focused on incorporating environmental factors into transportation systems planning, many of the case studies showed various efforts to make project development more efficient as well.

Minnesota Department of Transportation' two major efforts that illustrate Mn/DOT's commitment to incorporate environmental considerations into project development and design focus on streamlining project delivery and developing an organizational procedure for fostering context-sensitive solutions.

Project delivery streamlining: Not only was TEA 21 an impetus for looking seriously at streamlining the project development process, but Mn/DOT was also facing pressures from the construction industry, the legislature, and the public to deliver transportation projects and services in a more timely manner. In response, the Mn/DOT Commissioner created a task force of internal DOT staff with a charge to identify (1) current streamlining activities that needed support and recognition, (2) high-payoff processes that could be implemented within one year, and (3) high-payoff, longer-term changes to the program delivery structure. This task force recommended to the Commissioner that several steps

be taken to improve program delivery. These recommendations were categorized into the following areas:

- *Concurrent activities*—Where feasible, develop a "footprint concept" of the project early so that several project development steps could begin at the same time (e.g., right of way, environmental analysis, preliminary engineering).
- *Project management*—Monitor project phase milestones; shorten the time needed to obtain municipal agreements for projects; expand use of partnership agreements; use more timely mapping options; use the same project manager for all pre-construction activities; establish project decision-making teams and processes.
- *Environmental process/document*—Develop letters of understanding with resource agencies; use concise report format for environmental assessments (EAs) and impact statements (EISs).
- *Decentralization*—To the extent feasible, decentralize reviews and approvals to district offices.
- *Right of way*—Use consultants to develop total right-of-way or total pre-construction packages for projects; implement other right-of-way recommendations that were developed by an internal DOT group.
- *Organization change*—Create a full-time manager and "champion" for project delivery streamlining within the DOT, supported with three-to-five staff members and consultant resources; set aside funds to support this activity; create task forces to focus on more specific improvements to the process; jointly establish measurable goals, objectives, and time frames for streamlining activities; consider adding project development liaison engineers in the central office and environmental managers in the district offices; and consider combining preliminary and detailed design activities into one process.
- *Planning/program*—Develop a strategic plan and action plan for program delivery streamlining; incorporate provisions for streamlining into Mn/DOT business planning; and conduct a streamlining workshop as part of scoping for every new major project.
- *Communications*—Develop a communications strategy for disseminating information on streamlining activities to stakeholders; implement pilot projects; develop an annual conference that highlights good practice.
- *Training*—Develop training programs on project streamlining.

Mn/DOT acted on these recommendations by reforming the original task force as an "Oversight Committee," and included representatives from FHWA and the construction industry. Several Mn/DOT staff members were assigned, on a full–time basis, to the streamlining activity. Three task forces were created to focus on project development issues in the environmental analysis, design, and right-of-way functions. The recommendations from these three task forces were extensive and covered every aspect of preconstruction activities. The recommendations that relate most to this research were as follows:

- Central office review of roadway plans will be focused on critical plan errors only.
- A certification process will be used to validate a consultant's or district office's capability to conduct traffic forecasts without central office oversight.
- Project memoranda that do not require FHWA approvals should be the responsibility of the district offices; in the future, the FHWA-approved projects could also be shifted to the districts.
- A project liaison unit with responsibility for expediting project delivery and becoming a program delivery advocate for preconstruction activities should be established.
- The current initiative of funding environmental resource agency staff should be evaluated before expanded to other agencies.
- Environmental coordinator positions should be established in all district offices.
- Early agency coordination and letters of understanding should be used more in developing interagency cooperation on project development.
- Programmatic agreements with the State Historic Preservation Office and Native American tribes should be concluded as soon as possible.
- Concise environmental impact statements should be used where feasible.

Figure 14 shows the expected savings for three types of projects—major construction, reconditioning, and resurfacing—that would occur if these recommendations were implemented. The reduction in project delivery time compared to existing processes was 30% for major construction projects, 33% for reconditioning projects, and 17% for resurfacing projects. Of the 42 different streamlining initiatives considered, 22 were expected to result in less work, 17 were expected to result in fewer document handoffs, 12 reduced review and approval time, 5 automated project development steps, 12 made such steps concurrent, 7 changed the way consultants were used, and 10 resulted in earlier involvement of environmental agencies, thus reducing the amount of rework later in the process.

Context-sensitive solutions: Mn/DOT officials wanted to know what caused some projects to be successful (defined as being implemented on time and with public approval), while others seemed to experience significant problems. Ten factors identified that had shaped past success included effective planning and public involvement, perseverance of the individual project leader, visionary leadership on the project team, maximizing funding opportunities, integrating interdisciplinary experts, flexible and innovative design sensitivity, learning from others' success and failures, visual and environmental quality without excessive cost, presenting and

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ATTACHMENT 'B'

STREAMLINING TIME SAVINGS ESTIMATES (Pre Construction)

PHASE → SCOPING	PRELIMINARY DESIGN & ENVIRONMENTAL	DETAIL DESIGN & R/W ACQUISITION	PS & E	CONSTRUCTION
MAJOR CONSTRUCTION / RECONSTRUCTION/BRIDGE REPLACEMENT PROJECTS → TYPICAL DURATION 4-6 YEARS				
°Early Mapping (3-6 Mo) °Digital Ortho Photos (3-6 Mo) °Early Agency Coordination (6-12 Mo) °Early R/W Discussion (6-12 Mo) °Use Streamlining Workshop (1-3 Mo) ≃ 6 Mos	°EAW for EA (1-2 Mo) °Concise EIS (2-4 Mo) °R/W Footprint (3-12 Mo) °Less CO Review of Envir. Doc. (1 Mo) °Less CO Layout Review (1 Mo) °Funding Resource Agency Staff (1 Mo) °Consultant Improvements (2 Mo) ≃ 6 Mos	°Design Within Set Constr. Limits (6 Mo) °Less Plan Content (3 Mo) °Less Multiple Appraisals (1 Mo) °Districts do Plats, Descriptions and Orders (1 Mo) °MDAs by Certified Staff (3 Mo) °Eliminate R/W Auth. Map (1 Mo) ≃ 6 Mos	°Earlier Co-op Agents (1/2 Month) ≃ 1/2 Mo	°Design/Build (1-2 Years) Savings Total ≃ 18 Mos + D/B (30%)
RECONDITIONING PROJECTS → TYPICAL DURATION (27 Months in Pre Construction)				
°Early Mapping or Digital Ortho Photos (3-6 Mo) °Better Early Coordination (1 Mo) ≃ 3 Mos	°Less CO Review of Envir. Doc. (1 Mo) °Less CO Review of Layouts (1 Mo) °Programmatic Agreements (1 Mo) ≃ 2 Mos	°Design within Set Construction Limits (3 Mo) °Lesser Plan Content Req'd. (3 Mo) °Consultant Improvements (1 Mo) °R/W Improvements (3 Mo) ≃ 3½ Mos	°Earlier Cooperative Agreements (1/2 Mo) ≃ 1/2 Mo	Savings Total ≃ 9 Mos (33%)
RESURFACING PROJECTS → TYPICAL DURATION (6 Months to 20 Months in Pre Construction)				
—	°Less Envir. & Design Documentation (1 Mo) °Programmatic Agreements (1 Mo) ≃ 1 Mo	°Less Plan Content Req'd. (1 Mo) ≃ 1 Mo	—	≃ 2 Mos (17%)

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Figure 14. Streamlining time-savings estimates (preconstruction) for Mn/DOT.
Source: Minnesota Department of Transportation, 2000 (*69*).

promoting results, and exuding an attitude and tradition of excellence.

Since a project design that is sensitive to the community and surrounding environment was recognized as an important ingredient to success, it is not surprising that Mn/DOT has been a national leader in fostering the concept of context-sensitive solutions/design. Mn/DOT defines context-sensitive design (CSD) as "the art of creating public works projects that are well accepted by both the users and the neighboring communities. It integrates projects into the context or setting in a sensitive manner through careful planning, consideration of different perspectives, and tailoring designs to particular project circumstances." (*68*)

According to Mn/DOT guidance on CSD, the six core principles that serve as the basis for CSD include

- Balance safety, mobility, community, and environmental goals in all projects.
- Involve the public and effected agencies or stakeholders early and continuously.
- Address all modes of travel.
- Use an interdisciplinary team tailored to project needs.
- Apply flexibility inherent in design standards.
- Incorporate aesthetics as an integral part of good design.

In addition to incorporating CSD into the Department's *Highway Project Development Process Handbook*, Mn/DOT has aggressively pursued CSD training workshops for consultants and its own staff. Mn/DOT officials viewed many of the project development streamlining efforts as tools to better integrate environmental considerations into transportation decision making. In particular, they identified the following strategies as some of the more effective means of implementing changes to the project development process: letters of agreement, programmatic agreements, partnership agreements, concise environmental impact statements, funding environmental agency resource staff personnel, establishing project/environmental coordinators in the district offices, training, and incorporating CSD into the design procedures of the agency.

Oregon Department of Transportation Two initiatives illustrate the important linkage between the environment and transportation that is found in project development in Oregon. The Collaborative Environmental and Transportation Agreement for Streamlining (CETAS) is a formal agreement for streamlining environmental decisions in transportation planning. CETAS, an agreement made by the Oregon Department of Transportation (ODOT), resource agencies involved in approving Environmental Impact Statements (EIS), land-use planning agencies, and the Federal Highway Administration (FHWA), strives for full communication, participation, and early involvement in major transportation projects of all agencies that have a role in environmental quality.

ODOT identified six major elements of an agency initiative that enhance efficient project delivery while promoting environmental quality. These six elements include

- *Environmental management system*—process for examining the life-cycle effects of ODOT's activities,
- *Habitat mitigation program*—purchasing or creating wildlife habitats in anticipation of future project effects,
- *Natural and cultural resource mapping program*—using GIS and a database from resource agencies to map sensitive natural and cultural resources,
- *Expanded programmatic approvals*—using programmatic agreements with resource agencies to provide expeditious approvals of agreed-upon impact categories,
- *Local government and contractor performance*—training staff and consultants on environmental management practices, and
- *Expanding CETAS partnerships*—entering into agreements with other federal, state, and local agencies to become part of the CETAS program.

ODOT officials anticipate that the CETAS approach will result in improved cooperation and efficiency among agencies, greater protection of sensitive environmental resources, and projects completed within budget and on time.

The second ODOT initiative relates to the NEPA planning process. By the early 1990s, ODOT staff had determined that major investment studies (MISs), the major approach for the planning of significant federally supported transportation projects at that time, did not provide a sufficient basis for removing alternatives from further consideration. This led to the concept of a tiered EIS, in which an EIS is performed at different levels of detail during various stages of planning and project development. The tiered EIS process is typically applied to major transportation projects that are expected to have notable effects on the environment. A location environmental assessment (EA) is prepared early in project planning using existing data found at a fairly coarse level to address such issues as what project effects might occur in sensitive environmental areas. Later in the project development process, a design EIS is prepared at a more detailed level appropriate to the design proposed in the corridor.

ODOT has conducted one location EA. This location EA examined a nine-mile stretch of highway that included three rural communities and one of the most popular tourist destinations in Oregon. The highway is also the primary route to the central Oregon coast from the Portland and Salem metropolitan areas. The highway had two lanes with at-grade intersections and direct access to adjacent properties. The location EA proposed a series of actions over the next 20 or more years to convert the highway to a four-lane divided highway, replace most of the major intersections with interchanges, and remove highway access from adja-

cent properties by developing a system of local access roads linked to the interchanges.

According to ODOT officials, preparing a location EA for this project resulted in the following benefits:

- ODOT was able to evaluate the cumulative environmental impacts of highway improvements planned for the corridor over a time frame of 20 or more years.
- ODOT was able to make basic location and design decisions for improvements that will not be developed for many years, but which allowed them to be incorporated into the local long-range plan. This provided some level of certainty for property owners who wanted to know future plans.
- ODOT was able to conduct the location EA with much less design detail than was used for design-level documents. This resulted in substantial savings in time and money, and will permit future design efforts on individual segments to focus on only a single design concept and location.

The Oregon NEPA planning also involves a continuous transition between the transportation systems planning and project development processes. The process is intended to provide a continuum between system-level plans and the projects that are proposed to accomplish system-level goals. In Oregon's NEPA planning (Figure 15), many of the NEPA steps (such as defining purpose and need, identifying a range of alternatives, the evaluation criteria, etc.) are moved into system planning activities through the use of a location EIS. Before the projects are programmed, a concurrence is sought from the CETAS participants on the Purpose and Need Statement. When project development is initiated on a project, the agreed-upon range of alternatives, criteria, and even a preferred alternative are used as the basic point of departure. ODOT officials strongly believe that this process is saving them substantial amounts of time in project development.

Pennsylvania Department of Transportation Following passage of ISTEA, PennDOT implemented a coordinated environmental review for all major transportation projects that might be affected by this law. PennDOT developed a 10-step transportation process flow diagram, which involved concurrent reviews by agencies and public/agency concurrence points throughout the process and provided a systematic process to ensure that transportation projects are developed in an environmentally sensitive manner that reflects agency and public input. PennDOT's 10-step transportation process (*79*) is described as follows:

- Steps 1-3 focus on establishing project need. Information is gathered and an analysis of the need for the project is competed and reviewed with resource agencies and the public.
- Step 4 considers a full range of alternatives and establishes the preliminary alternatives that will be evaluated in greater detail in Step 5.
- Step 5 seeks agreement on detailed alternatives and is characterized by detailed engineering and environmental analysis of the smaller number of alternatives

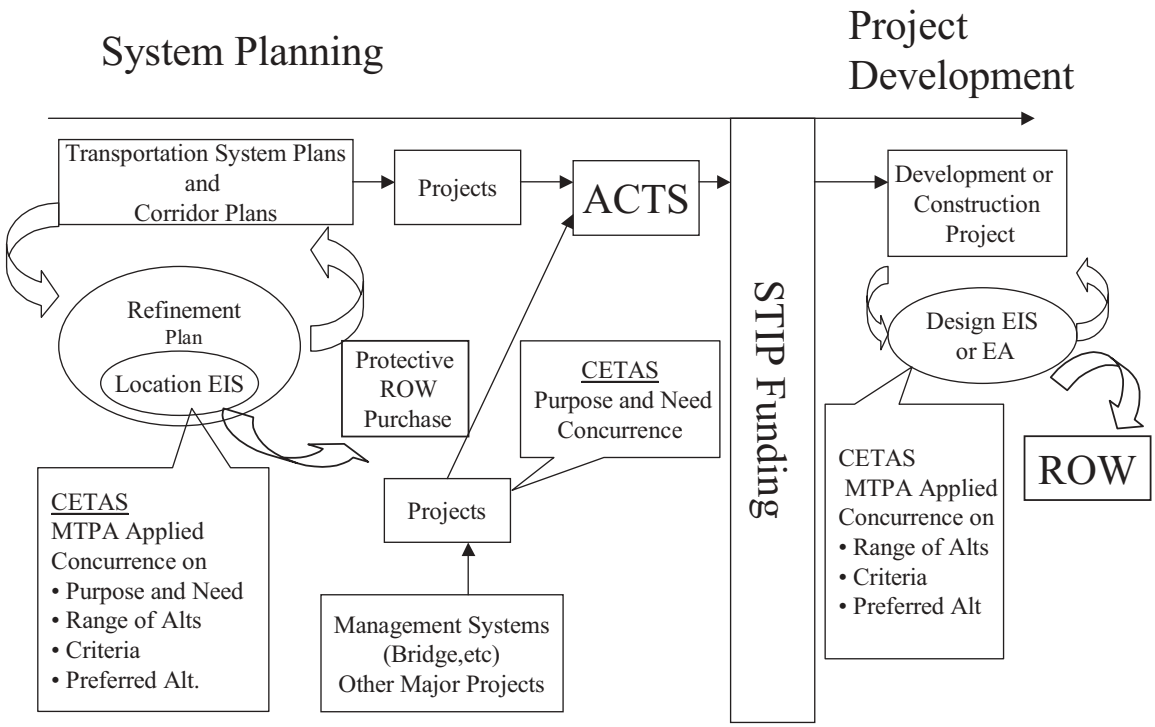


Figure 15. Oregon's NEPA process with streamlining.

identified for further development in Step 4. In this step, the alternatives to be evaluated in detail in the draft EIS are identified.
- Steps 6 and 7 involve preparation of the draft EIS, as well as circulation of the document for agency and public review, as well as a public hearing. During these steps consensus is sought for a preferred alternative.
- Step 8 involves the preparation and distribution of the final EIS, which documents and addresses comments received from agencies and the public on the draft EIS.
- Steps 9 and 10 include the preparation and issuance of a record of decision, which documents the final decision on the selected alternative and completion of a mitigation report for use in final design and construction of the project. The mitigation report outlines the measures that will be taken to lessen the effects of the project.

As part of the overall coordination effort, FHWA authorized, and PennDOT's Program Management Committee (PMC) approved, the use of Surface Transportation Program funds for Interagency Funding Agreements with seven state and federal resource/regulatory agencies to support 10 staff members who would expedite project reviews and provide technical assistance to the DOT. In 1998, the PMC approved funding for two additional positions to address the growing number of threatened and endangered species issues effecting department projects. In 1999, the PMC approved the funding of four additional positions to support major projects in one PennDOT district that was facing significant environmental project challenges. A total of 16 positions in nine state and federal agencies have been funded at an 80/20 federal-state match, with PennDOT and the Pennsylvania Turnpike Commission splitting the 20% local contribution (*80*).

Other PennDOT activities that promote improved or expedited consideration of environmental issues in transportation decision-making include

- *Environmental streamlining*—PennDOT conducts agency coordination meetings with state and federal resource and regulatory agencies to review projects, identify effects, and develop mitigation plans for projects. These meetings are attended by all federal and state agencies that either play a regulatory or advisory role relative to environmental or social resources, including the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, the Pennsylvania Department of Environmental Protection, and the Pennsylvania Game Commission.
- *Secondary and cumulative effects of projects*—PennDOT works closely with regional and local governments to identify the potential secondary and cumulative effects of projects and to develop strategies that can be used to control the long-term problems that could result from projects.
- *Innovative tools/procedures*—PennDOT has contracted with a state university to develop a catalog of major cultural and historical sites in the state. PennDOT is also developing an electronic expert system to guide users through project development (*81*). The 10-step process flow diagram ensures that transportation projects are developed in an environmentally sensitive manner that reflects agency and public input.

Washington State Department of Transportation Like all DOTs, WSDOT funds mitigation efforts to identify less harmful alternatives or to minimize and mitigate adverse effects. However, the proportion of funding dedicated to this purpose in Washington shows this DOT's high level of commitment to such efforts. At present, WSDOT spends approximately 16% of its total project funds on environmental protection and mitigation. WSDOT has also developed an environmental retrofit initiative to reduce the effect of existing transportation facilities and services on air, water, habitat, and watershed quality; minimize the use of resources; and increase the use of recycled materials. WSDOT expects to spend approximately $8.1 billion to address environmental issues over the next 20 years (*66*).

With respect to the project development process, WSDOT officials have identified 38 federal and state regulations and local ordinances that can affect their operations (*82*). WSDOT maintains an environmental procedures manual to clarify the rules and regulations that pertain to each part of the project development process.

A 2001 law, the Transportation Permitting Efficiency and Accountability Act, streamlines the environmental permit process for transportation projects. This act links planning and project development so as to reduce the redundancies in the processing of environmental documentation. In particular, WSDOT has been granted the authority to prepare certain permits, although permitting agencies retain approval authority. A Transportation Permitting Efficiency and Accountability Committee (TPEAC) has been created consisting of 17 members that include legislators; representatives from the Departments of Ecology, Fish and Wildlife, and Transportation; local governments; and other interest groups. TPEAC's tasks include identifying and integrating processes to streamline the permitting process for pilot transportation projects, projects of statewide significance, and programmatic projects.

TPEAC objectives include

- Development of a GIS application for environmental issue detection to red-flag environmental issues in the 20-year plan,
- Development of environmental cost-benefit models to improve decision support systems related to environmental mitigation and project delivery,
- Development of training materials, and
- Modification of transportation models to include environmental assessment components.

Through TPEAC, WSDOT has formed formal collaborations with several resource agencies to implement environmental streamlining procedures. TPEAC currently includes a liaison program to fund 31 staff members in natural resource agencies. This is similar to the previous example in Pennsylvania.

To simplify and clarify the permitting process for projects effecting water resources, several agencies further developed the Joint Aquatic Resource Permit Application (JARPA). JARPA consolidates seven aquatic resource permit application forms from federal, state, and local agencies into a single form, including the following:

- Section 404 permit of the Clean Water Act (U.S. Army Corps of Engineers),
- required permit of the Rivers and Harbors Act (U.S. Coast Guard),
- Hydraulic Project Approvals (Washington State Department of Fish and Wildlife), and
- Water Quality Certifications and Short-Term Modifications of Water Quality Standards (Washington State Department of Ecology).

Finally, WSDOT is studying a state highway as one of three national pilot projects chosen by FHWA to test a new process for streamlining the review and approval of transportation projects. The pilot project moves completion of NEPA requirements into the early project planning stage (*83*).

SUMMARY

This chapter presented a conceptual framework that was used to illustrate how environmental factors could be considered in the early stages of transportation systems planning, as well as in the initial steps of project development. The relevant case studies presented provide important lessons on how some DOTs and MPOs have been developing institutional strategies for promoting this early consideration.

The Caltrans case study illustrates the importance of a vision in guiding the activities of a state DOT. This vision includes important concepts relating to sustainability, environmental preservation, and social equity.

The Cape Cod Commission has been at the forefront of using GIS for inventorying and analyzing environmental resources. As such, it provides a good example of the types of environmental impacts that can be incorporated into such an approach and how this information can be used. The Regional Policy Plan that guides all other planning efforts on Cape Cod is also a good example of how policy-level guidance can provide greater sensitivity to environmental considerations as they relate to development and infrastructure decisions.

The Eugene/Lane Council of Governments example shows an MPO using a well integrated approach to land use, transportation, and environmental planning that occurs within a broader state-defined legislative framework. This framework requires statewide comprehensive planning, with transportation as just one element of the overall comprehensive plan. The case study highlights the evaluation of alternative plan scenarios based on well articulated criteria to enhance accessibility, support predetermined land-use choices, protect the environment, and preserve regional quality of life. These attributes are tracked through multiple measures of performance. This case study also illustrates a process in which environmental quality is achieved primarily through land-use strategies. Transportation planning is viewed as a supporting activity for land-use goals.

The Florida case study described a long-term involvement on the part of a DOT in linking environmental factors to transportation planning and programming. FDOT has been a national leader in context-sensitive solutions and community impact assessment. These efforts have been integrated into a new approach for screening plans and projects early in planning and project development to identify critical environmental and community effects. An extensive involvement of transportation and environmental agency staff in developing the ETDM process is an indication of the level of effort that might be necessary to develop a similar process statewide.

The important role of technology in fostering the exchange of information is also well illustrated by this case study. It is not likely that resource agencies would participate in the ETDM process if they did not have access to the web-based GIS Environmental Screening Tool. The rapid exchange of information and the visualization capabilities of identifying the extent of potential environmental impacts have provided an important enabler for the type of process that FDOT is spearheading.

The Maryland case study is a good example of evolving transportation planning in the context of a smart growth framework where increasing emphasis is placed on transportation improvements that will support smart growth from the outset rather than focusing solely on project mitigation at the end of project development.

The Minnesota case study illustrates the use of performance measures/indicators in transportation planning, as well as how environmental considerations can be included in such an approach. In addition, Mn/DOT's experience with project delivery streamlining and context-sensitive design is directly relevant to the different types of strategies that could be used for better linking planning and environmental factors.

The New York State example illustrates the significant progress that can be made in linking environmental quality to the everyday activities of a DOT. This has been done by modifying the mission of the organization and establishing a new value system among DOT employees. The internal NYSDOT engineering procedures have been modified to reflect this new environmental ethic and to provide an institutionalized means of keeping this approach in place over the

long term. New staff capabilities were introduced into the organization, and new approaches to planning and design were employed. The results have shown that not only does an environmentally sensitive approach toward planning, design, and operations provide for better decisions, but it also expedites project delivery.

The Oregon DOT experience highlights the critical importance of a legislative framework to support integrated planning and a proactive approach to preserving and protecting the environment in planning. It illustrates how a formal linkage can be created between land use and transportation planning. Oregon's CETAS process demonstrates how interagency partnerships can be used to accomplish environmental consideration early in the planning process. ODOT's model for integrating NEPA with planning is one of the first in the country to formalize and advance environmental considerations in transportation planning.

The Pennsylvania case study shows how a DOT can aggressively pursue coordination in project development based on many innovative partnerships with environmental resource agencies. PennDOT has a public-driven process for generating the overall policies for the long-range transportation plan. In addition, there is a clear link between transportation system policies and goals and the measurable objectives and targets developed to achieve these goals within specified time frames. Furthermore, there is a component of accountability in the process in which PennDOT annually presents an achievement report on its progress toward the system objectives and targets clearly defined in the long-range plan to the public.

The Portland Metro case study highlights an integrated approach to land use, as well as environmental and transportation planning supported by a legislative framework that enables comprehensive planning. The case study shows how transportation planning is used as a tool to achieve predetermined goals for managed growth that protects and preserves a region's environment and other natural resources.

The San Francisco Bay case study shows how a metropolitan area can consider the environment at the systems plan level in response to a state environmental law. This MPO has been proactive in implementing various programs to arrest major environmental problems in the metro area, including air quality, noise, loss and degradation of wetlands, and community disruption. The agency's ITS Program and Livable Communities Program; involvement in the area's Smart Growth Initiative; and efforts to address the transportation needs of minority, low-income, elderly, and disabled populations all point to continuing efforts to address environmental quality in transportation planning.

The Seattle case study provides a good example of addressing environmental factors in planning. Planning is aimed at managing regional growth as well as providing long-range transportation planning. The PSRC showcases land-use constrained transportation planning, which produces transportation decision-making supportive of land-use choices that protect and preserve the environment and other natural resources.

The Southern California case study illustrates that the traditional institutional framework for transportation and land-use decision making faces significant challenges in attempting to solve regional growth and quality of life problems in a large metropolitan area that is struggling to keep up with growth. The activities of SCAG illustrate how a transportation planning agency with such constraints can take the initiative to forge interagency partnerships that allow them to influence land-use decisions that have a direct effect on transportation.

The Tahoe Region case study probably represents the most extensive application of environmental principles to comprehensive planning of any region in the United States. Starting with the vision of the region and ending with the ordinances that are used to implement and enforce the comprehensive plan, environmental quality is a driving force in the planning and decision-making process. In addition, this case study illustrates the concept of environmental carrying capacity and the use of environmental performance measures.

The Toledo case study, which represents a typical MPO approach toward transportation planning and environmental concerns, introduces the use of a formalized multiattribute framework for the analysis of plan alternatives. The transportation plan was developed through extensive public involvement and with important input from the public and private sectors. One of the four goals that guided plan development was to create a "sustainable transportation system" (i.e., to reduce transportation effects on the natural environment). In addition, enhancing environmental quality was part of another plan goal aimed at improving the quality of life in the region. These goals were applied as various environmental attributes in the multiattribute scorecard.

The Washington State DOT case study highlights the important role that legislation can play in elevating environmental considerations to a high priority level in planning. In addition, it demonstrates the importance of funding to develop the required tools and human resources to support new planning procedures and techniques. It also illustrates the importance of formalizing institutional arrangements to advance environmental considerations in transportation planning and achieving environmental stewardship in a cost-effective manner.

Finally, the Wisconsin DOT case study shows the effect of a state rule that requires environmental assessment of transportation system plans, and the level of analysis that accompanies such an assessment. The most important benefit of the TRANS 400 process, as identified by WisDOT officials, was the early involvement of other agencies and interest groups in the environmental issues associated with transportation investment.

CHAPTER **4**

TOOLS AND METHODS FOR CONSIDERING ENVIRONMENTAL FACTORS

INTRODUCTION

As noted in Chapter 3, identifying the location and severity of potential environmental problems is one of the key challenges facing efforts to consider environmental factors in transportation systems planning. However, rapid advances in computer technology and database management capabilities have led to new tools and methods being available to planners and engineers. This chapter examines tools either being used or being considered for use. The first section discusses the results of the survey and case studies as they pertain to tools and methods used to consider the environment in planning. Next, recent and ongoing research is reviewed to discuss emerging tools for addressing the environment in systems planning. The chapter concludes with a discussion of the methods and tools being used in strategic environmental assessments (SEAs) overseas.

COMMONLY USED TOOLS AND METHODS

The results of the DOT and MPO surveys indicate that the most commonly used tools for considering environmental factors in transportation planning are

- Data trend analysis,
- Geographic information systems (GIS) and overlay mapping,
- Socioeconomic/community impact assessment methods,
- Public or expert surveys,
- Focus groups, and
- Environmental impact models (specifically, air quality impact models).

The case studies provide a detailed look at typical or evolving tools for environmental analysis in transportation systems planning. Some of the more notable approaches are described below.

Cape Cod Commission

During the 1990s, the Cape Cod Commission developed a methodology for examining the environmental capacity limits of selected geographic areas of Cape Cod (this formed the basis for the updated Regional Policy Plan). Two studies of environmentally sensitive areas, the Outer Cape Capacity Study and the Monomoy Capacity Study concluded that both parts of Cape Cod were severely constrained by a lack of available transportation infrastructure and water supply. Projected build-out of developable land was projected to create a more serious situation. Management options identified in the studies included the identification and protection of environmentally sensitive areas such as future well sites; potential zoning changes and land acquisition; transit and travel demand management strategies; and the purchase or easements of sensitive resource areas to protect habitat and open space.

One aspect of the Outer Cape Capacity Study that was directly aimed at bringing environmental considerations into transportation planning early in the process was the use of an environmental sensitivity index. The intent of this index was to identify the amount and proximity of environmental resources to critical transportation facilities. The index was a sum of weighted scores assigned to four environmental resources—wetlands/surface water bodies, rare species habitat, rare plant habitat, and critical upland areas. The index was applied to Route 6, the major highway serving the length of Cape Cod. A 100-meter band on each side of Route 6 was established as a required boundary. A score for each resource was given on the basis of the distance from the centerline of the road. A score of 100 was assigned if the centerline passed directly through the resource; the score decreased linearly with distance in the bandwidth. The indices for each of the four resource areas were then averaged to determine the environmental sensitivity of the surrounding environment for Route 6. Figure 16 shows the locations along Route 6 having varying degrees of environmental sensitivity. Wider bands indicate greater sensitivity.

Florida Department of Transportation

FDOT's efficient transportation decision-making (ETDM) process is one of the most advanced in the United States, especially when considering the level of technical support that has been provided to make the ETDM process successful. As noted in Chapter 3, the foundation of the ETDM process is the Environmental Screening Tool. This Internet-

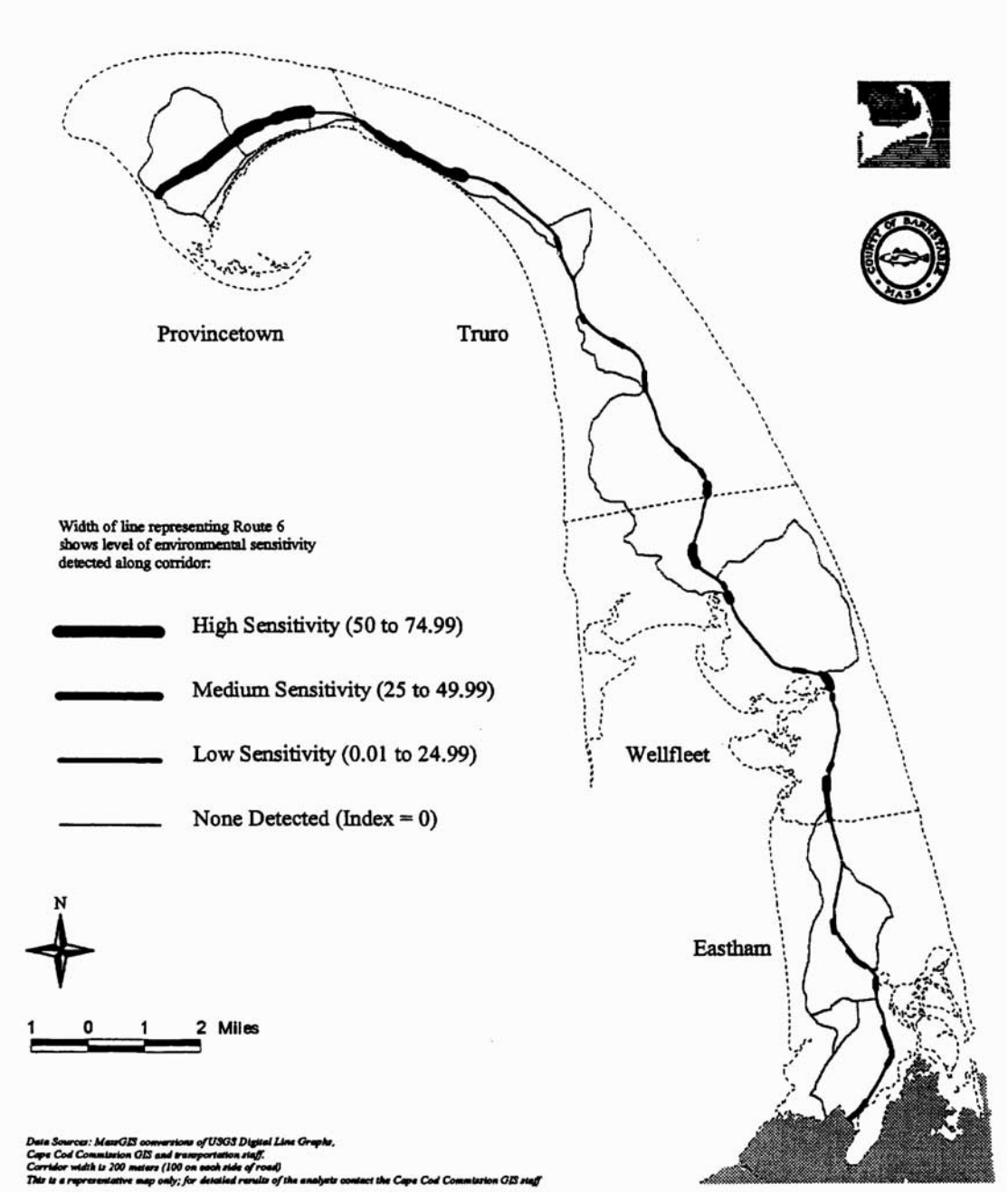


Figure 16. Environmental sensitivity index, Cape Cod.

based GIS application provides several key capabilities to the process.

- Data Input—The Environmental Screening Tool allows those responsible for transportation studies or projects (i.e., FDOT or the MPOs) to input and update information about the proposed actions. The primary data that are input relate to environmental resource information and project planning information. Environmental resource information is provided by the responsible environmental agencies.
- Standardized Analyses—Standardized analyses have been developed by environmental resource agencies and are automatically performed by the Environmental Screening Tool. For example, the tool compares the location of proposed projects with known locations of environmentally sensitive resources. Where possible, quantitative information is provided to the user of the

tool (e.g., how many acres of wetland could possibly be affected?). Data can be displayed in tabular form or in various graphical forms. The environmental resource agency representative to the ETDM process is notified when new data is received from a project sponsor. The agency is then given 45 days to conduct any direct, secondary, or cumulative impact analyses on the resource for which it is responsible.

- Summary of Comments—The Environmental Screening Tool collects the comments from ETDM participants and provides a summary of all agency comments and recommendations. In particular, agency comments associated with key issues are highlighted, especially those relating to the Purpose and Need Statement, the degree of effect of the proposed action, project scoping recommendations (including recommendations for additional technical studies), and a running summary of comments received at public meetings during the project development process.
- Read-Only Public Access—The general public is granted general access to only some components of the database. Accessible information includes such things as project description, summary impact graphics, and previously submitted comments. As configured, the Environmental Screening Tool will not allow public comments to be directly entered into the system. Comments must be submitted to an ETDM coordinator who acts as a gatekeeper for the information that is placed in the database.

The Environmental Screening Tool is used in both the system planning and programming processes to expedite the exchange of information concerning potential transportation investments or specific projects. Figure 17 shows where the screening tool fits into both the planning process and the programming decision process. Typical planning summary reports include

- Project description,
- Purpose and Need Statement,
- Agency comments,
- GIS mapping,
- Secondary and cumulative impacts evaluations,
- Public involvement comments, and
- Preliminary project concept based on agency and public input.

Programming summary reports include the following information:

- Project description and logical termini,
- Purpose and Need Statement,

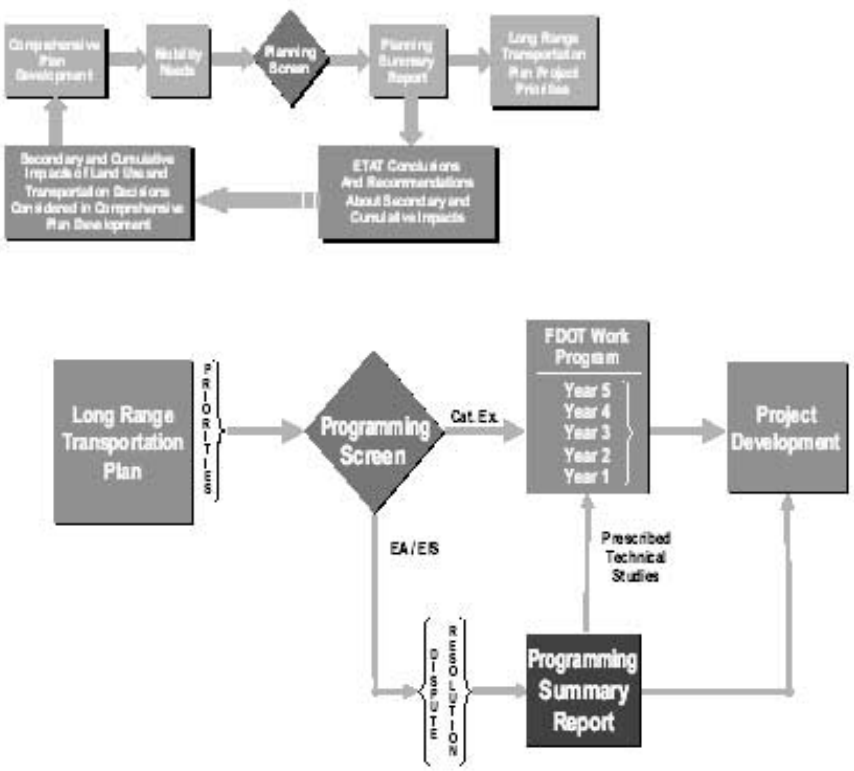


Figure 17. FDOT screening tool in planning and programming.
Source: Florida Department of Transportation, 2002 (*77*).

- Class of action determination,
- Agency comments,
- Comments from affected community,
- Preliminary project concept,
- Required technical studies to achieve NEPA compliance and project permit,
- Reasonable alternatives for further study,
- Dismissed alternatives (including reasons for dismissal), and
- Dispute resolution issues.

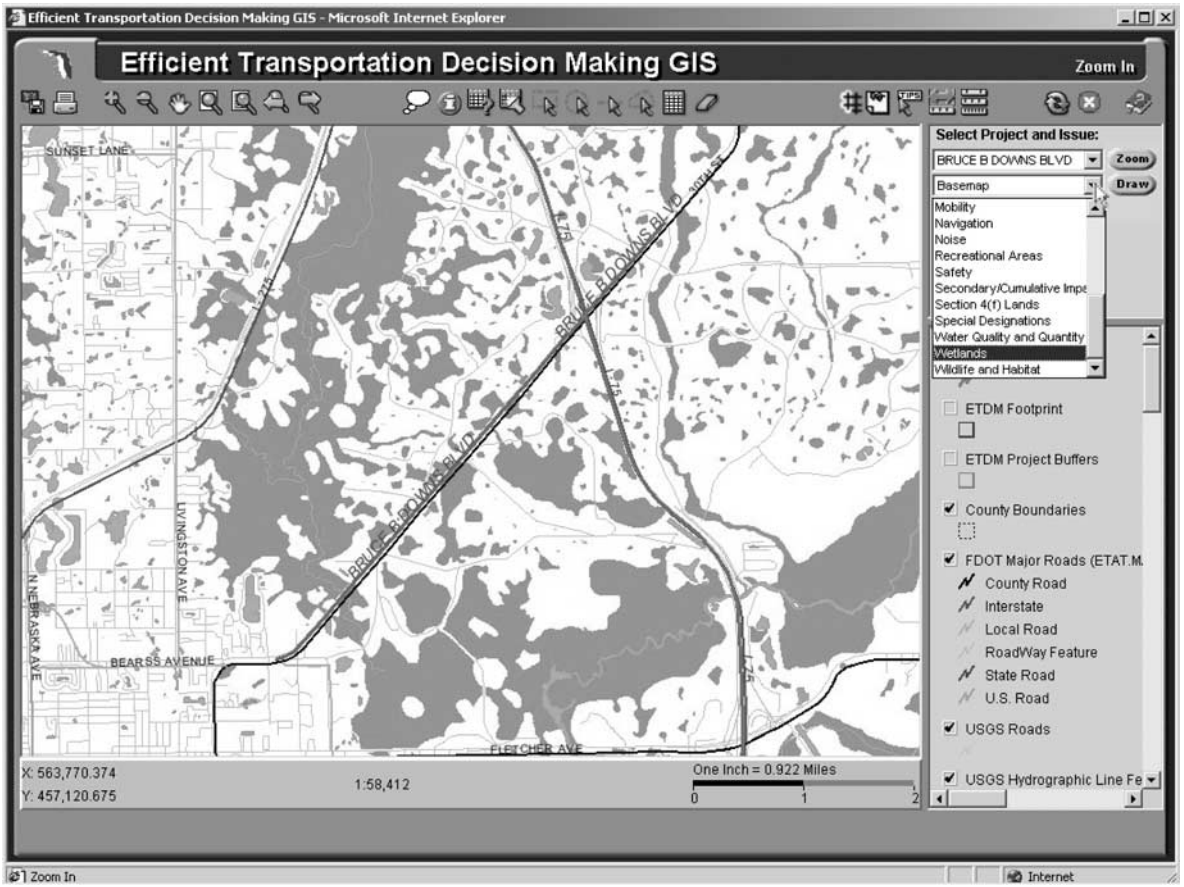
As shown, the summary reports provide a comprehensive overview of the relevant information concerning possible environmental impacts.

FDOT is developing agency operating agreements that outline the responsibilities of those who will participate in the process. In particular, these agreements relate to the types of information that will be provided by each participant, the reviews that will be conducted, and the steps that will be taken by signatory agencies to undertake required environmental analyses. Some resource agencies are still uncertain about participating in this process because of their concern about giving up legislatively mandated review powers. Trial runs of the system, however, have been so successful that it seems likely that all resource agencies will eventually participate.

Approximately $1 million has been spent on the system to date. FDOT will be working with MPOs over the next several years to put in place the technology and staff training that will be necessary to operate the system in the regions.

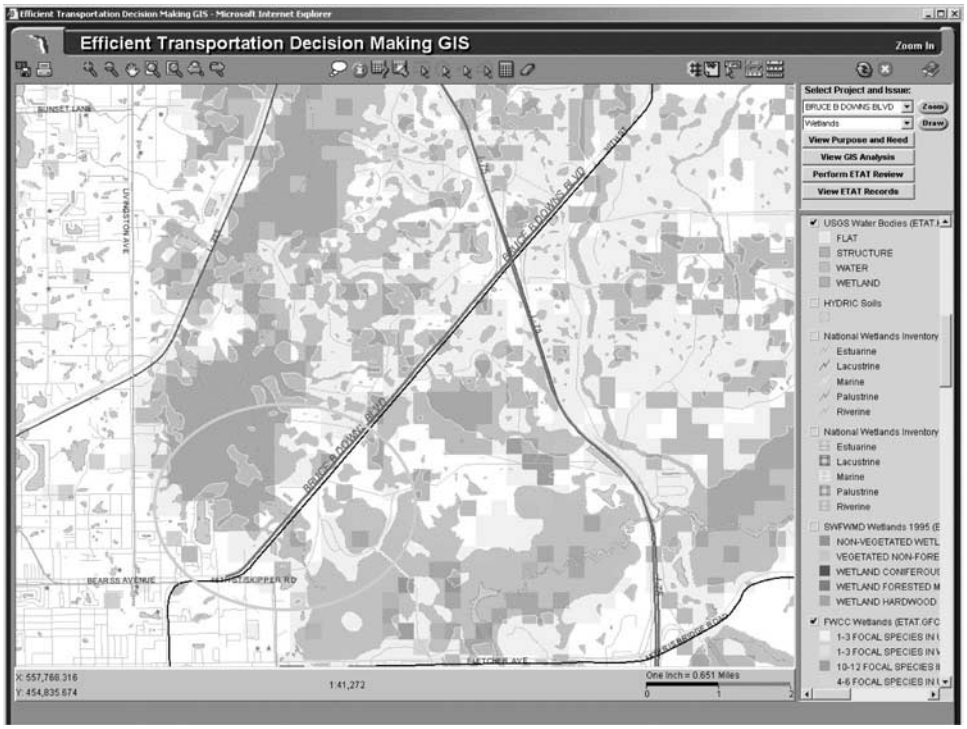
The initial FDOT assessment of the ETDM process is that it permits the identification of critical environmental issues early in the process; can narrow the scope of project plans, specifications, and estimates; eliminates the involvement of agencies that do not have to be involved in the process; maintains a continuous record of the information provided by key participants in the process; establishes a basis for permitting; and provides up-to-date information to the public. The downside is that additional staff work needs to occur earlier in the process and a substantial investment in technology is needed to keep the process running. However, FDOT officials strongly believe that the positive long-term benefits of this process will far outweigh the short-term costs.

Figure 18 shows some of the Environmental Screening Tool screens available on the system.

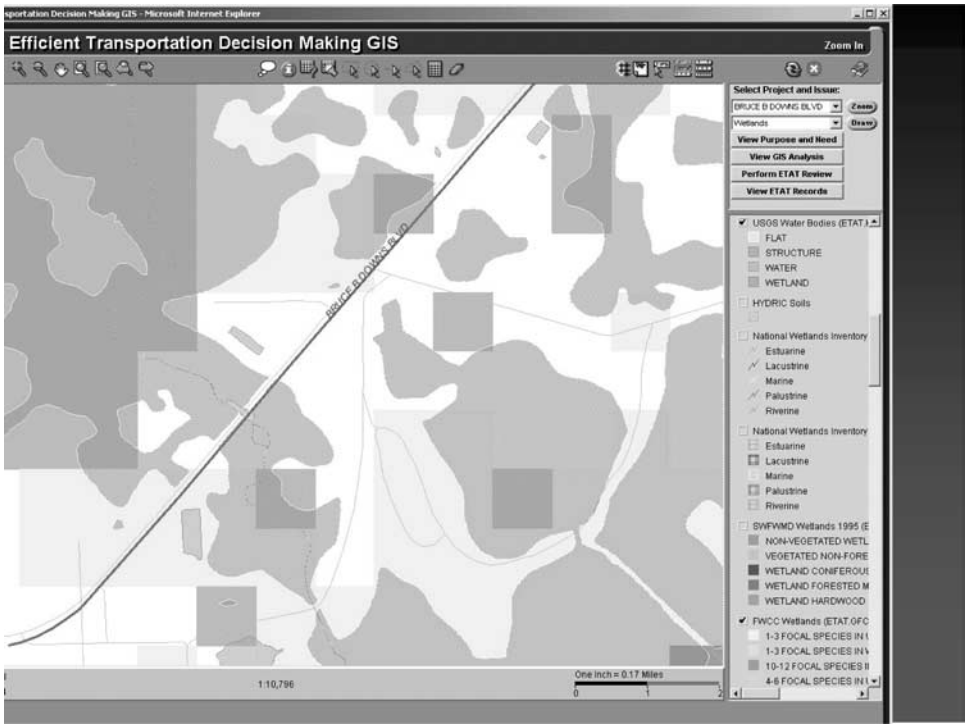


a **Identifying the Wetlands Inventory**

Figure 18. Using the FDOT Environmental Screening Tool.

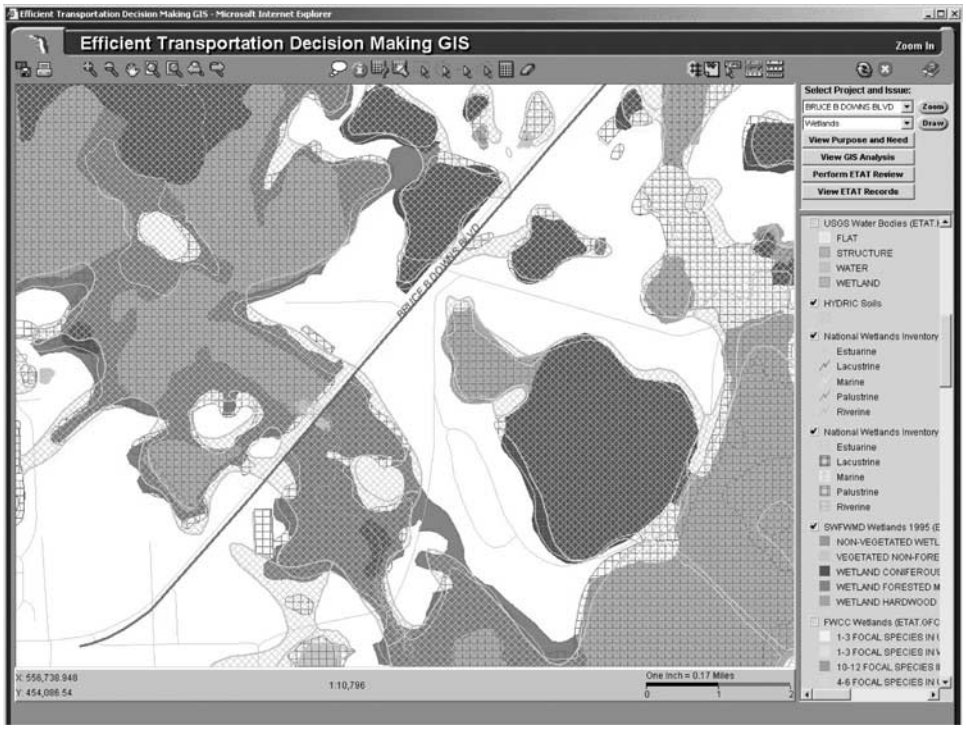


b **Identifying Wetlands by Type**

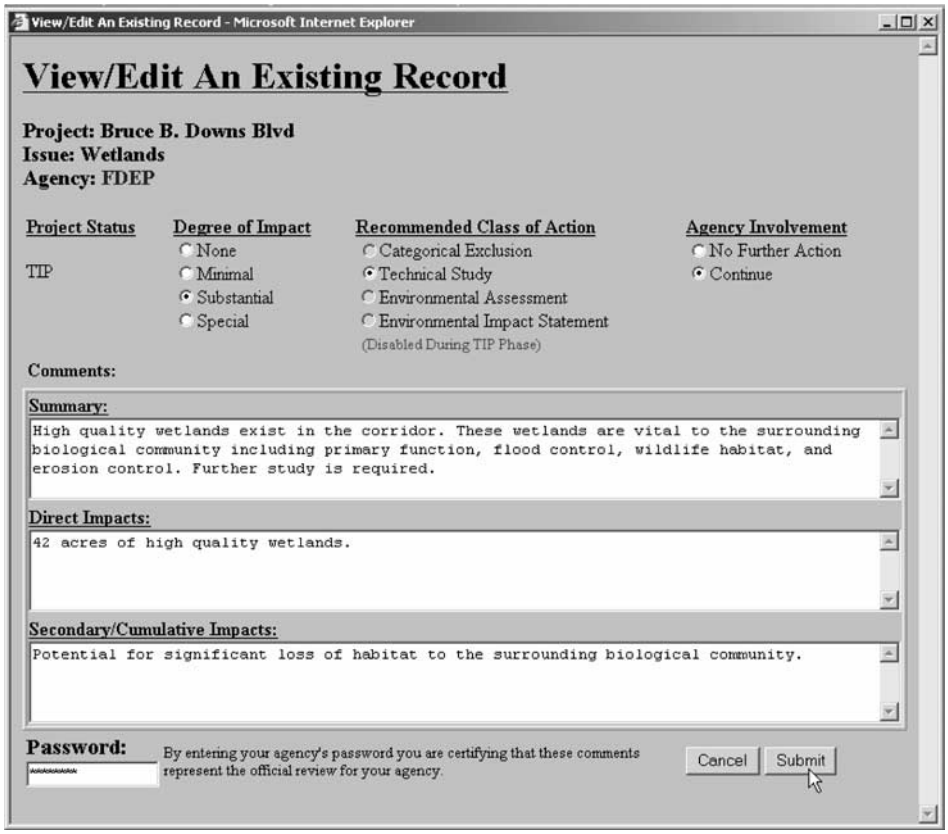


c **Focusing on Wetlands at Particular Site**

Figure 18. (Continued) Using the FDOT Environmental Screening Tool.

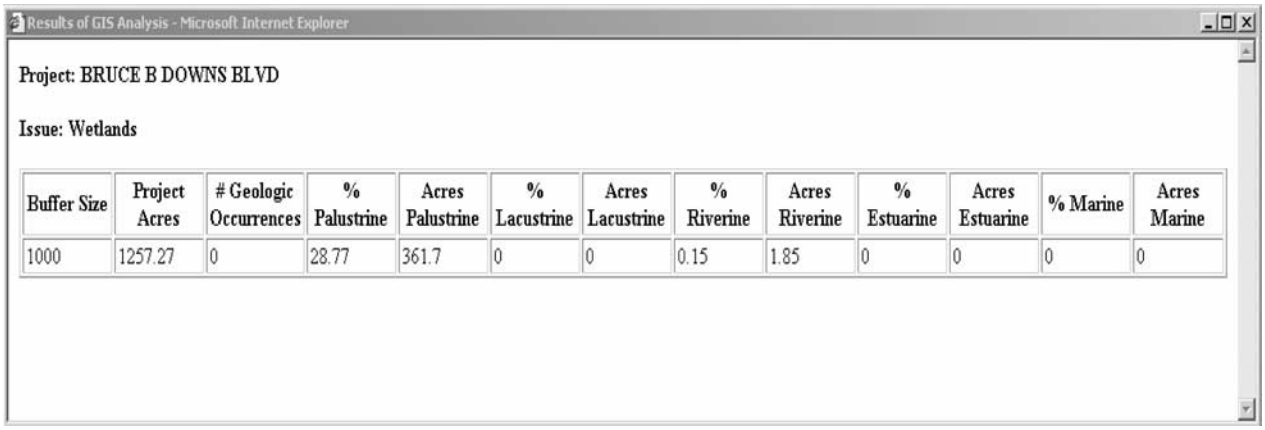


d **Wetlands by Type in Selected Area**



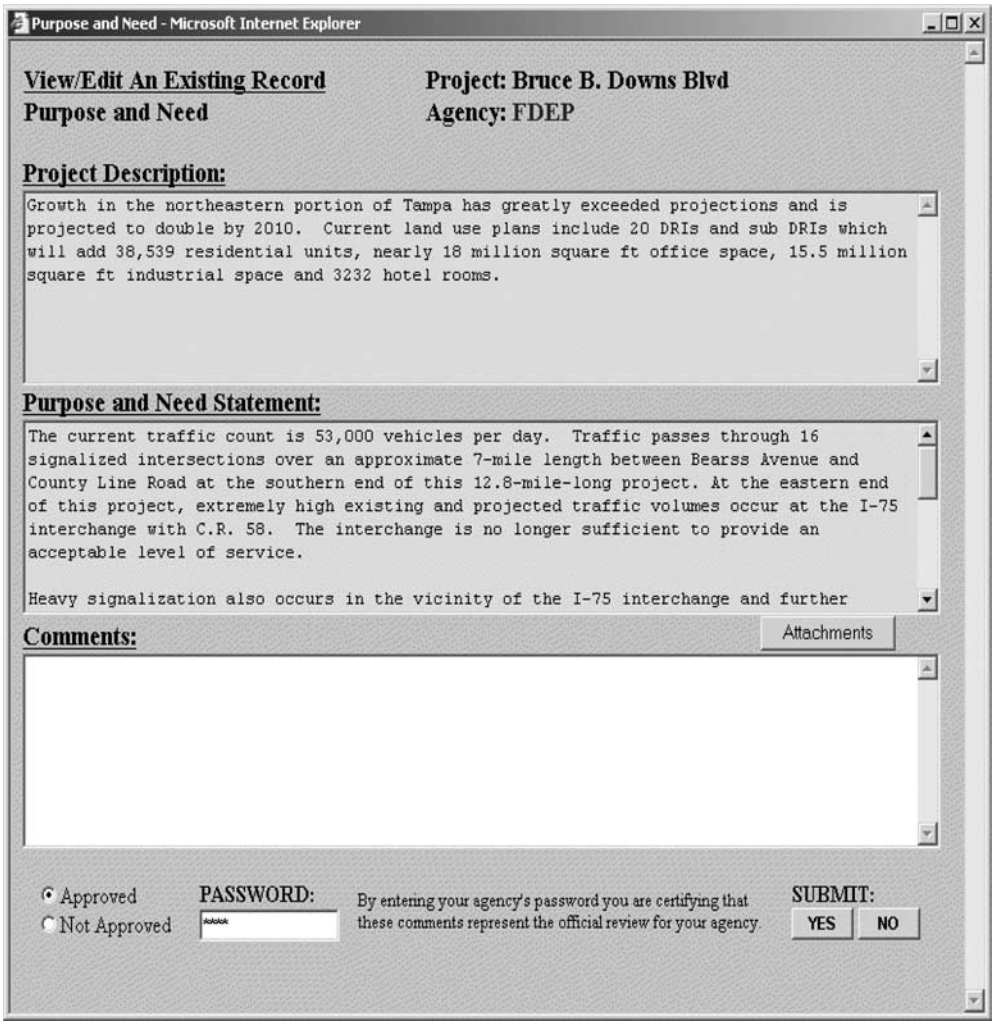
e **Project Record**

Figure 18. (Continued) Using the FDOT Environmental Screening Tool.



Buffer Size	Project Acres	# Geologic Occurrences	% Palustrine	Acres Palustrine	% Lacustrine	Acres Lacustrine	% Riverine	Acres Riverine	% Estuarine	Acres Estuarine	% Marine	Acres Marine
1000	1257.27	0	28.77	361.7	0	0	0.15	1.85	0	0	0	0

f **Summary of Impact: Acres of Wetlands Affected**



g **Purpose and Need Statement**

Figure 18. (Continued) Using the FDOT Environmental Screening Tool.

Maryland Department of Transportation

MDOT uses various approaches to better integrate environmental concerns into its planning and decision-making activities, including

- Secondary and Cumulative Effects Analysis (SCEA)—MDOT has developed procedures for considering secondary and cumulative effects of proposed projects in compliance with the NEPA process and Council of Environmental Quality (CEQ) regulations. They have worked closely with local agencies in developing a methodology based on an expert panel review of land-use data to determine what these effects will likely be in major transportation corridors (*84*).
- Storm Water Management—The SHA's stormwater management program is one of the first and most comprehensive efforts of any highway agency in the country. To prevent the adverse effects of storm water runoff, the state has developed 14 performance standards for development sites.
- Erosion and Sediment Control—To protect the Chesapeake Bay, Maryland has enacted sediment control requirements for all construction projects. The SHA's sediment control program has been adopted by many DOTs.
- Stream Restoration—The SHA engages in watershed planning with the U.S. Army Corps of Engineers, local jurisdictions, and MPOs on a project-by-project basis. Detailed technical analyses are performed to support watershed planning. In the last decade, there has been a strong national emphasis on restoring impacted or degraded streams using natural channel design. The SHA has used this technique extensively.
- Parkland and Forest Conservation—The SHA has worked closely with conservation agencies and groups to develop procedures for environmentally sensitive design and construction. As part of the design process, for example, consideration is given to saving trees designated as "specimen" or "significant." Road alignments have been shifted to avoid such trees in several cases.
- Cultural Resources Program—The SHA has a staff of professional architectural historians to ensure that historical resources are considered during the planning and design process for proposed highway projects. The SHA is developing a preservation plan for historic highway bridges to ensure the continued effective use of historic bridges.
- Archaeological Resource Protection—Similar to cultural resources, the SHA employs professional archaeologists to ensure that archaeological resources are considered during the planning and deign process of proposed highway projects. Working in close coordination with architectural historians, SHA's archaeologists perform assessments and field studies for several hundred projects each year ranging in size and scope from minor traffic management and control studies to large capacity improvement projects. From 1995 to 1999 for example, SHA archaeologists performed 1,750 assessments.
- Aesthetics—The SHA is involved in several beautification initiatives. A wildflower program was introduced in 1991 when the SHA adopted a reduced mowing policy to encourage the growth of native wildflowers. The SHA also has initiated an extensive urban highway reconstruction program called Streetscapes. Projects under this program are conducted in partnership with local communities and include enhanced amenities as sidewalks, landscaping, drainage improvement, and traffic management.
- Wetlands—For each highway project in project development, the SHA develops an extensive inventory of natural resources within the study corridor including all wetlands and waterways. The SHA attempts to select the roadway alternative having the least effect on these resources. While in the past it was common to see 10 or more wetland acres affected by a typical highway project, in the last decade, several projects have had less than 1 or 2 wetland acres affected.

Minnesota Department of Transportation

Although Mn/DOT has developed one of the most comprehensive processes for considering environmental factors in systems planning, this process relies on more traditional analysis tools to identify problem areas. As noted by Mn/DOT officials, the types of tools used are specific to the types of environmental issues being faced. For example, environmental justice analyses are based on census data that relates transportation services provided to different population groups. For the natural environment, a GIS called MnModel divides the state into 20-acre squares, with 27 layers of information associated with each square. Mn/DOT officials believe this model has strong potential for identifying archaeological and historic sites, sensitive soils, slopes, and water resources that would be critical for the types environmental systems planning they envision.

Pima County (Tucson), Arizona

One of the most extensive examples of identifying sensitive ecosystem and human habitats before developing a comprehensive plan is found in Tucson. The Sonoran Desert Conservation Plan is a strategy adopted by Pima County to preserve critically sensitive areas of the desert, of which Pima County occupies six million acres, in the face of expected substantial growth (*85*). With an estimated 7 to 10 square miles of desert lost to urbanization every year, the

plan was undertaken to precede the efforts to update the county's comprehensive plan so that important strategies could be incorporated into the investment and policy directions that would result from this latter effort.

As noted in the draft plan, "The original purpose of the conservation plan is to logically plan for continued community growth and expansion without significant adverse regulatory consequences from enforcement of the Federal Endangered Species Act." In other words, what could the county do to avoid federal regulatory constraints on the future growth in the region? However, as the plan was being developed, local officials found that understanding the sensitive ecosystem of the desert and the public interest in providing protection of this resource for future generations resulted in the plan becoming "a form of growth management plan that will guide future urban growth and expansion by ecosystem-based planning guidelines." Local officials expect that the principles and strategies espoused in this conservation plan will carry strong weight in the deliberations associated with updating the county's more general comprehensive plan.

The Pima County Board of Supervisors is spearheading this effort, coordinating with 12 government land management agencies and a 74-person steering committee. Steering committee members represent a wide range of interests, from environmental advocates to development interests.

Five critical areas were identified for detailed assessment.

- Ranch conservation lands were intended to preserve sufficient land to support ranching. As noted in the plan, "ranching is a significant land use that has served to protect our natural open space, and it continues to be an important traditional industry that has shaped the rural landscape."
- Cultural and historic resources are an important element of the Sonoran Desert. Although only 12% of the targeted land area had been surveyed by the publication of the plan, over 4,000 archaeological and historic sites had been catalogued. The plan identified the most critical parts of the desert that should be targeted for historic preservation.
- Mountain parks have been one of the most important natural resources in the Pima County Region. Since 1998, when the conservation plan was first proposed, over 135,000 acres of Bureau of Land Management land has been conserved. The plan identifies potential locations for further conservation efforts.
- Riparian (or water) resources are considered the most threatened and vulnerable by the conservation plan. The threat includes not only contamination and draw-downs of surface waters, but also the lowering of groundwater levels. The plan identifies opportunities where riparian systems can be enhanced and preserved not only to provide water, but also to secure future recreational and park lands.
- Critical and sensitive habitats and biological corridors identified in the plan supported 39 species that needed protection. The key to the analysis was the importance of interconnectivity of the habitats that supported these species. The multispecies conservation plan has become a very important point of departure for the development of the county's comprehensive plan and, in particular, for identifying the areas where development should be avoided.

With a determination of the acreage necessary to stabilize endangered species, along with targeted historic and cultural reserves, Pima County planners are able to identify environmentally sensitive lands (ESLs) that will be protected from development pressures. In addition, guidelines have been developed that provide road designers with strategies to minimize impacts to the environment along designated environmentally sensitive roadways (ESRs). Figure 19 illustrates the approach that was taken by Pima County planning staff in conducting the resource analysis for the Sonoran Desert.

San Francisco Bay Area

The Metropolitan Transportation Commission (MTC) has an active program of initiatives and planning efforts aimed at providing environmentally sustainable development and transportation system performance in the region. Some of the MTC's more innovative efforts include the following:

- Addressing Equity in Transportation Planning and Service Provision—Many of the programs in the regional transportation plan (RTP) focus on equitable access to transportation services for people with low incomes or who are elderly or disabled. The RTP is subject to an environmental justice (EJ) analysis to assess the distributive impacts of the plan. Equity analysis for the RTP includes an explicit evaluation of the benefits and burdens of the transportation plan on minority and low-income communities. Other MTC efforts on this topic include the development of transportation solutions for those transitioning from Welfare to Work, the Transportation for Livable Communities Fund that helps revitalize some of the region's most disadvantaged communities, the Low-Income Flexible Transportation Program, and other efforts to improve the availability and affordability of transportation options. As part of its equity review, the RTP defines a Lifeline Transit Network, including transit routes, service levels, and costs. The system addresses both spatial and temporal service gaps in providing low-income and minority populations with access to major services at a reasonable level of service. The MTC also performs project-level EJ analysis.
- Corridor-Level Planning—MTC has identified 16 multimodal corridors in the Bay Area that are the most

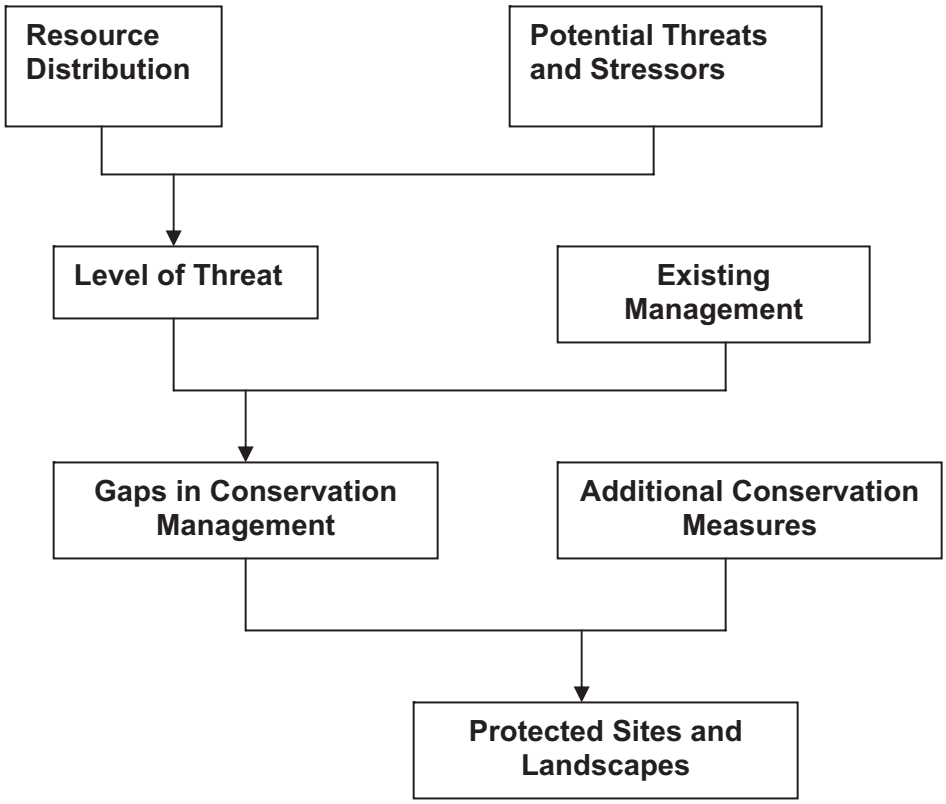


Figure 19. Resource analysis methodology for the Sonoran Desert Conservation Plan.
Source: Pima County, 2000 (*85*).

traveled routes on the region's rail, highway, and bridge networks. These 16 corridors are the focus of many planning activities. For each corridor, management objectives are defined for improving the levels of transportation service on all modes, and associated environmental impacts are assessed. For example, management objectives for the Golden Gate Corridor include the following:

  – Minimize travel times for HOV and transit in entire corridor;
  – Develop ramp metering for US–101 to balance access for local and through trips;
  – Expand commute period transit options in corridor, and
  – Develop bicycle and pedestrian access to existing and future rail and ferry facilities.

- Major Investment Studies—MTC has adopted the policy of subjecting all major projects in the transportation improvement plan (TIP) to a major investment study (MIS), including an analysis of the environmental impacts of the proposed projects. These studies allow the agency to begin addressing environmental considerations at a broader level and at an earlier stage in planning relative to when project-level NEPA considerations are made.

Washington State Department of Transportation

WSDOT officials are undertaking several initiatives designed to integrate environmental considerations into agency operations. These include

- Environmental Benefit/Cost Assessment System—WSDOT has been particularly concerned about internalizing the externalities of transportation decisions and is developing an approach for environmental benefit/cost assessment. This system is expected to improve transportation project delivery by enabling agency officials to identify the most cost-effective actions to meet environmental compliance (*86*).
- ISO-Compliant Environmental Management System — WSDOT is developing a multimodal environmental management system (EMS) that will comply with ISO 140001. The EMS is expected to embrace all of WSDOT's program functions and will be equipped to evaluate environmental attributes and impacts of all transportation modes including the ferry system.
- The Environmental Work Bench—WSDOT is developing a GIS-based tool called the Environmental Work Bench for use by planners and environmental staff. The

Environmental Work Bench is being used on a limited basis to identify and detect environmental issues early in the planning process. This system is being defined as an early environmental detection program for identifying "red flag" environmental concerns at the statewide highway systems level. The analyses performed by this system will also provide important information to regional transportation planners. MPO officials are expecting to incorporate this approach into their planning processes, especially those relating to the environmental assessment of regional plans as required by state law.

- Performance Measurement Quarterly Reporting—Although neither targets nor standards have been established for the WSDOT's environmental goals, DOT staff uses a performance measurement quarterly report to assess and publicly report on how well the system is performing.

Wisconsin Department of Transportation

The System-Plan Environmental Evaluation (SEE) required by Wisconsin state law and implemented by a state administrative rule is one of the most demanding of such legal mandates in the United States. As seen in Chapter 3, the rule that has implemented the law was very specific in the types of impacts that were to be part of an SEE analysis. There was little doubt among WisDOT officials about the type of information that was necessary for the SEE analysis, but it was not clear what types of tools and what level of sophistication would be needed to satisfy legal requirements.

The first step in the SEE approach was to develop a screening tool to determine whether an SEE was necessary. For the most recent plan evaluated with an SEE, the Wisconsin State Highway Plan, the types of environmental criteria considered for each of the system alternatives included: air quality, energy consumption, sensitive land and water resources, indirect land-use impacts, economic development consequences, and community and neighborhood impacts. For each of the impact categories, the SEE analysis provided a description of the types of mitigation that were likely to be implemented for the different projects and impacts being considered. In each case, WisDOT experience with each mitigation strategy was highlighted. Figure 20 shows the screening tool used to determine whether an SEE is necessary.

Because of the mandate to conduct SEEs, WisDOT prepared a reference manual that outlined the tools and methods that were appropriate for the level of analysis that was to occur in systems planning. Unlike other states, WisDOT has a fairly sophisticated statewide modeling capability. Freight flow projections are based on national databases and a statewide model allows WisDOT officials to forecast traffic volumes. In addition, GIS data for agricultural land, endangered resources, and water resources have been an important component of the SEE.

The key approaches and concepts recommended in the WisDOT reference manual are described below:

- Key Concepts
  - System-level impacts should consider cumulative impacts that build upon one another, secondary impacts that occur after the immediate influence of a project or program, complementary effects that occur when the impacts of one group of actions reinforce the effects of another set of actions, and mitigating effects that can be undertaken to offset the effects of another set of actions.
  - Impact assessment at the systems level should include a comparative assessment of the following three factors: type of action category, scale of action, and location.
  - The types of impacts that potentially should be reported include direct, indirect, and secondary impacts.
  - Proposed Methods for Identified Impact Categories
  - Traffic congestion is a direct transportation effect that must be addressed in an SEE. Two approaches are feasible depending on the existence of a statewide traffic network model.
    1. Recent traffic volume counts can be adjusted based on assumed population growth rates to estimate future traffic volumes, or extrapolate future volumes from historical data. Increased traffic congestion then can be estimated by identifying congested facilities where additional volumes would likely occur, growth areas that could overwhelm existing facilities, and induced travel that could shift development patterns and/or generate additional traffic.
    2. A statewide traffic model can be used to predict future traffic volumes on selected network links, thus providing such information as changes in volumes, levels of service, or hours of delay.
  - General energy impacts will be influenced by land-use patterns, mode shifts, induced travel, and speed/congestion changes. System plans should be compared with a determination of whether smaller, greater, or approximately equal changes of these dimensions will occur. If model outputs are available that produce VMT and average speed estimates, these outputs can be used with fuel mileage rates to estimate energy consumption.
  - Air quality impacts should be considered in light of land-use patterns, mode shifts, induced travel, congestion reduction, and location of travel growth (e.g., in a nonattainment area). VMT-based analysis would use pollutant emission factors from air quality models to estimate the total emissions generated based on travel volumes, VMT, and travel speeds. In nonattainment areas, the regional travel demand model could be used to produce estimates of emissions directly.

Wisconsin Department of Transportation

System-Plan Environmental Evaluation

SEE Screening Sheet

A. GENERAL INFORMATION

1. Title of System Plan: _____
2. Description: _____
   _____
   _____
   _____
3. Responsible Agency: _____

B. ASSESSMENT

1. System Plan

a. Does the plan examine a statewide transportation system or a major portion of a statewide system, or update or change a statewide system plan?

- ☐ Yes, statewide system, or portion [continue]
- ☐ Yes, update to statewide system plan [continue]
- ☐ No, corridor or specific location only [not a system plan, no SEE required]
- ☐ No, other explanation [no SEE required, not DOT responsibility]

If yes, identify transportation system (e.g. "interregional highway system"):
_____

If yes, identify geographic scope (e.g. "statewide"): _____
_____

b. Does the plan identify transportation facility or service needs?

- ☐ Yes [continue]
- ☐ No [not a system plan, no SEE required]

2. Potential Significance

Five questions to be used to address significance:

1. What are the short- and long-term environmental effects, costs, and benefits which may only become obvious from indirect or secondary results?
2. What are the cumulative effects of this proposal and other related actions which can reasonably be anticipated?
3. Is there uncertainty, or are there substantial unknowns, in predicting the environmental impacts or for effectively controlling environmental impacts?
4. Would this proposal establish a precedent for future proposals or actions or foreclose any future options?
5. What controversy may arise concerning the environmental effects of this proposal?

[These questions are included for reference purposes. It is not necessary to answer them on this form.]

Figure 20. Wisconsin's Systems-Plan Environmental Evaluation Screening Tool.

a. Does the plan contain any "major and significant new proposals" (proposals are significant if the combined impact of all the plan's elements is potentially significant with respect to the human environment, and if the combined effect of all the elements in the plan or any single element would represent a significant departure from (or expansion of) the WisDOT's existing responsibilities as identified in TRANS 400.04(19).)

☐ Yes [SEE required; list at least one of these proposals below]: _____

_____

☐ No [attach list of **all** proposals contained in the plan, and the reason for finding as non-major: (a) not developed by DOT, (b) no significant environmental impact, or (c) not a significant departure from or expansion of DOT responsibility]

☐ Unknown at this time [additional study required to support finding on SEE]: _____

_____

☐ No [list **all** actions on a separate page, along with the reason they are found to be non-major: (a) category III action, or (b) category IV action.]

☐ Unknown at this time [additional study required to support finding on SEE]

b. Does the plan, in its entirety, represent a "major and significant new proposal"?

☐ Yes [SEE required]

☐ No ☐ Plan not developed by DOT

☐ No significant potential for environmental impact

☐ No significant departure from or expansion of DOT responsibility.

☐ Unknown at this time

C. DETERMINATION

[Fill in blanks and delete phrases or sentences which do not apply.]

Based upon the findings stated above and the requirements stated in the Wisconsin Department of Transportation's regulations on environmental documentation (Trans 400), I have determined that a system-plan environmental evaluation (SEE) [is/is not/may be] required to be prepared as part of this plan [and additional analysis will be done during the preparation of this system plan to make a final determination].

Approved by:

_____ _____

Director, Bureau of System Planning — Date

Reviewed by:

_____ _____

Director, Office of Environmental Analysis — Date

_____ _____

Chief, Environmental Strategies Section — Date

Prepared by:

_____ _____

Signature — Date

Figure 20. (Continued). Wisconsin's Systems-Plan Environmental Evaluation Screening Tool. Source: Cambridge Systematics, Inc., 1994 (*87*).

– A general assessment of land-use impacts would include both the direct and indirect effects of transportation improvements. Direct impacts that should be considered in an SEE include the cumulative effect of acquisition of agricultural land for system needs and the cumulative effect of land acquisition for other land uses that may not be replaceable. These direct impacts would depend on the type of action being considered, scale of application, and location. Similarly, indirect land-use impacts would be influenced by these characteristics.
– Economic effects should consider the overall level of investment, the source of funds, the cost of doing business such as shipping costs, construction-related employment, and longer-term operating and maintenance jobs. Once again, the type of facility, scale of application, and location will influence the eventual economic effect of plan investment.
– Community impacts will be directly influenced by the type of investment being considered and the characteristics of the neighboring community. The number and significance of the potential impacts for each alternative's elements should be explained in narrative form. With respect to noise impacts, the plan alternatives should be ranked in order of their potential noise impacts.
– System plans should be compared based on their overall potential effect on large system scale natural areas and ecosystems. This includes both sensitive land areas as well as water resources. At the system planning level, in most cases, only general conclusions can be made about potential impacts in this category.
– An evaluation matrix should be used to present the overall results of the comparative analysis. This matrix most likely would be in narrative form.

The impacts considered, and the manner in which they were analyzed, included traffic congestion, direct and indirect land-use, economic development, and community and neighborhood impacts.

Traffic Congestion Impacts

- Air quality—The latest MOBILE model emission factors were multiplied by VMT for each alternative to arrive at an estimate of total emissions. The analysis showed that implementation of the recommended plan would result in emission levels that were 14% lower than in 2000.
- Energy consumption—Miles per gallon data for 1997 were applied to 2020 annual VMT classified by various levels of congestion and by functional classification in both urban and rural areas. Fuel consumption under the recommended plan was slightly less than the base case.

Direct Land-Use Impacts

- Sensitive land—The types of sensitive land identified were agricultural land, habitat fragmentation, and endangered resources. The effect on agricultural land was estimated as the number of acres taken to build highways. The number of lane-miles added and potential new bypasses constructed were used as a surrogate for habitat fragmentation. The effect on endangered resources was measured by using National Heritage Inventory data to determine how many sites were within one mile of a potential highway improvement. This analysis showed that the recommended plan could affect endangered resources about 700 times compared to 250 times for the base case.
- Sensitive water—The two types of water quality impacts reported were construction-related erosion/runoff and postconstruction storm water runoff. The measures used for construction-related water issues included the number of lane-miles added, the number of bridges replaced, the number of new bridges constructed, and the number of wetlands affected. The evaluation showed that the recommended plan would require two-and-one-half times as many lane miles as the base case, the replacement of 337 bridges over water, and the construction of 217 new bridges over water (in comparison, the base case would replace 45 fewer bridges and would construct 76 new bridges). The recommended plan would also convert 900 to 1,100 acres of wetlands. Postconstruction storm water runoff was measured with the additional new lane-miles variable, thus indicating a two-and-one-half times impact over the base case.

Indirect Land-Use Impacts

Indirect land-use impacts reflect the potential of new transportation capacity to either induce new development or alter the existing pattern of development. As noted in the report, quantifying this effect, especially at the systems level, is very difficult. The recommended plan includes quantitative, comparative statements on potential secondary land-use impacts by citing miles of new roads by location and type, and by identifying general impacts that may occur. Table 13 shows the qualitative information that was presented in the plan to illustrate the different types of land-use impacts that may occur by location and type of road investment.

Economic Development Impacts

The discussion on economic development impacts was very general, with linkages between improvements to mobility and subsequent enhancement of economic activity

TABLE 13 Indirect land-use impacts described in Wisconsin State Highway Plan

	Urban Areas	Urban Periphery	Rural Areas
Additional freeway capacity may:	• reduce congestion • make properties adjacent to interchanges and frontage roads more desirable for development or redevelopment • assist existing businesses located at interchanges and along frontage roads through improved access • generate some displacement of existing businesses and homes • increase noise	• encourage development of all types adjacent to or near the facility due to increased access, especially at interchanges and along frontage roads • have greatest potential impacts on development by increasing access to areas most attractive to development • displace existing homes and businesses • impact environmentally sensitive lands	• allow for better movement of people and goods • encourage scattered-site residential development in rural areas, including vacation properties • encourage residential development in smaller communities within the extended commuting radius of larger metropolitan areas • generate auto-oriented commercial development at interchanges • impact environmentally sensitive lands
Additional expressway capacity may:	• have similar impacts to those resulting from freeway expansion • have impacts at both intersections and interchanges due to higher visibility • increase demand for access points	• have similar types of impacts to those resulting from freeway expansion • have impacts at intersections and interchanges	• have similar effects to those resulting from freeway expansion • have impacts at intersections and interchanges
Additional arterial capacity may:	• make adjacent properties more desirable for development and redevelopment • assist adjacent existing businesses through improved access • impact aesthetics of older, established neighborhoods, and business districts • increase demand for off-street parking, if on-street parking is eliminated	• hasten development by making commercial and residential development on available land more desirable • have a more pronounced effect in areas adjacent to larger municipalities • displace some existing businesses and homes • impact environmentally sensitive lands	• according to the definitions used in the SEE analysis, there are no arterials in Rural Areas
Additional interchanges may:	• encourage auto-oriented development and redevelopment • encourage office and/or retail development • displace existing businesses and homes • increase noise and traffic along non-principal roads	• attract all types of development on adjacent land • generate larger-scale effects than improvements in Urban Areas due to larger parcels of semi-vacant land being available • displace some existing businesses and homes • impact environmentally sensitive lands	• generate some auto-oriented development on adjacent land • attract some light industrial and warehousing development • attract some residential development, if within a commuting radius of major city • impact environmentally sensitive lands
Additional bypasses may:	• relieve congestion in downtown business districts • have adverse economic impacts in smaller communities from the loss of through traffic stops • encourage and/or direct development to interchanges along bypasses, especially if urban services are provided there • displace some existing homes and/or businesses • create barriers between neighborhoods if adequate crossings are not provided	• encourage annexation of Urban Fringe Areas by adjacent municipalities, using the bypass as a new growth boundary • direct development of all forms to interchanges, intersections, and adjacent areas • displace existing homes and businesses • impact environmentally sensitive lands	• have minimal impacts, since little opportunity for land use conversion exists without urban services • impact environmentally sensitive lands • fragment and convert farmlands

Source: Wisconsin Department of Transportation, 2000 (*88*).

highlighted. For example, this section made statements such as

- "Recommended improvements are intended to enhance both mobility between Wisconsin communities and linkages to major destinations in neighboring states."
- "The plan's recommended improvements to the Corridors 2020 system would better enable tourists traveling on those routes to experience a more enjoyable trip to and from Wisconsin tourism destination points than would improvements recommended in the base case."

- "The recommended improvements in SHP 2020 would reduce transportation costs for businesses in the state, making them more competitive with out-of-state businesses, as well as potentially attracting new business to the state."

Community and Neighborhood Impacts

The approach to this impact category was similar to that used in the economic development impact category—general statements were provided on the potential positive and negative relationships between transportation investment and community/neighborhood integrity. In addition, this category introduced archaeological and historical site analysis as a community impact issue. This was measured by the number of such sites that would potentially be affected by each alternative. For example, the recommended plan was determined to have a potential of affecting a total of 835 archaeological and 576 historical sites (compared to 430 and 372, respectively, for the base case).

SUMMARY OF LITERATURE AND CASE STUDIES

Numerous books have been written on the different approaches that can be used for assessing the effect of change on the natural and human environment. Two excellent sources, for example, are Dale and English (*89*) and Jensen and Bourgeron (*90*). However, only recently has there been a concerted effort in the transportation field to develop a comprehensive package of tools and methods for conducting environmental assessment. Individual tools have been developed for all of the impact categories of interest to transportation planners and engineers. However, there are very few publications that provide an overview of all the possible tools and methods that might be appropriate for a given situation.

A resource guide on assessing the social and economic impacts of transportation projects was recently completed as a product of NCHRP Project 25-19. This guide, *Evaluation of Methods, Tools, and Techniques to Assess the Social and Economic Effects of Transportation Projects,* describes the analysis methods and tools that could be used to assess the social and economic effects of a transportation project. It also presents the results of a survey of state DOTs and MPOs that characterized the level of use of these methods, tools, and techniques. Key findings of this study included the following:

- A wide range of methods and tools are available for assessing social and economic impacts. Examples include
  - GIS and spatial-statistical analysis for environmental justice analysis;
  - Resident or neighborhood surveys for studies on neighborhood cohesion;
  - Risk models for analyzing the settlement of displaced populations;
  - Regression models, spatial interaction and entropy-maximizing models, Markov models, and simulation models for modeling pedestrian movement;
  - Photomontage techniques for visual impact assessment involving the superimposition of images of transportation system changes onto an existing street scene;
  - Noise prediction models such as STAMINA, the FHA's noise prediction software; and
  - Simulation models to estimate economic development impacts of transportation investments.
- Neighborhood surveys are one of the most promising approaches for estimating the social effects of transportation projects, allowing planners to deduce the attributes of neighborhoods that are valued by residents in order to consider these attributes when formulating transportation system changes and mitigating their negative impacts.
- Although many of the methods, tools, and techniques in use have been applied to study current circumstances, few have been applied to predict the effect of a planned change.
- Methods, tools, and techniques for estimating economic effects are substantially more advanced than is generally true for techniques to measure social effects.
- State DOTs, in general, are much more likely to conduct social and economic impact analyses with their own staff than are MPOs. MPOs are more likely to engage the services of consultants for this type of assessment.

The results of the literature review and case studies indicate that GIS is becoming a standard tool for environmental assessment in transportation planning. This tool is particularly useful for spatial analysis of equity issues. For example, the Toledo Metropolitan Area Council of Governments (TMACOG), Bay Area Metropolitan Transportation Commission (MTC), Delaware Regional Valley Planning Council, LA Southern Californian Association of Governments, North Carolina DOT, Georgia DOT, and the U.S. Army all use GIS to incorporate equity issues into planning (see, for example, *72*, *91, 92, 93,* and *94*).

In addition, several agencies are using GIS as a tool to catalogue environmental resources and evaluate the effect of various project, corridor, or plan alternatives on environmental resources. Agencies such as the Oregon DOT and Caltrans are developing GIS capabilities for "fatal flaw" and scenario analyses. Mn/DOT has initiated the development of a GIS to track and analyze the effects of proposed alternatives on the state's archeological resources and, as described in the previous section, FDOT has developed a GIS for environmental

assessments applicable at the planning and project development levels.

GIS is particularly useful for visualizing the impacts of various alternatives on multiple environmental resources (e.g., wetlands and archeological resources). These types of analyses can be conducted at the plan, program, or project levels of decision making.

EMERGING ANALYSIS AND DATA COLLECTION TECHNOLOGIES

One of the most comprehensive research efforts on data and technologies for incorporating environmental factors in transportation decision making was recently completed as NCHRP Project 25-22: *Technologies to Improve Consideration of Environmental Concerns in Transportation Decisions*. The 21 technologies highlighted by this research project were categorized into five broad headings as follows:

1. Geospatial database technologies,
2. Remote sensing technologies,
3. Transportation impact modeling technologies,
4. Decision science technologies, and
5. Visualization/simulation technologies.

Geospatial Database Technologies

Geospatial database technologies refer broadly to GIS and interactive databases, including Internet- and intranet-enabled technologies. These technologies provide structured and systematic tools for collecting, storing, analyzing, and disseminating information about spatially defined areas as they effect, or are affected by, transportation activities. While there are numerous potential applications of these tools, the research evaluated a representative sample of those that could be readily implemented with existing hardware and software, including electronic field data collection technologies, collaborative planning and design tools, documenting and processing management tools, and facility information management systems.

Electronic field data collection technologies are portable computer devices (e.g., laptops, palmtops, or handheld devices) used to collect and compile electronic inventories of geographic feature data such as wildlife habitats, wetlands, land use, historic sites, and physical features. They are capable of displaying image, vector, and tabular data. They allow user-defined updates to map layers and linked attributes. The high-end products support real time, full duplex, wireless connections to GIS databases and enable immediate synchronization of environmental data into the centralized database, eliminating data integrity and resource issues associated with manual field processes.

The low-end products require data to be transferred into the database after field activity. Data import software such as GPS receivers, laser range finders, and digital cameras can be linked to data collection tools and used to import data directly into a database. For example, a GPS receiver can be used to map exact coordinates of a wetland, plant community, or some other resource; a laser range finder can be used to measure the exact distance between two points and automatically upload the information into correct database fields; and a digital camera can be used to collect digital data of resources and then the data can be uploaded into a database.

Collaborative planning and design tools refer to a combination of computer-aided design and engineering and other GIS tools. These tools allow stakeholders to collaborate in a workshop setting to refine a project design or resolve specific design/construction related issues. Multiple sets of data relating to such things as problem identification (accident sites, congested areas, geometric deficiencies, etc.), existing conditions (facility location, soil types, etc.), constraints and impacts (historic resources, parks, wetlands, etc.) and various other data are displayed on large screens in a group setting allowing stakeholders to engage in collaborative alternatives analysis at the planning or project level.

Document and process management tools include electronic reporting; web GIS; and multimedia and administrative record, document, and outcome tracking software. A multimedia administrative record is a permanent and easy-to-navigate electronic file that provides a record of the decision process and includes all official documents necessary to explain and record important decisions. These tools make use of electronic publishing and database features to communicate project information through electronic and online documents; record key steps in the project development process; and track project outcomes, mitigation, and completion of required documents. Examples of applications include virtual environmental assessments and environmental impact statements as well as other planning documents designed as easy-to-use multimedia products that are visually interesting, engaging, and informative.

Facility information management systems (FIMS) are a comprehensive transportation and environmental inventory containing the entire set of environmental (e.g., thematic) data that comprise, support, effect, or are impacted by transportation systems. In addition to transportation infrastructure (e.g., travelways, pavements, bridges, and terminals), the inventory data includes travel and commodity movements as well as other natural and cultural feature information necessary to the transportation facilities' life-cycle functions. The data contained in FIMS ranges from historical to current to near real-time conditions. FIMS can be thought of as a one-stop data warehouse containing or providing access to all information used throughout the planning, project development, and systems operations phases. In addition to containing all in-house transportation and environmental feature data, FIMS must also provide access to data warehouses containing natural, constructed, and other social environmental data maintained by other agencies.

Remote Sensing

Remote sensing provides digital information on land and earth features that can be combined with spectral analysis and GIS modeling to create a powerful screening tool for transportation corridor or regional evaluation. Remote sensing can quickly and cost-effectively categorize and quantify land cover types (wetlands, crop lands, forested lands, etc.). When combined with topographic, environmental constraint, geological, and planimetric information, this data also can be used for quantitative description and evaluation of plan or project alternatives. Combining remote sensing and GIS capabilities offers the ability to present plan or project scenarios in a three-dimensional environment, providing decision makers and the public with a clear picture of potential impacts. Examples of remote sensing technologies discussed in the NCHRP 25-22 report include (1) terrestrial and airborne lidar, (2) digital aerial photography and photogrammetry, (3) radar imaging and mapping and ground-penetrating radar; and (4) multispectral and hyper-spectral satellite and airborne imaging.

Transportation Impact Modeling Tools/Technologies

Transportation impact modeling tools/technologies refer to the numerous models used to evaluate potential environmental effects of transportation projects such as air quality, noise, water quality, and biological resources. Illustrative models include biological resource models such as Wetland Environmental Tools (WET) for planning and ranking of wetland areas and Habitat Evaluation Procedures (HEP) for habitat-based impact assessment and resource management in both terrestrial and aquatic environments. Examples of water resources models include the Stormwater Management Model (SWMM), a computer simulation model for the analysis of quality and quantity problems with urban runoff; the Bridge Scour Data Management System (BSDMS); and the Cornell Mixing Zone Expert System known as CORMIX, a model used for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharge into diverse water bodies.

Air quality models include the U.S. Environmental Protection Agency (EPA) MOBILE models that calculate gram per vehicle-mile emissions of carbon monoxide (CO), oxides of nitrogen (Nox), and volatile organic compounds (VOCs) on a vehicle fleet basis. Another model, CAL3QHC, uses MOBILE outputs to calculate emission concentrations at specific locations and other state-specific models that have the same function as the EPA models but include stricter vehicle emission control factors.

Noise impact models include the Integrated Noise Model, the approved Federal Aviation Administration noise model used to calculate noise exposure in the vicinity of civilian airports, FHA's Traffic Noise Model used for roadway noise prediction, and the Federal Transit Administration's FTANOISE model, a spreadsheet program for the assessment of rail noise exposure based on various train and track types.

The NCHRP 25-22 report discussed three emerging techniques for impact modeling. These are gap analysis, integrated modeling, and expert systems.

Gap analysis organizes baseline data on existing features according to user specifications, but provides no interpretation. Gap analysis is the use of GIS in a structured way to determine the nature and location of potential impacts on the built, natural, or social environment. Most commonly, the user specifies buffers around sensitive natural resources or other features as a first step in identifying constraints related to a given project. Gap analysis is a screening tool that precedes quantitative and other analyses through the use of models and other tools. Examples of potential uses and scales range from local or regional land-use analysis to statewide natural resources analysis.

Integrated modeling (where interactions among impact areas are modeled) could include some impact areas and interactions (e.g., land use and water quality, land use and air quality, various plant and wildlife species). Integrated models generate high-level predictive model output using single, integrated, or multiple model systems. Integrated models recognize the interdependence of resources and that modeling each impact independently may not accurately represent the natural ecology of the relationships among the different resources.

Although integrated models could be developed and used for some impact areas, some of the most visible examples are those being used to analyze the interaction between changes in transportation infrastructure and changes in land use. Examples include land-use forecasting models that incorporate transportation system impacts (e.g., EPA's INDEXEPA); transportation models such as TRANSIMS that incorporate land-use impacts; and multimodal systems that seek to address both topics and others (e.g., econometrics) in a single model or models (e.g., Metroscope or Urbanism). Multimodal systems for transportation and land-use attempt to address transportation and land-use interactions in a single comprehensive model or through multiple models used as an iterative system.

In addition to connecting traditional land-use and transportation models, tools in this category also integrate economic considerations such as land prices and other real estate conditions. These models take the innovations of the individual models and combine them into even more comprehensive representations of reality.

Expert systems generally consist of a set of rules and user-supplied data that interact through an inference engine, an expert, or knowledge-based system able to derive or deduce new facts or data from existing facts and conditions. Expert systems have become widely available, allowing users to define the database and rule base without using artificial intelligence programming languages. Less often, individual organizations will create their own expert systems for specific purposes.

Decision Science Technologies

Decision analysis tools can help transportation agency staff define problems, manage expectations, identify an appropriate range of alternatives, clarify information needs, identify and quantify uncertainties and their impacts on a decision, avoid decision traps in evaluating alternatives, and ensure meaningful involvement of stakeholders. The application of decision science methodologies is advantageous for technical analysis as well as public outreach processes and generally assists in creating a credible and auditable decision process. Examples of these technologies include multiple-attribute utility analysis, prioritization, risk analysis, and optimization.

Multiple-attribute utility analysis methods are used to evaluate and select alternatives based upon multiple attributes or criteria. This approach allows for the management of multiple objectives, the quantification of objectives, and the illustration of trade-offs. This approach is typically applied when multiple stakeholders concerned about multiple issues are required to select one alternative. The Toledo Metropolitan Area Council of Governments (TMACOG), as described in Chapter 3, uses a formal application of a multiple-attribute framework for selecting among various plan alternatives (or project clusters).

Prioritization methods rank competing alternatives based upon objective criteria and specified constraints. This method is primarily used to prioritize multiple activities or projects and to illustrate explicitly that the maximum benefit is being derived from the investment.

Risk analysis is an approach designed to determine how risk contributes to decision success and how to manage that risk. An example of an application of this technology is deciding when to proceed with a project to minimize the cost, risk, and uncertainty related to a parallel project.

Optimization methods involve the development of an optimal system solution based on the comparison of multiple variables. This technology may be applied to determine traffic-timing elements at a complex intersection.

Visualization/Simulation Technologies

Computer-based simulation creates a 3-D, motion-based visual environment. This 3-D environment relies on three spatial axes (corresponding to the dimensions of length, height, and width) to create a spatial scene. The image is visually created in a computer graphic format, including the capability of incorporating motion as part of the scene generation. Other senses (particularly sound) are beginning to be synchronized to such simulations. Four-dimensional simulation adds the variable of time to 3-D simulation. The time variable permits heuristic examination of spatial change. Real-time analysis provides insights for traffic management, safety analysis, environmental change, construction management, and master planning (e.g., short range versus long range). Applications for design of transportation alignments in a "virtual reality" setting incorporating a full set of environmental constraints are the next likely steps in the evolution of this technology. Time-based visual simulation is not as advanced as 3-D simulation and, consequently, it is less common.

Another important completed research effort on environmental information management was NCHRP Project 25-23: *Environmental Information Management and Decision Support System for Transportation* (*95*). The project was responding to the need of state DOTs and MPOs to manage environmental information in support of the decision-making process. The resulting guidebook develops the concept and implementation approach for an EIM&DSS that complies with ISO 14001 and has multiple applications and uses within an agency.

The environmental information management and decision support system (EIM&DSS) is designed to provide decision makers involved with the planning, programming, project development, operations, and maintenance of any mode of transportation with information and analytical capabilities. Already existing decision support systems within state DOTs and MPOs may be considered functional building blocks of an EIM&DSS and could interface with the DSS. For example, the standard four-step transportation model (rail, air, bus, and waterborne traffic simulation models; management systems; noise, water pollution, land use, contaminant fate, and transport impact models; and economic development models) could each be part of a broader environmental management system. Washington State DOT has begun to develop an ISO-compliant environmental management system.

Some active research projects sponsored by the National Cooperative Highway Research Program are looking at developing analysis tools/technologies for considering environmental factors in transportation systems planning. The results of these research activities could provide important analysis capability to the consideration of environmental factors in transportation planning. Examples of these projects are discussed below.

- *Predicting Short-Term and Long-Term Air Quality Effects of Traffic-Flow Improvement Projects* (NCHRP Project 25-21)—The objective of this research is to develop and demonstrate, in case study applications, a methodology to predict the short-term and long-term effects of corridor level, traffic-flow improvement projects on CO, VOCs, NOx, and particulate emissions (PM). The methodology will evaluate the magnitude, scale (such as regionwide, corridor, or local), and duration of the effects for various representative urbanized areas.
- *Effective Methods for Environmental Justice Assessment* (NCHRP Project 8-41) —The objective of this research is to identify and develop processes, procedures, and techniques for integrating environmental justice considerations in transportation systems planning and decision making at the statewide, regional, and metropolitan levels. The research will improve the analytical capabilities of states, MPOs, and their planning partners. The research will build on existing community-impact assessment methods and will focus largely on the adaptation and

extension of these methods to environmental justice analyses employed at the systems, corridor, and project levels of transportation planning and development.

TOOLS AND METHODS FOR CONSIDERING ENVIRONMENTAL FACTORS

This chapter has examined tools and methods that can be used to consider environmental factors in systems planning. Depending upon the type of environmental factor of concern, various tools are available that will enable transportation agencies to consider the potential environmental implications of transportation investments. As was shown in the Florida ETDM case, such tools can be quite sophisticated and comprehensive. But as shown in other case studies, simpler tools are being used as well.

Such a range of capability was found in a recent survey of 11 strategic environmental assessments (SEAs) that covered the diverse topics of road, rail, waste management, electricity supply, gas development, underground infrastructure, an ecological district, and a political program (*96*). In addition, various countries were represented in the survey, including Germany, the United Kingdom, the Netherlands, New Zealand, and China. Table 14 shows various methods used for such assessments.

As indicated by the survey undertaken for this project, very few agencies considered inadequate analysis tools and methods as a substantial constraint in their efforts to consider environmental factors in transportation planning. Where agencies have determined a need for new or different tools, resources have usually been allocated to their development. Examples include Caltrans, FDOT, and ODOT initiatives to develop GIS to catalogue their environmental resources and analyze the effects of various plan and project alternatives on these resources. Other notable examples are WSDOT's development of an environmental benefit-cost analysis tool, and the San Francisco Bay Area MTC's development of GIS capabilities for environmental justice analysis. In this regard, the dissemination of practical applications of emerging tools could be useful to agencies that have identified analytical needs and are identifying options for developing or acquiring capabilities to meet these needs.

Beyond agency needs, there also could be value in broadly disseminating useful applications of emerging methodologies to showcase how tools and methods could be integrated into existing planning processes. For example, the use of integrated models, especially land use–transportation models, could find a role in agencies that have begun to see a need for promoting land-use decisions that also provide efficient transportation but that have not yet articulated analysis needs to support this effort.

Another possible example is the dissemination of GIS applications for inventorying and conducting systems-level

TABLE 14 Strategic environmental assessment (SEA) methods

Phase/Category	Method
Screening, scoping, definition of objectives	Checklists
	Case comparison
	Literature survey
	Model mapping
	Consultation of experts
	Formal procedures
Impact analysis	Impacts prediction • Screening • Scenario development • Computer modeling • Geographic information systems • Project EIA as case study
	Use of baseline data
	Uncontroversial aggregation • Index methods • Monetary methods • Natural methods
Information analysis	Presentation of information • Textual descriptions • Impact matrices • Consistency analysis
	Further aggregation
Dealing with uncertainty	Scenarios
	Sensitivity analysis
	Showing points of view
	Decision analysis
	Geographic methods
	Postponing decisions

Source: National Cooperative Highway Research Program, 2003 (*95*).

environmental assessments. A major prerequisite for moving environmental considerations early into the planning process is knowing where sensitive environmental resource areas are located. GIS platforms are ideally suited to providing this type of information. It is not surprising that those states that have progressed the furthest in systems-level environmental assessment have been those that made early investment in GIS technologies. However, as also was seen in some of these cases, such as in Florida and Wisconsin, determining possible impacts at such broad scales of application often relies on subjective expertise.

Tools and methods do not always have to result in quantitative output. For example, Table 15 offers different, noncomputerized approaches to providing important information in the early stages of the planning and decision-making processes.

Given the range in tools and methods that can be used in environmental analysis, a regular synthesis on such methods and tools, as well as their practical applications, would be very helpful in ensuring that transportation agencies have the best capability for addressing different environmental issues. Forums for sharing DOT and MPO experiences with the use of various methods and tools would also be useful in this regard.

TABLE 15 Tools for identifying environmental values

Category	Tool	Use	Strengths	Weaknesses
Economic Measures	Restoration/ replacement costs	Assigns economic cost to environmental damages	Estimates costs directly related to damaged resource	Some resources irreplaceable; ignores loss of use before replacement
	Travel costs	Assigns economic value to resource based on visitation	Works well when distance to site is key for estimating benefits	Trips often have multiple objectives; confuses payment with value
Ecological Relationships	Health	Relates ecosystem quality to the performance of key indicators	Provides useful summary measures to gauge impacts of changes over time	Hard to link cause and effect in ecological relationships; choice of indicators may be controversial
	Integrity	Focuses on synergistic and system relationships	Recognizes systemwide characteristics of complex ecosystems	Definitions can vary greatly across experts; human versus nonhuman factors problematic
	Resilience	Assesses the long-term viability of a resource	Captures threats to future environmental quality based on past events and ecosystem response	Difficult to measure; translation into comparable policy terms can be controversial
	Carrying capacity	Relates fundamental qualities of ecosystem value to productivity	Tracks key threats to future resource use and availability	Relation of productivity to value may be contested; choice of impact baseline difficult
Expressed Preference Surveys	Attitudinal and opinion surveys	Gathers information about ecological understanding and support for policies	Viewed as egalitarian and democratic; can be closely targeted to issues or market	Subject to strategic and motivational biases; may encourage superficial responses
	Constructed preferences	Elicits values used in making decisions about environmental choices	Attempts to reflect actual decision processes and the key tradeoffs of stakeholders	Responses may be difficult to integrate into cost/benefit framework
	Image	Assesses affective and psychological reactions to scenarios or events	Incorporates perceptions and beliefs associated with a proposed action	Stimulus-response characteristics tough to anticipate; high geographic variability in responses
	Narrative and effect	Elicits concerns of stakeholders through dialogue and conversation	Can yield compelling stories; methods grounded in familiar feelings and emotions	Subject to bias via small-sample selection; coding of responses problematic
	Referenda	Asks individuals to vote for or against a specific proposed action	Provides familiar method for gauging opinions of diverse stakeholders	Knowledge level of participants can vary widely; responses sensitive to framing of questions
Small-group Input	Focus groups	Elicits responses to proposed action through informal small group discussions	Inexpensive; directly targets question of concern; uses insights from diverse populations	Sessions can be dominated by one point of view; values remain implicit; and conflicts difficult to address
	Advisory committees	Develops broad perspective on an issue; involves interested and knowledgeable representatives	Allows for open discussion; can increase trust in agency and empower local citizens	Objectives and powers of committee may be unclear; diversity of viewpoints easily suppressed

Source: Adapted from DHV Environmental and Infrastructure BV, undated (*96*).

CHAPTER **5**

INCORPORATING ENVIRONMENTAL STEWARDSHIP INTO TRANSPORTATION PLANNING AND PROJECT DEVELOPMENT

Establishment of procedures for early and continual coordination and cooperation in developing mitigation plans will provide more cost effective and efficient mitigation, and ultimately, a higher level of protection and conservation of our valuable resources. (*97*)

INTRODUCTION

This chapter presents the lessons learned from this research and recommends steps that transportation agencies can take to integrate environmental considerations into their system planning. To do so, the conceptual framework presented in Chapter 3 will be revisited; major findings (as determined from the literature search, surveys, and case studies) presented; institutional aspects of implementing change in organizations, with particular attention given to examples from this research that show how transportation agencies have successfully done so, discussed; and additional research needs identified.

CONCEPTUAL FRAMEWORK REVISITED

This report began with the presentation of a conceptual framework that pointed to parts of transportation planning and project development where environmental factors could be more fully considered. Considering environmental factors early in planning could provide an important opportunity to discover potential environmental problems and build a working relationship with those environmental resource agencies that would be likely to play key roles in project implementation.

Figure 21 shows the conceptual framework that was used to guide this research and indicates where environmental factors could be incorporated into system planning and project development. Table 16 describes the types of actions and activities that might be found in each of these steps. It seems likely that considering environmental factors in the different planning and project development steps indicated in Figure 21 would have varying degrees of benefit as perceived by different participants. For example, including environmental concerns in the vision and goals/objectives/performance measures planning steps could be an important issue to planners and environmental specialists. By so doing, the influence of this important point of departure could permeate throughout planning and project development, resulting in better projects. However, it might not speed project development, an objective identified by many DOT officials as a reason for moving environmental concerns into systems planning. It seems clear from this research that the transportation and environmental participants' joint identification of the benefits of moving environmental considerations early into planning is a prerequisite for successfully doing so.

The concepts illustrated in Figure 21 and described in Table 16 can act as a checklist for agencies seeking ways to incorporate environmental considerations into agency operations, especially into systems planning. For example, the following questions could serve as an assessment or audit tool for determining where additional steps were needed to implement an effective environmental stewardship program:

1. Has your agency included concern for the environment in its mission or vision statement? Have guidelines or standard operating procedures been developed to disseminate this vision throughout the agency?
2. Has transportation planning included environmental issues in the goals and objectives statement?
3. If your agency has defined a set of performance measures relating to system or agency performance, are environmental measures a part of this list?
4. Does your agency collect data on environmental conditions on a systematic basis? Are sufficient resources available for continuing such data collection?
5. Has your state or region developed an inventory of sensitive environmental resources? If so, is this inventory used for planning or project development purposes, in particular, in efforts to avoid or minimize environmental impacts caused by project implementation?
6. Does your state or metropolitan area's transportation planning provide sufficient information that can be used in a determination of "need and purpose" for subsequent project development?
7. Does your agency systematically consider environmental factors in the definition of alternatives? Is at least one of the alternatives designed to minimize environmental impacts to the extent possible?
8. Has your agency defined project alternatives that both provide transportation benefits and enhance environmental quality? Does your agency actively pursue such project alternatives?

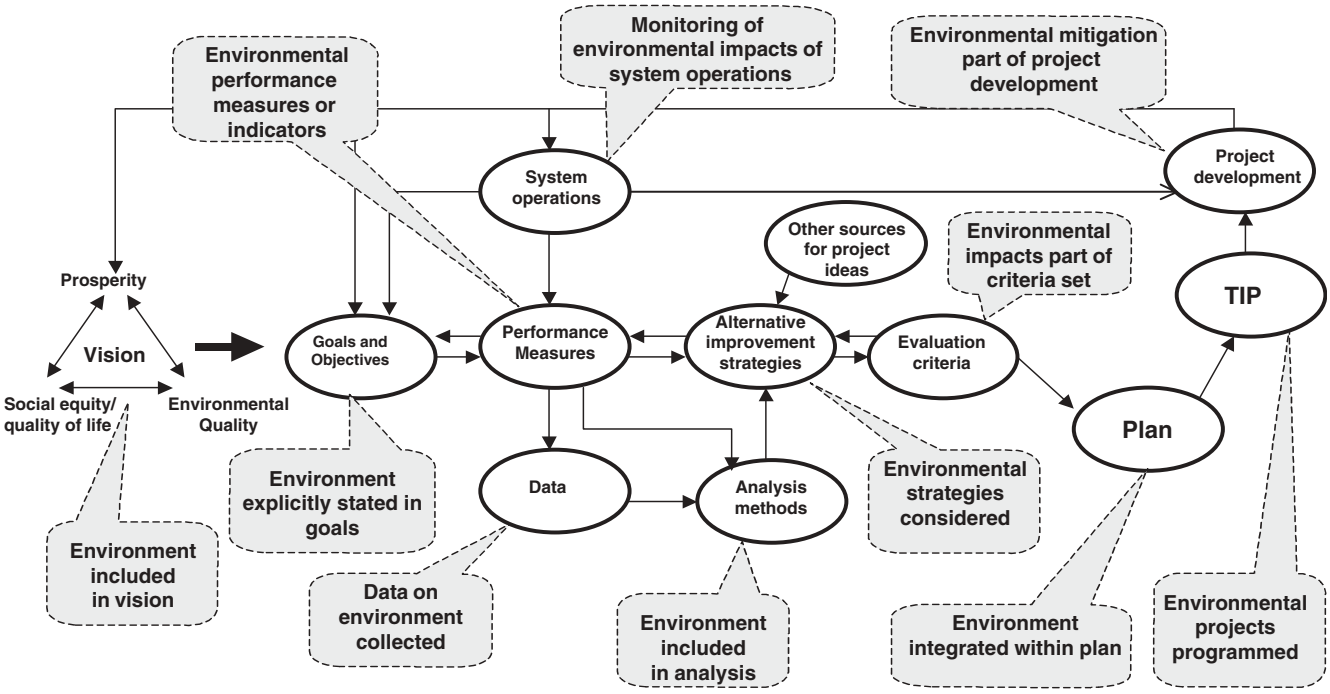


Figure 21. Environmental factors in transportation planning and decision making.

9. Do the criteria used to evaluate alternatives include the range of environmental concerns that are of most interest to the community and to environmental stakeholders?
10. Does your state or metropolitan transportation plan explicitly consider environmental factors in its description of desired future investments?
11. Has your agency entered into partnership arrangements with environmental resource agencies and environmental stakeholders in order to develop common understandings of how environmental factors will be considered in system planning and project development?
12. Do your agency's public involvement and outreach efforts specifically target environmental quality and its relationship to transportation system performance as an issue brought to public attention?

This list of questions was applied to the metropolitan transportation planning process in the Atlanta metropolitan area to show how it could be used as an audit tool (see Table 17). The subjective assessment ratings for each question were determined through interviews with transportation planners and a selected set of key decision makers in the region. This effort was not intended to be a detailed assessment of the effectiveness of metropolitan transportation planning with respect to environmental issues, and thus the results below should not be construed as a rigorous evaluation. The ratings from 1 to 5 indicate an average assessment of those interviewed, with 1 indicating little or no effort underway, and 5 representing a full-scale implementation of the concept.

As shown in Table 17, regional planning has two strengths with respect to integrating environmental factors into systems planning, but overall planning has many more areas in need of improvement.

MAJOR FINDINGS

This research has identified several important characteristics of efforts to move the consideration of environmental factors into system planning.

States having strong environmental laws have undertaken more efforts to consider environmental factors in transportation systems planning. The survey results indicated that most agencies considered competing interests that detracted from environmental objectives as a major obstacle for addressing environmental factors in system planning. However, the survey results and the case studies showed that states with strong environmental laws—especially where the laws effect transportation decisions—have reshaped their transportation planning in response to these laws. Deciding which environmental factors are to be considered in planning is often left to the transportation agencies themselves, which presumably are best positioned to know what the major environmental concerns, needs, and opportunities are likely to be. However, in some cases such as Wisconsin, state law is fairly specific about which environmental factors need to be considered. The system-plan environmental evaluation (SEE)

TABLE 16 Environmental factors in transportation planning

Planning Step	Consideration of Environmental Factors
Visioning	A community's vision should include explicit consideration of desired environmental characteristics. This could include targeted resources (e.g., air or water quality), geographic areas (e.g., wetlands or habitats), or a more general quality-of-life consideration. Some MPOs that have used scenarios as a means of better defining desired community visions have included a "protection of environmental resource areas" as one of the scenarios. In such scenarios, economic development and consequent infrastructure provision for these areas are limited.
Goals and Objectives	In most cases, environmental factors are found in some form in a planning goals and objectives set. This most often takes the form of a specific statement as a goal or objective that expresses the intent of "minimizing the impact on the environment" or a qualifying phrase that modifies a more important goal to "maximize system performance in a way that minimizes environmental impacts."
Performance Measures	This is one of the newest elements of transportation planning that puts in place a set of measures that is continuously monitored to identify the status of the transportation system and its linkages to other factors. One type of measure or indicator that could be included in this set is related to environmental quality. For example, several jurisdictions include air quality measures as part of their system measurement. Other indicators might relate to water quality, wetlands exposure, habitat reduction, historic and cultural resources, and archaeological sites.
Data/Analysis Methods	Given the importance of environmental considerations in the evaluation of plans and alternatives, data should be collected on environmental factors that are of concern to decision makers. Analysis capability using such data is needed to provide some sense of the environmental consequence of each alternative. At the systems planning level, the data and analysis methods might be very general, but would presumably become more specific as the analysis occurs on detailed project or plan alternatives.
Alternative Improvement Strategies	The actions adopted as part of the transportation plan could include strategies targeted at enhancing environmental quality. Certainly, the actions that fall out of such programs as the Congestion Mitigation and Air Quality (CMAQ) initiative would relate to improving air quality. Projects could also relate to Transportation Enhancements, strategies to reduce single-occupant vehicle use, actions aimed at environmental enhancement (e.g., brownfield developments), and water quality. At the systems planning level, where alternative plan configurations are considered, one scenario could be "environmental preservation," which might focus on such things as minimizing development in river discharge basins.
Evaluation	The evaluation process is, in essence, a synthesis process that brings together all of the information that has been produced as part of the analysis process. The evaluation criteria structure how the information is presented to decision makers, and thus are important in raising decision-maker awareness to environmental issues. The evaluation criteria should include measures that relate to environmental impacts of proposed alternatives.
Plan	The transportation plan should reflect the results of the goals setting, analysis, and evaluation. As such, the plan should provide an explicit linkage to the environmental consequences of the proposed set of projects or of the selected alternative, if such was the focus of the study. In those cases where plan alternatives must be analyzed from an environmental perspective, the plan might include a section that shows the results of this analysis.
TIP	The transportation improvement program (TIP) reflects the types of projects that are recommended in the transportation plan. Therefore, it is likely that several projects aimed at enhancing environmental quality will be found in the TIP.
Implementation of Projects/Strategies	The implementation of projects and strategies will include the project development process as well as the mitigation strategies that are necessary as part of project implementation. Thus, project implementation could very well include such things as context-sensitive solutions, environmental mitigation, and efforts to minimize or avoid serious environmental impacts.
System Operations	The performance of the transportation system, otherwise known as system operations, will naturally include an emphasis on the ability of the transportation system to satisfy demand. However, it is important that the monitoring of system operations also keep track of the consequences of such operation on the natural and human environment.

conducted for statewide plans in Wisconsin closely follows this format. California's Environmental Quality Act (CEQA) is an even stronger law that states not only must environmental impacts be identified and considered in transportation plans, but they must be mitigated. All regional transportation plans in California go through this assessment.

The scientific literature is increasingly identifying a systems-level perspective on environmental impact determination as being the most appropriate. The environmental science literature shows a significant trend toward increasing concern for environmental factors that can only be dealt with at a systems level of definition. This seems to be true in particular for environmental factors that are directly and indirectly affected by transportation investments. These environmental factors include such issues as ecosystem health, watershed effects, regional air quality, environmental

TABLE 17 Assessment of Atlanta transportation system planning process for integration of environmental factors

Criterion	Assessment	Comments
Existence of mission and vision statement; guidelines	2	The region has fully integrated air quality concerns into system planning and project development, and is doing so for water quality as well. Other environmental factors are not explicitly found in mission or vision statements.
Goals and objectives statements	3	Similar to above, air quality is an overriding issue in the region; general environmental quality is stated as a goal; regional development policies very much oriented to preserving environment.
Performance measures	2	Air quality is monitored and reported on an annual basis; there are no other environmentally related performance measures.
Data collection	2	Data are collected on air quality, water quality, and development patterns/trends. Less information is collected on other environmental factors.
Inventory of sensitive environmental areas	2	This has been done for a major subarea study, however, not for the entire region. Inventories do exist for watersheds and historic sites.
Information for need and purpose	1	The regional planning process has not connected system planning with more detailed project development efforts.
Alternatives definition	2	The plan alternatives strongly consider air quality impacts, but do not include other environmental factors in a systematic way.
Evaluation criteria	4	The evaluation criteria for plan and project evaluation come from extensive public outreach and comprehensively consider environmental impacts.
Environmental consideration in plan	3	The region's plan gives considerable attention to environmental issues.
Partnerships	2	The regional agencies work together on plan and project development, but have not entered into formal arrangements concerning expedited review.
Public involvement consideration of environmental factors	4	The region's public involvement program covers all aspects of environmental quality, especially air quality. Public concerns with respect to the environment are incorporated into planning activities.

Note: 1 = little or no effort; 5 = fully implemented

justice, habitat preservation, and the public health effects associated with urban form and related transportation investments. Each of these environmental topics, if addressed in a substantive way, must be examined at a systems level, even though individual project impacts could also be important.

The concept of ecological carrying capacity, which relates to this idea of an environmental alternative, is one that has been receiving increased attention in the scientific literature. The case studies from Cape Cod, Lake Tahoe, North Carolina, Pima County (Arizona) and Riverside County (California) illustrated the use of this concept. There is little doubt among scientists that urban development and other human activities influence the health of often-sensitive ecosystems. As urbanization continues with substantial increases in population expected to live in metropolitan areas, it seems reasonable to assume that this additional population will carry with it increasing burdens on the ecological systems that exist in urban areas.

State and MPO officials expect increasing attention to the types of environmental impacts that are best addressed at a systems level. The survey of state and MPO officials asked which environmental factors would most likely be more important 10 years from now in connection to transportation systems planning. The types of factors having the largest jump in importance were those best analyzed at the systems level. For example, DOT officials suggested that the biggest increase would be for cultural, historic, energy, water quality, farmland conversion, and human health. The results from the MPO survey identified energy, water quantity, water quality, aesthetics, storm water runoff, farmland

conversion, and noise. Except for aesthetics and noise, all of these factors are best handled at a scale of analysis much greater than the project level.

A few states and metropolitan areas have taken major steps in integrating environmental factors into transportation systems planning. Most states and MPOs have much experience with considering environmental factors in project-level planning. Only a few examples were found where transportation agencies were incorporating environmental concerns into systems planning. Case studies from the Tahoe Regional Planning Agency; Cape Cod Commission; Pima County, Arizona; Riverside County, California; and FDOT provided the most advanced examples of a comprehensive approach to doing so. In the first four cases, a fragile ecology provided the impetus for public intervention in the land development market and for a more targeted approach toward the provision of infrastructure. In the FDOT example, top management leadership provided the motivation to implement arguably the most advanced transportation/environmental decision support system in the United States.

NYSDOT has taken major steps to inculcating an environmental ethic in all of its activities. (It was not listed with the above five because it does not have a systems planning process as do the others.) However, such an organizational strategy represents an important step in the evolution toward a more comprehensive approach to linking environment and transportation decision making.

One important issue that must be addressed in better involving environmental resource agencies in system planning efforts is how to motivate such participation. Many states have provided resources to such agencies to support their participation, but this has been primarily at the permit review level. Getting agencies to participate in system planning efforts will require, at a minimum, a top management commitment to participate; an understanding (usually codified in a memorandum of understanding) of the roles that each participant will play; and as noted above, the commitment of resources.

The importance to decision making of including environmental factors early in systems planning very much depends on the degree to which impacts can be defined at a level that allows an understanding of consequences. At the systems planning level, the degree to which environmental analysis influences decisions seems to vary according to the level of information provided to the decision makers. If the "systems plan" is really nothing more than a policy document that outlines general directions for a state, regional, or metropolitan investment program, the level of environmental analysis will not be very rigorous. If, however, the plan represents a detailed analysis of alternative futures and the desire to link infrastructure investment to community goals, then a more detailed level of environmental analysis is likely to present useful information to decision-making.

Several case studies illustrate this concept. The Tahoe Regional Planning Agency's efforts in one of the most environmentally sensitive areas in the country shows how important environmental impact information can be when provided at a very detailed level (and backed up with laws and regulations mandating such consideration). However, several states (e.g., Wisconsin and Washington) require that environmental analysis be conducted on all statewide transportation plans. In each case, the analysis was conducted at such a broad level that state and local officials felt that the information provided had very little influence on the selection of the preferred system plan. In Wisconsin, for example, state officials felt that the most important effect of the required environmental review of the state plan was that it brought the state's natural resources agency into planning much earlier than would normally occur. The state environmental officials were not as positive about this experience in that they felt there was little that could substantively be done at such an early stage of decision making.

The availability of powerful database management capabilities has spurred intensive efforts to identify sensitive environmental resources. It is not surprising that the five agencies mentioned previously as being some of the best examples of considering environmental factors in planning and project development are national leaders in the use of GIS for locating and labeling environmental resources. GIS is a critically important tool in that it provides an efficient means of defining potential environmental impacts. In the absence of a database that permits a quick examination of potential environmental impacts, it is likely that the "give-and-take" that so often characterizes the interactions with environmental resource agencies would be less successful.

The revolution in data handling and data analysis capabilities that has occurred over the past 10 years in the United States has enabled a level of initial analysis of potential impacts that permits environmental agencies to participate in a more inclusive process without foregoing their statutory responsibilities. Serious attention to environmental factors early in systems planning will depend on the ability of transportation agencies, perhaps in cooperation with environmental resource agencies, to identify sensitive environmental resource areas. For example, efforts to develop statewide programs in historic preservation and archaeological sites would require some effort at identifying where such sites exist.

The concept of assessing the level of environmental sensitivity of habitats, ecosystems, and watersheds has been used by several planning and transportation agencies as a starting point for comprehensive community planning. Some of the more comprehensive efforts at integrating environmental factors into community and infrastructure planning have started with a fairly detailed examination of environmental resources. Pima County, Arizona, and Riverside County, California, undertook extensive multispecies habitat studies to identify areas that needed to be preserved. The Cape Cod and NCDOT cases provided examples of a much broader assessment of ecosystem preservation, not habitat protection.

Each of these efforts was part of a much broader community development planning effort.

Some planning efforts are defining transportation plan alternatives that focus on minimizing environmental impacts. Defining alternatives is an important step in transportation planning. One of the interesting aspects of planning that have seriously considered environmental factors in systems planning is the definition of plan alternatives or scenarios that result in infrastructure policies and investment decisions that purposely avoid or minimize the negative impacts on environmental resources. Examples of this were found in Cape Cod, Lake Tahoe, and Atlanta.

The use of scenarios in the formative stages of transportation systems planning is an important approach for showing the significance of environmental factors in planning for the future. This approach not only provides important information on the likely environmental impacts of transportation investment, but it represents learning and education where participants gain an understanding of how important ecological health is to a community. This learning experience has been one of the benefits noted by participants in the few cases where this approach has been used.

Successful consideration of environmental factors in system planning will require substantive public involvement and participation of environmental stakeholders. Efforts to advance environmental considerations early into systems planning most likely will require more extensive public involvement and the presentation of information in ways that makes such considerations understandable. According to opinion surveys, environmental quality, especially at the local level, is one of the most important issues for the public. Serious attention given to environmental factors in systems planning could mobilize many of the groups that traditionally become involved during project development. The approach toward planning may need to be different in cases where environmental assessment is now being conducted on system plans. For example, one might envision a public meeting for a transportation systems plan starting with general environmental data, maps of environmentally sensitive or community sensitive areas, and projections of the environmental health of the region. In addition, in the two cases where substantive environmental assessment was undertaken (Pima County, Arizona and Riverside County, California) environmental scientists were part of the habitat screening and evaluation. In both cases, representatives of each community served on the study steering committee.

Moving environmental considerations early in planning requires the participation of environmental resource agencies in these early stages as well. The WisDOT example of undertaking an environmental assessment of systems plans suggests that, in fact, one of the benefits of doing so is getting environmental resource agencies involved. Other DOT examples can be found in California, Florida, Maryland, North Carolina, Oregon, and Pennsylvania. Whatever approach is used to incorporate environmental considerations into transportation systems planning, the role for public and environmental stakeholder involvement will be critical.

By conducting environmental assessments earlier in systems planning, project development has been made more effective. One of the major motivations for state transportation agencies to consider environmental factors in systems planning is a perception that environmental analysis requirements provide onerous delays in project development. If only contentious environmental issues could be dealt with earlier—and/or redundant consideration of environmental factors eliminated—project development could be more efficient and effective. In particular, if the definition of a project's "need and purpose," a federally required part of an environmental assessment or environmental impact statement, could be established in systems planning, it need not be repeated during project development. The counter argument to this suggestion is that insufficient information is available in systems planning to provide enough substance to such a finding that would satisfy federal intent.

This research found several instances where need and purpose statements were developed during systems planning. The best example of this was the ETDM process used by FDOT. However, the characteristics of the process in developing this statement are important to understand. First, as noted previously, the ETDM process is supported by an extensive environmental database that is able to show potential environmental problems in regions or corridors. Second, the environmental resource agencies have access to this database and all information pertaining to the study or project so that they can make their own judgment on the adequacy of the need and purpose statement. A summary of all comments on this statement is kept by the environmental screening tool. Third, the environmental resource agencies reserve the right to revisit the statement if circumstances change as a project goes from system planning to project development.

This approach, in essence, is a "management by exception" strategy. By far, most projects will pass through this screening with little delay or additional work on the statement. However, in some cases, where circumstances change or more information becomes available, the statement might need to be reexamined. This is an appropriate response to such an instance. Therefore, this research suggests that linking system planning information to the development of a need and purpose statement in project-level environmental analysis is an important improvement to project development.

DOTs are implementing other changes to agency operations to expedite projects through project development. Several of the DOTs examined in this research have conducted internal studies of the delays that occur in project development. In almost every case, delays caused by decisions unrelated to environmental issues have been identified as being at least as important as those associated with environmental requirements. Changes in project scope, separate professional contracting for environmental and design services, poor project expediting, insufficient revenues to carry

forward a project, changes in political administration, and lack of coordination between DOT units as a project proceeds from one step to another have all been identified as important sources of delay. Changes to the organization, management oversight, and improved project information systems are being viewed as the most appropriate ways of dealing with this issue.

Other types of strategies are being considered by implementing agencies to reduce the amount of time that projects spend in project development because of environmental reviews. These include: listing certain categories of projects in a programmatic permit approval, parallel processing of NEPA and engineering design, funding environmental resource staff to work on transportation projects, and establishing interagency agreements that define the respective roles of the agencies participating in project development.

A context-sensitive solutions (CSS) approach to project development is viewed by DOTs and MPOs as a mutually beneficial situation. Although not the same as considering environmental factors early in systems planning, the concept of CSS as an approach to project development was a noticeable policy directive in all of the DOTs visited, and was being encouraged by MPO officials as well. In some ways, CSS is being viewed in similar terms as incorporating environmental considerations early in systems planning. This approach to project development calls for early and continual involvement of community stakeholders, a mutual definition of problems, and a collaborative development of solutions. If applied to systems planning, this is, in essence, the concept that was being explored in this research project.

The response to CSS has been very positive. The projects that have been completed in the states visited were noted with pride by all involved as showing what can be accomplished when everyone works together. The image of the DOT was enhanced, community support for projects was at much higher levels than for previous comparable projects, and engineers developed confidence in their abilities to meet the mobility needs of the community while providing a creative design that received community accolades.

The concept of CSS as an approach to project development can be linked closely with the early consideration of environmental factors in system planning. Not only can system planning identify areas where CSS might be very appropriate (e.g., sensitive or historic areas), but system planning can also identify key participants who could play important roles as the project moves closer to reality.

INSTITUTIONAL STRATEGIES TO IMPLEMENT CHANGE

Throughout this research, each of the successful efforts to incorporate environmental factors into the policy, planning, or project development activities of a transportation agency was implemented with strategic deliberation and consideration of how such a change could best be carried out in the organization. Although each of the case studies presented different aspects of incorporating environmental factors into organizational procedures or agency culture, the strategies usually had many common characteristics. These characteristics included

- *Top Management Support*—In many cases, requirements of state law provided an incentive for state transportation officials to consider environmental factors during systems planning. However, even in such cases, the level of commitment to this concept very much depended on the extent to which the secretary, commissioner, or chief engineer held a strong positive position on the policy. This continuing top management interest and support provided the motivation to continue facing the organizational barriers that often accompanied such efforts. In California, Florida, New York, and Pennsylvania, for example, the secretary of transportation was personally interested in seeing that the agency's environmental or CSS efforts were successful. The concept of an internal champion to "push" new planning concepts was found in Mn/DOT where full-time staff were reassigned to develop the environmental streamlining strategy for the agency.

  Some the case studies also showed the importance of a political champion or leader in fostering more attention to environmental issues in systems planning. For example, the governors of Pennsylvania and Maryland may be appropriately viewed as having been the champions of environmentally sensitive development in their states through their leadership and endorsement of environmental and growth management laws. The consensus building and general public awareness that occurs during the passage of laws and the adoption of policies may begin to create a more supportive environment as a backdrop for planning activities in a state. It is not necessarily the case that this policy approach would readily carry over into agencies that are tasked with implementation. They may not be prepared to take up the tasks associated with new laws, policies, and their associated regulations, or they may disagree with the intent. In Wisconsin, for example, the actual requirements of TRANS 400 were debated and legally challenged for over 10 years before the DOT finally agreed to the present form of implementation. However, where laws are passed and resources provided for their implementation, the legislative foundation serves as an enabler for accomplishing environmental goals.
- *Organizational Assessment*—For those agencies that targeted the entire organization and its procedures for change, an organizational assessment was conducted to understand what functions provided opportunities for incorporating environmental factors into agency activities. This often meant forming task forces or committees with a mandate to recommend changes. Table 18, for

TABLE 18 Work groups formed by FDOT for the ETDM process

Task Work Group	Objective
Environmental Permits	1. Develop a process to obtain construction permits simultaneously with the NEPA Record of Decision 2. Achieve concurrent and simplified notices where feasible 3. Develop criteria for categorically excluding certain projects from permitting
Two-Year State Transportation Improvement Program	1. Evaluate the feasibility of implementing a two-year STIP and a two-year TIP development cycle 2. Determine the steps required to implement this two-year planning cycle with FDOT
Programming NEPA Projects	1. Develop a method for proceeding with environmental studies earlier in the FDOT Five-Year Work Program
NEPA Decision-Making Process	1. Determine how project development will be accomplished in the ETDM process and create a linkage to project development 2. Describe the timing during the planning process, the content, and the audience for the documents
Secondary and Cumulative Impacts	1. Create a framework in the ETDM process for conducting secondary and cumulative assessment that incorporates needed data from land use, transportation, and resource protection plans
Bridge Program	1. Investigate and document how the FDOT Bridge Program enters the Five-Year Work Program 2. Recommend a method for interfacing the Bridge Program with the ETDM process
Cultural Resources	1. Investigate and document how to complete archaeological and historical assessments for transportation projects more efficiently and earlier in the project development process 2. Ensure how appropriate identification, avoidance, minimization, and mitigation of Native American issues are considered and documented
Community Impact Assessment (CIA)	1. Document how CIA and public involvement are accomplished in the ETDM process

Source: Florida Department of Transportation, 2002 (*77*).

example, shows the different working groups established in FDOT to assess where changes in internal procedures were appropriate. In many cases, representatives of environmental resource agencies, regional planning organizations, and other concerned stakeholders were part of this process.

- *Internal Implementation Strategies*—Some of the more comprehensive programs examined in this research included efforts to consider environmental factors in many aspects of an agency's activities, thus influencing many different units within the organization. Successful implementation of these programs entailed a broad perspective on the types of actions that different units would take to implement the program. Table 19, for example, shows Caltrans' plan to implement CSS in the organization. Note that responsibilities for actions range from the director to public relations staff. Key units in the organization, such as district offices (which in most state transportation agencies would have important implementation responsibilities) are targeted for special responsibilities.
- *Institutional Change in Standard Procedures*—Many state transportation agencies rely on standard operating procedures to guide agency staff in their approach to standardized situations. Thus, many procedures relating to project design follow accepted practices that are prescribed in design manuals. Incorporating environmental factors into this prescribed practice is a good way of institutionalizing such a process in the daily operations of the organization. This was certainly an important part of the strategy in the NYSDOT for institutionalizing its Environmental Initiative in all parts of the organization.
- *Resources*—The most important obstacle cited by DOT and MPO officials as hindering the incorporation of environmental factors into transportation planning was "competing objectives that detract from environmental

TABLE 19 Caltrans implementation strategy for CSS

Focus	Strategy	Technique	Responsibility	Schedule
Academies/training/tools	• Provide focused training for staff regarding CSS concepts and applications • Provide specific tools and applications for implementation	• Develop CSS guidelines • Include CSS modules in existing functional academies • Share technical case studies/lessons learned •Develop and distribute tools and applications	• Districts and divisions will organize CSS training and guides districtwide and departmentwide • Districts will contribute CSS case studies and lessons learned • HQ divisions will lead tools and application development with districts	Now
District system management plan (DSMP)	• Use DSMP as Caltrans policy-level system planning document to communicate CSS as department policy	• Include CSS considerations in DSMPs, particularly under the stated policies and strategies	• Districts will include CSS concepts in DSMP • DOTP will incorporate CSS support and info in DSMP guidelines	Now
Transportation corridor report (TCR)	• Long-range Caltrans concepts for state highways must address CSS	• Include CSS considerations in TCRs TCR should include a route/corridor context for use in project documents	• District planning will include CSS strategies in TCRs • DOTP will revise system planning guidelines to include CSS	Now
Transportation system development program (TSDP)	• TSDP, as project information element in Systems Planning process, must address CSS	• Include CSS element in TSDPs	• Districts will include CSS elements in each TSDP • DOTP will include CSS in guidelines	Now
Transportation planning grants	• Use DOTP discretionary planning grants as stimulus for CSS considerations by planning and local agencies	• Incorporate CSS support in grant guidelines • Include information in grant criteria to encourage CSS	• DOTP will include CSS support in grant guidelines • Districts will facilitate consideration of CSS strategies in all grant applications	Now
Project initiation documents (PIDs)	• CSS as part of project initiation becomes an integral part of all projects	• Include CSS strategies in PID guidelines • Include CSS consideration in all PIDs • Include "Statement of Context" in all project reviews	• Districts will include CSS strategies in PIDs • Districts will facilitate the involvement of CSS stakeholders in the development of PIDs • HQ Design will enhance CSS concepts in PDPM	Now
Project reports	• Projects final scope of work; cost estimates and time-lines should consider and, if appropriate, incorporate CSS	• Include strategies in project review guidelines • Include CSS consideration in project reports • Include “Statement of Context” in all project reports	• Districts will include CSS strategies in project reports • Districts will facilitate the involvement of CSS stakeholders in the development of project reports • HQ Design will enhance CSS concepts in design manual	Now
Intergovernmental review	• Use reviews as opportunities to advocate CSS regarding local development proposals	• Include CSS review and, if appropriate, recommendations in Caltrans intergovernmental review process	• District planning functions will include CSS strategies in intergovernmental review program	Now
California transportation plan/interregional transportation strategic plan/regional plans	• Reflect department’s commitment to CSS in Plan	• Include CSS description and support strategies in Plan • Include CSS strategies in state plan development guidelines • Include CSS strategies in regional plan development guidelines	• DOTP • Districts will recommend CSS strategies during the development and review of regional transportation plans • HQ Programming to provide CSS criteria in program themes	Now

(*continued*)

TABLE 19 (*Continued*) Caltrans implementation strategy for CSS

Focus	Strategy	Technique	Responsibility	Schedule
Regional overall work programs (OWPs)	• Promulgate CSS through regional planning efforts	• Include strategies in OWP guidelines • Recommend CSS-related activities in OWP	• Districts will work with regional agency OWP staff	Now
Environmental assessments	• Highlight CSS considerations in Caltrans environmental program	• Include CSS in all environmental documentation, including initial studies and full impact reports	• Environmental Programs to highlight CSS considerations in documents and meetings	Now
Maintenance and operations	• Integrate CSS in maintenance and operations	• Review routine maintenance and operations activities to identify opportunities for minimizing impacts to communities and the environment	• Each program area	Now

Source: California Department of Transportation (Caltrans), 2002 (*99*).

considerations." In one sense, this could be interpreted as a resource allocation problem (i.e., a lack of sufficient resources to consider environmental factors in planning). If a state perceives that an environmental problem is serious or important enough—such as the deterioration of the Chesapeake Bay in the case of Maryland—it will pass the laws necessary to address the problem. Enabling legislation for environmental analysis is probably the most important motivator for transportation agencies in considering environmental factors in transportation planning.

Many of the case studies in this research indicate that the early consideration of environmental factors can consume a great deal of time and resources. Transportation agency staff must often spend considerable time with environmental resource agencies explaining the rationale for a particular project and the actions to be taken by the DOT in environmental mitigation. The expectation is that the extra time spent early in the process will result in greater progress in moving the project through project development when it reaches that stage.

The case studies illustrated the level of support that was deemed necessary to assure success. In New York, the DOT hired environmental managers for every district in the state to act as catalysts for the Environmental Initiative. In Minnesota, the DOT dedicated full-time staff in the effort to change the internal procedures of the organization. In Florida, millions of dollars have been spent on the environmental screening tool that serves as the foundation of the ETDM process. All of these efforts were critical to the success of the initiatives in each agency.

- *External Implementation Strategies*—Much of the success in considering environmental factors in systems planning relies on establishing agreements with environmental resource agencies that articulate the respective roles of each actor in planning and project development. The usual means of doing this is through memoranda of understanding, or in the case of FDOT's ETDM process, agency operating agreements.

An example of such an agreement can be found in California. California's state transportation agencies have been national leaders in establishing formal partnership relationships with environmental resource agencies. California's Business, Transportation, and Housing Agency has recently entered into a partnership agreement with the California Environmental Protection Agency and the Resources Agency to identify program areas in which additional cooperation will result in a more successful integration of statewide mobility goals with environmental protection. This Tri-Agency Partnership, which realigns institutional relationships to improve the scope and pace at which environmental considerations are incorporated into transportation planning, identifies two purposes for the partnership. First, the partnership is designed to foster cooperative interactions among the three agencies. Second, the result of this cooperation is the timely planning and implementation of transportation projects that protect or restore environmental resources.

The specific goals of this partnership included

- Identifying and sharing information on transportation and environmental priorities;
- Developing transportation and environmental performance criteria to evaluate transportation projects and to improve their selection and design;
- Ensuring the timely development of environmentally beneficial transportation plans and projects that recognize the priorities of livable communities, the principles of environmental justice, regional planning, cultural and natural resource conservation, and environmental protection;
- Ensuring compliance with all applicable environmental laws, rules and regulations, permits and policies while reducing the time required to develop and implement transportation policies;
- Encouraging early and continuous participation of effected state, federal, and local agencies, public interest groups, and the public throughout the local land-use planning, resource conservation planning,

transportation planning, project development, and regulatory approval; and
  - Establishing an interagency issue resolution process with appropriate timeliness for completion.

The agencies have agreed to share and develop resources to support their objectives, including the use of shared training and interagency staff rotational assignments, as well as the development and deployment of a GIS and data to facilitate the analysis of the environmental impacts of proposed planning and project alternatives. One of the issues raised by the resource agencies is the lack of sufficient data to support project-level decisions and to consider environmental consequences in the early stages of planning.

- *Defining Benefit*—Changing organizational procedures in, and approaches to, transportation planning and project development could require significant changes in the attitudes and mindsets of agency staff. Convincing environmental resource agencies to change their standard procedures and approaches similarly require such changes. The case studies indicated that one of the necessary first steps in bringing about such change is clearly articulating what benefits will occur when a new approach is adopted. All participants, especially when the process relates to a regulatory procedure, must perceive the benefits. Some of the benefits of early consideration of environmental factors include
  - Increased opportunities to avoid adverse impacts to natural resources;
  - The opportunity to provide "in place" and functioning compensation and eliminate the lag time between loss and replacement of resource values;
  - The opportunity to integrate the mitigation into regional environmental goals and preservation objectives;
  - The establishment of more efficient and effective monitoring and evaluation procedures;
  - The ability to provide the greatest resource benefit for the expenditure of mitigation funds;
  - Swift utilization of the diminishing opportunities for habitat conservation and preservation; and
  - The reduction in the potential for delays in project approval due to mitigation concurrence and permit processing (*98*).
- *Partnership Benefits*—Environmental resource agencies often hesitate to participate in a process where environmental factors are considered early in system planning. Primarily, this hesitation is caused by a concern that such early participation could be construed as approval of a project long before some of the specific impacts are known. State transportation agencies that have successfully formed partnerships with their respective resource agencies have done so by promising to consider seriously the likely effect of transportation projects on the environmental factor at issue, and often supporting environmental staff review of the agency's projects. Many states (e.g., Pennsylvania, New Jersey, Maryland, and California) have agreed to fund environmental resource agency staff for their efforts at project review.

  For example, Caltrans signed a memorandum of agreement with the state's Department of Fish and Game in 1990 concerning expedited review of transportation projects. The intent of this agreement was "to (1) foster the early consideration of biological impacts in transportation systems planning, (2) provide continuous coordination and early consultation between the transportation agencies and the resource protection agencies, (3) replace valuable habitat unavoidably lost through the creation of high-quality habitat before impact, and (4) exercise creativity within an atmosphere of mutual respect." (*98*) Figure 22 shows the typical types of actions that resource and transportation agencies agree to in such arrangements.

  Appendix D, which is contained in *NCHRP Web-Only Document 77*, presents an example of a memorandum of understanding among transportation and environmental resource agencies in Minnesota.

FUTURE RESEARCH

In many ways, this research project suggests a rethinking of the way systems planning is conducted in the United States. At the very least, it suggests a different mindset among most transportation planners and engineers of how environmental factors should be considered during planning. It also focuses attention on the types of environmental issues that are likely to be faced in the future, and the types of expertise that will be necessary if these issues are to be dealt with in a serious way.

The ability of transportation agencies to adapt to a new approach toward planning will, to a large extent, depend on their understanding of the importance of the issues and on how system planning can best incorporate these concerns from a process and technical point of view. The following proposed research topics are designed to get the transportation profession to this point.

Understanding the systems effects of ecosystems, human development, and transportation investment. Scientists have been focusing on ecosystem health for many decades and are just now beginning to understand many of the complexities that characterize ecosystem health. Some attention has been given to the negative impacts of human activity on ecosystems, although most of this research has been at the macro level (e.g., number of wetlands and wetland functionality lost). Very little attention has been given to the relationship between ecosystem health and transporta-

The Resource Agencies Agree to:

- Commit or redirect staff and resources to accomplish early planning and coordination goals;
- Assist Caltrans in evaluating impacts of future transportation improvement projects during the early planning stages and respond to requests for information, recommendations, and coordination in a timely manner;
- Identify the natural resources of concern within the area of potential impact and recommend measures to avoid, or minimize and compensate, impacts to natural resources;
- Explore all appropriate mitigation and enhancement options consistent with the policies and guidelines of the agencies;
- Assist in developing mitigation proposals that take into account the extent of the project impacts, the effected habitat values, benefits to the ecosystem, cost effectiveness and opportunities for coordinating with other conservation efforts; and
- Consider application of excess compensation for future projects and permit "banking" when an appropriate opportunity exists.

Caltrans and FHWA Agree to:

- Pursue a policy of proactive consideration of environmental issues and concerns in which the sequencing principles of avoidance, minimization, and compensation are applied to natural resources;
- Incorporate all feasible and practical features of project design which avoid and minimize adverse project impacts before employing compensation measures;
- Where mitigation is required, achieve on-site and in-kind compensation whenever feasible and recommended by resource agencies;
- Implement compensation in advance of project impacts whenever feasible and appropriate;
- Explore opportunities for natural resource enhancement during project development;
- Keep all agencies updated on planning and project development activities;
- Provide for monitoring and periodic evaluation to determine if modifications are necessary to ensure that project compensation measures meet the overall planned mitigation goal and permit requirements;
- In addition, Caltrans agrees to provide for the sustained maintenance and operation of the compensation sites and habitat values sufficient to offset the unavoidable losses; and
- To the extent that such activities are not part of regularly funded planning assistance and review, fund on a reimbursable basis as needed and mutually agreeable, the resource agencies to provide technical assistance, technical studies, and expedited review as part of early mitigation planning.

Figure 22. Principles of Agreement in a Memorandum of Understanding between Caltrans and the state's Department of Fish and Game.
Source: California Department of Transportation (Caltrans), 1990 (*97*).

tion investment. Such research would examine the basic science involved with this relationship and develop methods and tools that can be used to investigate ways of reducing the influence of transportation-induced disruptions. This research would have to be truly multidisciplinary to bring the scientists that are knowledgeable about ecosystems together with engineers and planners who understand the construction and operational characteristics of transportation system performance.

Understanding the political, social, and land-use contexts for transportation planning, and how they influence the opportunities for, and constraints on, considering environmental factors during systems planning. This research has identified several cases where initial steps have been taken to integrate community planning, infrastructure provision, and environmental assessment. In many cases, these planning activities have evolved in separate institutional constructs, and it is only through the intervention of community activists, political leadership, or legislative mandate that such integration has been attempted. Research is needed to better understand the different social and political contexts that foster such coordinated planning and those that serve as a hindrance.

Developing tools for integrated environmental/transportation systems planning. Although the survey of MPO officials indicated that the inadequacy of analysis tools for addressing environmental problems at the systems level was not considered a serious constraint, it is likely that these officials did not have the integrated concept proposed in this research in mind. It is very clear from this research that one of the prerequisites for getting mutually beneficial participation from the environmental and transportation communities in systems planning is to have an analysis capability that provides important indications of potential problems. This was shown in Florida to be one of the key determinants for environmental resource agency participation. Although GIS capabilities are important points of departure for identifying sensitive environmental areas, additional analysis tools and methods are needed to develop a level of comfort at the systems level that the decisions being made are done so with good information.

Investigating the use of monitoring and surveillance technologies. The sensitivity of ecosystem health to disruption is often so fragile that minor changes in conditions can have significant negative impacts. If environmental quality is an important planning concern, then systems planning should include the continuous monitoring of the environmental health of the state or region. This could entail the use of satellite imagery, environmental sensors, biological indicators, and community quality-of-life measures. Mn/DOT's movement toward environmental indicators as part of its family of performance measures is indicative of the types of direction that DOTs and MPOs might take.

Developing environmental resource protection/conservation plans. Such plans are not new to environmental professionals, but they are new to transportation officials. This research project would examine the process used to develop such plans and answer questions such as the following: What are the goals of such studies? Who is involved? What are the typical results? What have been the factors of success and failure? What are the data needs? How do the results relate to transportation systems planning? Given the principles of ecosystem management that have come to the fore in environmental policy, the transportation community needs to know more about what these types of studies mean to transportation systems planning.

Developing performance measures to track progress toward environmental goals. Various experiences with sustainable transportation planning, both in this country and internationally, suggest that performance measurement and public reporting are critical components of demonstrating agency accountability and credible progress toward environmental goals. Although a comprehensive set of performance measures and indicators may not have been identified by any particular agency, several agencies (including ODOT, WSDOT, PennDOT and Eugene/Lane COG) have undertaken programmatic initiatives on performance measurement and reporting. The research will examine the linkages between environmental goals/objectives and measures/indicators of performance, appropriate scopes of measures for tracking how well agencies are achieving predefined goals, the need for a dynamic set of measures to reflect changing emphases on various environmental issues, and best practices of performance measurement for considering the environment in transportation planning.

Assessing organizational strategies for environmental stewardship. Except for NYSDOT, few transportation agencies have examined all of their activities from the point of view of environmental stewardship. This research project would develop guidelines on how an organization could conduct such an analysis (different for the ISO 14001 approach). All of the organizational activities would be examined and strategies developed to foster greater consideration of environmental factors in all aspects of an agency's daily functions.

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation