United States General Accounting Office

GAO

Report to Congressional Requesters

October 2001

ENVIRONMENTAL PROTECTION

Federal Incentives Could Help Promote Land Use That Protects Air and Water Quality

GAO-02-12

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Highlights

ENVIRONMENTAL PROTECTION Federal Incentives Could Help Promote Land Use That Protects Air and Water Quality

Highlights of GAO-02-12, a report to congressional requesters

Why GAO Did This Study

"Urban sprawl"—developing farmland and open space away from an urban core—while providing housing and economic development opportunities, can increase traffic, impair the quality of life, and increase air and water pollution. The Congress asked GAO to examine how (1) state and local transportation and air and water quality officials consider impacts of land use on the environment and (2) federal agencies can help these officials assess land use impacts. GAO surveyed local transportation planners and state air quality officials nationwide and 32 experts on land use and water quality.

What GAO Recommends

- EPA should devise an overall strategy to help states and localities assess land use impacts and provide them with financial, technical, and other assistance.
- DOT should encourage transportation planners to assess the emissions impacts of their plans and share their data with land use officials.

GAO also suggests ways the Congress could encourage a better link between land use and environmental protection.

EPA and DOT generally agreed with GAO's findings and recommendations to their respective agencies.

What GAO Found

Most states and localities do not comprehensively assess the impacts of land use on air and water quality and develop ways to mitigate any adverse effects, according to survey results. Transportation officials in areas with poor air quality were more likely to estimate whether different land uses would reduce the amount of vehicle emissions from their transportation plans, but this is because the law requires them to ensure that their plans do not worsen air quality. Assessing air quality impacts is important because land use that increases reliance on cars can increase emissions containing carbon monoxide and other pollutants in certain geographic areas, such as developed areas that already have air quality problems. These emissions can cause respiratory, cardiovascular, and other illnesses. Assessing water quality impacts is important because land use that increases paved surfaces increases polluted storm water runoff, endangering water quality and public health.

State and local transportation and environmental officials do not consider the environmental impacts of land use because

- they are not required to consider these impacts;
- land use is a local decision and they believe that they have little ability to influence it; and
- they lack resources, data, and technical tools, such as modeling capabilities.

While cleaner cars and fuels will improve air quality nationwide, some congested or growing areas may still need to consider altering land use as a way to meet federal air and water quality standards. This is especially true if the Environmental Protection Agency (EPA) implements, as planned, more stringent air quality standards and a water quality rule (the total maximum daily load rule).

Survey respondents said the federal government could help and provide

- financial incentives for transportation, environmental, and land use officials to collaborate on more protective land use strategies;
- technical assistance to assess and mitigate land use impacts; and
- public education on the environmental impacts of land use and transportation decisions.

EPA and the Department of Transportation (DOT) have initiatives that provide some of this support, but others are limited in scope and not part of a coordinated strategy. The Congress is also considering ways to remove federal barriers and provide states and localities with additional assistance.

This is a test for developing highlights for a GAO report. The full report, including GAO's objectives, scope, methodology, and analysis is available at www.gao.gov/cgi-bin/getrpt?GAO-02-12. For additional information about the report, contact John Stephenson (202-512-3841). To provide comments on this test highlights, contact Keith Fultz (202-512-3200) or email HighlightsTest@gao.gov.

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Abbreviations

ARC	Atlanta Regional Commission
DOT	Department of Transportation
EPA	Environmental Protection Agency
GAO	General Accounting Agency
GRTA	Georgia Regional Transportation Authority
ISTEA	Intermodel Surface Transportation Efficiency Act of 1991
MPO	metropolitan planning organizations
MS4s	municipal separate storm sewer systems
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbons
SIP	state implementation plans
SUV	sport utility vehicle
TEA-21	Transportation Equity Act for the 21st Century
TIP	transportation improvement program
TMDL	total maximum daily load
USGS	U.S. Geological Survey

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United States General Accounting Office
Washington, D.C. 20548

October 31, 2001

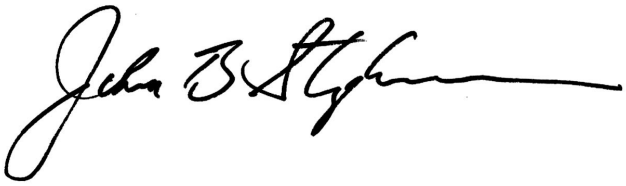
The Honorable James M. Jeffords
The Honorable Carl Levin
United States Senate

The Honorable Wayne T. Gilchrest
The Honorable Martin T. Meehan
House of Representatives

As requested, we are reporting on the extent to which possible environmental effects from land use and development patterns (including patterns commonly known as "urban sprawl") are taken into account in transportation, air quality protection, and water quality protection efforts. This report contains recommendations to the Secretary of Transportation and the Administrator of the Environmental Protection Agency (EPA). The recommendations address ways that the agencies can provide states and localities with financial incentives and technical support, among other things, to help them give greater consideration to the environmental impacts of their land use decisions.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 10 days from the date of this letter. We will then send copies to the appropriate congressional committees; the Secretary of Transportation; the Administrator, EPA; and the Director, Office of Management and Budget. We will make copies available to others upon request.

If you or your staff have any questions on this report, please call me at (202) 512-3841. Key contributors to this report are listed in appendix VII.



John B. Stephenson
Director, Natural Resources
and Environment

Executive Summary

Purpose

Americans have begun to focus on the downside of certain patterns of growth and development—increasing dependence on automobiles; worsening traffic congestion; and contributing to the loss of farmland, forests, and open space. Increasingly, some are also concerned that this prevailing pattern of land use, commonly called "urban sprawl," can increase air and water pollution, threatening their health and, in some cases, their livelihood. Vehicle emissions in congested areas can trigger respiratory and other illnesses, and runoff from impervious surfaces can carry lawn chemicals and other pollutants into lakes, streams, and rivers, thus threatening aquatic environments. Some states and localities—spurred in part by citizens' lawsuits and ballot initiatives—recognize that growth provides housing and economic development opportunities and is inevitable, but would like to better manage their future land use. The Congress has also expressed an interest in better understanding how federal policies and programs affect growth and land use. In two prior reports, GAO discussed how a broad array of federal policies can help or hinder state and local efforts to limit any negative effects and the general types of federal assistance that states and localities want to help them achieve this goal.[1]

For this report, the Senate Smart Growth Task Force and the House Sustainable Development Caucus asked GAO to (1) determine the extent to which local transportation planners and state air quality managers responsible for meeting federal clean air requirements consider the impacts of different land use strategies on their efforts to protect air quality; (2) determine how, if at all, state and local officials responsible for water quality and land use consider the water quality impacts of different land use strategies and work together to limit any adverse impacts; and (3) identify actions the federal government can take to help transportation, air quality, and water quality officials better link land use decisions with environmental protection.

To determine the efforts to assess land use impacts on air quality, GAO surveyed those officials responsible for managing each of the 50 states' and the District of Columbia's plans to protect air quality and meet federal air quality standards from March through July 2001. GAO also surveyed

[1] See *Community Development: Extent of Federal Influence on "Urban Sprawl" Is Unclear* (GAO/RCED-99-87, Apr. 30, 1999) and *Community Development: Local Growth Issues—Federal Opportunities and Challenges* (GAO/RCED-00-178, Sept. 6, 2000).

officials in each of the 341 metropolitan planning organizations nationwide who are responsible for designing the transportation plans to meet future land use needs during this time. GAO surveyed these local transportation planners because they have an important role in helping to protect air quality and ensure that the transportation plans designed to meet land use needs do not further degrade air quality. More specifically, these officials are responsible for ensuring that transportation plans do not increase vehicle emissions to the point that they exceed state-established emissions limits. Eighty-six percent of the local transportation planners and 46 of the 50 states, in addition to the District of Columbia, responded to GAO's surveys.

To evaluate the efforts to assess land use impacts on water quality, GAO surveyed an expert panel of 32 individuals knowledgeable about water quality issues, land use, economics, and environmental law from March through June 2001. GAO took this approach because, while responsibility for water quality rests with the states, this responsibility has been diffused among different organizations across the states. Therefore, it was difficult to consistently identify the most appropriate officials to respond to a nationwide survey. To select the participants for its expert panel, GAO reviewed available research and literature on water quality protection and identified noted experts. GAO then asked these experts to recommend other experts in their respective fields. Those experts identified most frequently were asked to participate in the survey, along with representatives of key stakeholder groups, such as federal and state water quality agencies and environmental organizations.

The ultimate responsibility for deciding how land will be used in the future and whether to use it in ways that are protective of air and water quality rests with officials within each local jurisdiction. While GAO did not survey these officials for this report, it did incorporate the results from a survey it conducted with them from January through March 2000 for its prior report to determine, among other things, their concerns about future growth and environmental protection. (See app. I for GAO's detailed methodology and apps. II to V for the survey questions implemented.)

Background

After World War II, the expanding U.S. population began moving away from traditional urban and metropolitan centers, aided by the construction of new roads and infrastructure on lands that had once been farms and forests. While this trend provided access to new housing, especially single-family homes built on relatively large lots, as well as new jobs and

economic development, the homes were typically not located within walking distance of these jobs, stores, or other amenities, which increased dependence on the automobile. The continued conversion of open space for these land uses (often termed "urban sprawl") has raised concerns in recent years among the general public. While more immediate concerns have focused on traffic congestion and long commutes to work that result from prevailing patterns of development, some states and localities have also begun to be concerned about other quality-of-life impacts, including adverse effects on air and water quality.

In response to these concerns, some states and localities have begun to look for alternative ways to grow—sometimes referred to as "smart growth"—that encourage, for example, (1) redevelopment in established urban areas to minimize urban sprawl and (2) development that locates denser or geographically compact housing within walking distance of stores, schools, jobs, and transit systems to decrease dependence on automobiles. Integrating these types of land use decisions with environmental concerns can be a difficult task for localities, however. This can require collaboration among the different decisionmakers, including local transportation planners, environmental officials, and local land use officials, who each have their own, and sometimes competing, interests. For example, local land use decisionmakers may feel greater pressure to develop land in ways that promote economic development for their individual jurisdictions, rather than in ways that provide regional solutions for environmental problems.

To some extent, certain land use patterns can contribute to poor air quality. Increased reliance on the automobile, especially in congested areas, can increase emissions that contain or create pollutants—including carbon monoxide, nitrogen oxide, and ozone—which have been associated with respiratory, cardiovascular, and other illnesses, as well as premature death. To protect public health, the Environmental Protection Agency (EPA), under the Clean Air Act,[2] has set standards—or limits—on the amount of allowable pollutants in the air. State air quality managers must develop state implementation plans for implementing, maintaining, and enforcing these standards. Through these plans, air quality managers establish emissions limits, or budgets, for vehicle emissions. Under the Clean Air Act, any area with air quality problems must demonstrate that its transportation plans will not exceed the emissions budgets or interfere

[2] Clean Air Act, 42 U.S.C. §§ 7401-7671q.

with achieving the state implementation plan. Otherwise, the area risks the ability to spend federal transportation funding on some major projects. In transportation acts that became law in 1991 and 1998, the Congress provided additional incentives, including funding, to encourage local transportation planners to adopt projects that limit emissions and are more protective of air quality. Although these planners base their longer-term transportation plan and shorter-term transportation improvement program on the future growth projections that localities provide, the local transportation planners are not required to assess different land use strategies to determine if the resulting transportation plan and program would produce fewer emissions.

Sprawl can also impair water quality. More paved and other impervious surfaces increase polluted storm water runoff, potentially threatening public health, destroying aquatic habitats, and hindering economic activity. To protect public health and the environment, the Congress passed the Clean Water Act.[3] It required states to establish water quality standards that, among other things, designate the beneficial uses, such as swimming and fishing, that the waters should support. States must also submit to EPA a list of all water bodies that do not or are not expected to meet standards. To implement the act, EPA established permit-related requirements and technology requirements for discrete, identifiable sources (point sources) of potential pollution, such as factories and wastewater treatment plants, to limit polluted discharges from these sources. In subsequent amendments to the act, the Congress established a grant program to encourage states to develop programs to combat pollution from diffuse, difficult-to-identify sources—nonpoint source pollution. The Congress also developed regulations to control a major portion of this nonpoint source pollution—storm water discharges. More recently, EPA promulgated a rule to amend and strengthen its water quality regulations. Under these regulations, states must identify their most severely degraded water bodies and the principal pollutants causing the degradation. For each pollutant, the states then calculate the total maximum daily load that a particular water body could absorb and still meet the standards. If these amounts are exceeded, the states determine the discharge reductions that each source must make. Because the revised rule has been controversial, however, EPA has postponed its implementation and is considering possible changes.

[3] Clean Water Act, 33 U.S.C. §§ 1251-1787.

Results in Brief

Our surveys showed that most local transportation planners and state air quality managers do not consider the effects of different land use strategies on air quality. At the local level, about three-fourths of the planners said they do not estimate the emissions generated by different strategies when selecting transportation projects. The remaining one-fourth who generated such estimates were predominantly in areas with air quality problems. This suggests that the federal requirement to demonstrate that transportation plans and programs conform to an emissions budget serves as the primary incentive to assessing the emissions impacts of different land uses. Furthermore, such estimates had some effect on transportation and land use decisions. For example, almost half of the planners who reported conducting such estimates revised their transportation plans as a result, and about a third reported that local land use plans were revised. At the state level, most air quality managers reported that assessments of the impacts of different land use strategies were not part of their efforts to improve air quality. The local transportation officials, as well as the state air quality managers, are not required to assess different land use strategies. The state air quality managers also reported that they do not assess these strategies because they believe that land use decisions fall under the jurisdiction of local governments and that the managers have little ability to influence it. The state air quality managers also said they lack a collaborative working relationship with local officials to assess the effects of different land use strategies on air quality. In the future, more of the transportation and air quality officials may need to consider land use as a means to control emissions and improve air quality if EPA implements, as planned, two more-stringent air quality standards. These officials face several barriers to further considering different land uses and their emissions impacts, however, including a lack of required technical tools.

As with air quality, most states and localities do not comprehensively assess the impacts of different land uses on water quality and develop strategies to mitigate any adverse effects, according to members of GAO's expert panel and the studies that GAO reviewed. They do not do so principally because nonpoint sources are diffuse and difficult to identify and measure and because there are few regulations to require mitigation efforts. In addition, communities often lack the resources as well as the technical, public, and official support needed for such efforts. As a result, according to several panel members, water quality protection and improvement efforts have focused more on controlling pollution discharges from point sources or complying with regulations, such as those recently promulgated for storm water. However, some communities with

resources and public support have started to assess the health of their watersheds, identify nonpoint pollution sources, and implement more-protective land use and development strategies. More states and localities may have to take such actions in the future because of citizens' lawsuits demanding greater progress in reducing nonpoint source pollution and because of the anticipated implementation of EPA's revised rule for determining a water body's total maximum daily load of contaminants. GAO's expert panel noted that states and localities will face several barriers, however, including insufficient data on water quality and the benefits of different land use strategies, outdated local laws that hinder new approaches to land use, and the lack of technical tools.

According to local transportation planners, state air quality managers, and panel members, federal agencies could help remove barriers to, and provide incentives for, assessing and mitigating the environmental impacts of land use. They proposed actions in three key areas: (1) financial incentives for transportation, environmental, and local decisionmakers to collaborate on land use strategies that limit adverse impacts on air and water quality; (2) technical capacity to assess and mitigate land use impacts; and (3) assistance in educating the public and local officials about the environmental impacts of their transportation and land use decisions and alternative development strategies that better protect air and water quality. EPA and the Department of Transportation (DOT) have some initiatives in these areas, and the Congress is considering proposals that would provide additional support. However, many of EPA's actions have been one-time initiatives that are limited in scope and not part of a coordinated, overall strategy. Likewise, DOT's initiatives were designed to focus on helping localities manage the emissions and congestion that result from the land use they select, rather than providing them with an incentive to consider land use strategies that reduce or eliminate these effects.

Principal Findings

Emissions Impacts of Different Land Use Strategies Are Not Generally Assessed

According to GAO's survey, 75 percent of the local transportation planners and 36 (about 76 percent) of the 47 state air quality managers do not estimate the emissions generated from different land use strategies in their efforts to limit emissions and improve or preserve air quality. Local transportation planners consider land use forecasts that localities provide when they determine future travel demand. Most said that in addition to

prevailing development strategies, localities' land use forecasts are beginning to include some alternative strategies considered to be more protective of air quality, such as bicycle and pedestrian trails and urban redevelopment, which decrease reliance on the automobile. However, local transportation planners and state air quality managers are not likely to assess the emissions resulting from different land use strategies to identify the mix of projects that would provide the most air quality protection because (1) they are not required to assess different land uses and many do not have an incentive to do so because they are not in areas with air quality problems; (2) they believe that land use decisions fall under the jurisdiction of local governments and that they have limited ability to influence them; and (3) although the transportation planners must collaborate with local officials when deciding on the projects to include in transportation plans and programs, the planners are not required to share the results of any emissions assessments that they may conduct with the local officials to help these officials select protective land uses. Furthermore, many air quality managers said they do not have the collaborative working relationship with local officials needed to pursue more protective land use strategies.

Local transportation planners in areas with current or prior air quality problems, which therefore must demonstrate that transportation plans and programs conform to an emissions budget, were more likely to assess emissions from different land use strategies. For example, 46 percent of the 134 planners in areas with air quality problems reported conducting such assessments, while only 8 percent of the 155 planners in areas without problems reported doing so. However, the areas without problems covered by many of these planners contain at least one county that expects significant growth in the future and therefore could still influence land use decisions to accommodate this growth in ways that preserve their air quality. The difference between the two groups of planners suggests that although not specifically designed to do so, the federal requirement to demonstrate that emissions from transportation plans conform with emissions budgets serves as an incentive. The federal requirement encouraged certain local transportation planners to estimate the emissions generated by different land use strategies and factor land use into their efforts to achieve or maintain air quality standards.

Local transportation planners and state air quality managers that reported conducting such assessments also said that they affected transportation plans, and to a more limited extent, air quality and land use plans. For example, 34 local planners changed their transportation plans by, for

example, adding more public transit projects. Twenty-three also reported that land use plans changed so that, for example, development included housing, jobs, and shopping centered around transit stops. Likewise, air quality managers in four states reported that either a transportation, land use, or air quality plan changed as a result of emissions estimates of different land use strategies. Some of the remaining transportation planners or air quality managers who assessed emissions from different land uses but did not see a change in transportation or land use plans in their areas reported that change had not occurred principally because (1) the emissions reductions from such changes would not be significant and (2) localities making land use decisions faced more pressure to promote economic development, for example, than to protect the environment.

Stricter air quality standards for two pollutants—ozone and particulate matter—that EPA plans to implement could increase the number of areas with air quality problems, which may cause more transportation planners and state air quality managers to turn to land use strategies to help them achieve or maintain air quality standards. For example, EPA estimates that, as of 1999, about 123 million people have been living in areas that are expected to violate the new ozone standard—nearly twice as many as the nearly 54 million who live in areas that do not meet the current standard. However, local transportation planners and state air quality managers face several barriers to assessing the emissions impacts of different land uses on air quality and factoring this information into transportation and air quality improvement plans. They lack (1) the modeling capability to assess and measure certain emissions impacts from different land use strategies and (2) a means of ensuring that the land use strategies proposed to limit emissions can be or have actually been implemented and that the amount of emissions reductions are actually achieved.

Most States and Localities Do Not Comprehensively Assess and Mitigate the Adverse Impacts of Land Use on Water Quality

Most states and localities do not comprehensively assess the impacts of existing land use or future development on water quality and factor such analysis into water quality protection and improvement plans, according to members of GAO's expert panel and the studies reviewed. Urban land use is a significant contributor to nonpoint source water pollution, which, according to EPA, accounts for up to 40 percent of water quality problems in waters that have been assessed. However, nonpoint sources are diffuse and often hard to identify, assess, and control. Therefore, they received little federal attention until the 1987 amendments to the Clean Water Act. Section 319 of the amended act provides states with grants to implement

largely voluntary programs to combat nonpoint pollution. However, efforts to date have not been enough to significantly reduce this pollution, partly because the program is relatively new and has had limited funding compared with efforts to control point sources of pollution. While the 1987 requirements for EPA to regulate major sources of nonpoint source pollution, such as storm water runoff, show promise, it is too early to determine their effectiveness.

To further address nonpoint pollution and urban runoff, many states could better assess the impacts of land use on water quality and employ land use management practices and alternative development strategies to limit adverse effects. However, GAO's expert panel rated the lack of funding, technical staff, and public and official support as important impediments to a greater assessment of the impact of land use on water quality. Several panel members pointed out that analyzing the impacts of existing and future land uses on water quality is technically difficult and resource-intensive, and that neighboring jurisdictions often do not have, or will not cooperate to share, funds and staff. Furthermore, some local land use decisionmakers do not understand the relationship between their decisions and water quality or feel pressure to focus on economic development rather than environmental concerns. Nevertheless, some jurisdictions, with sufficient resources and public and official support, have begun to employ land use management practices and development strategies that limit adverse effects on water quality. For example, New York City and several upstate counties formed a watershed partnership with other local stakeholders and, among other things, purchased environmentally sensitive or undeveloped land within the watershed to protect drinking water sources from impairment by polluted runoff.

More states and localities may have to assess land use impacts and take similar mitigation measures in the future. In response to citizens' concerns about persistent water quality problems, EPA and the states are focusing more attention on controlling nonpoint pollution, as evidenced by EPA's revised rule for determining the total maximum daily load of contaminants that a water body can sustain. However, GAO's panel of experts identified a number of barriers that states and localities would have to overcome: the lack of (1) resources for assessing land use impacts and public and official support for land use controls and alternative development patterns; (2) scientific data on the quality of water bodies and on the cumulative impacts of land use and development practices; (3) needed technical tools, such as access to user-friendly models; (4) updated zoning laws, development codes, and other laws that allow for innovative land use

practices; and (5) regional organizations with the authority to take a more comprehensive, cross-jurisdictional approach to assessing water quality and influencing land use to protect it.

Federal Agencies and the Congress Could Take a Number of Actions to Help States and Localities Better Consider the Environmental Impacts of Land Use

The majority of local transportation planners, state air quality managers, and GAO's panel of experts suggested a number of federal actions to reduce the barriers they identified in order to promote more widespread assessment and mitigation of land use impacts on air and water quality. First, the Congress and agencies could provide additional financial incentives to encourage assessments of the air and water quality impacts of land use. Incentives could include providing more funds for transportation, environmental, or land use projects that were developed collaboratively with local transportation planners and air quality, water quality, and land use officials, and that minimize the environmental impacts of land use. Second, the agencies could provide local transportation planners, environmental officials, and communities with some of the technical tools they need to help them assess, mitigate, and prevent land use impacts. These tools would include guidance on land use practices that limit environmental effects and improved modeling practices for estimating the environmental impacts of different growth scenarios. Third, the agencies could help to better educate local land use decisionmakers and the general public about the relationship between air and water quality protection and their transportation and land use choices and encourage collaboration on protective land use strategies.

The federal agencies involved in air and water quality protection have initiatives under way, and the Congress is considering several legislative changes that begin to address some of these proposals. For example, EPA has provided a limited number of grants to encourage land use solutions to environmental problems and is developing methods to measure the air and water quality benefits of certain land use practices. It has also publicized best practices and encouraged their wider use. Similarly, DOT has several funding programs to (1) promote transportation alternatives that limit air quality impacts and (2) improve transportation models so that they can account for the impacts of small-scale changes, such as added bicycle and pedestrian trails, and for the ways in which transportation projects encourage or discourage travel demand. The Congress is also considering actions to support state and local growth management efforts, such as providing for better coordination among federal agencies that provide community assistance, and financial incentives to update outmoded state

laws that discourage innovative and environmentally protective land use strategies.

While EPA's efforts are commendable, some have not reached a large and diverse enough number of communities to have an impact nationwide. According to the manager for the agency's smart growth initiatives, EPA recognized that it had limited resources and authority to help the thousands of existing communities with their land management efforts. Therefore, the agency decided to use its funds as seed money for pilot projects in select communities. The agency tasked the Development, Community, and Environmental Division within the Office of Policy with the mission of helping to promote smart growth initiatives and gave it limited resources. However, the agency decided to allow each program and regional office to determine the extent to which that office could assist state and local efforts and did not give these offices a similarly defined smart growth mission or resources. While these offices have undertaken a number of initiatives, they have not coordinated them effectively and the level of activity has varied. For example, one region had a smart growth agenda and workgroups from the various program offices, while another region had little staff support to undertake initiatives. The agency will not have a more widespread impact until it, among other things, (1) takes stock of its initiatives to determine which were successful and effective, (2) lays out a strategic and better coordinated plan for its efforts, and (3) requests any necessary authority and funding to implement the plan. Likewise, while DOT's initiatives were designed to promote transportation options that control emissions, they were not designed to encourage local transportation planners to consider whether different land use strategies would result in more of these options or to encourage communities to consider altering land use plans as a means to implement these options. Transportation planners may not consider the impacts that different land use strategies have on emissions without additional incentives, such as making land use considerations a more explicit criterion for funding transportation projects or encouraging the planners to assess their impacts on emissions and to share the results with local land use decisionmakers.

Recommendations for Executive Action

GAO is making a number of recommendations on ways that EPA and DOT can better focus and coordinate their activities and provide additional incentives, technical support, and public outreach to promote a closer link between land use and environmental protection.

Matters for Congressional Consideration

GAO is making several suggestions on ways that the Congress may want to provide EPA with additional authority and funding, and provide states and localities with additional financial incentives, to limit the adverse environmental impacts of land use and update outmoded laws that prohibit the consideration of more protective strategies.

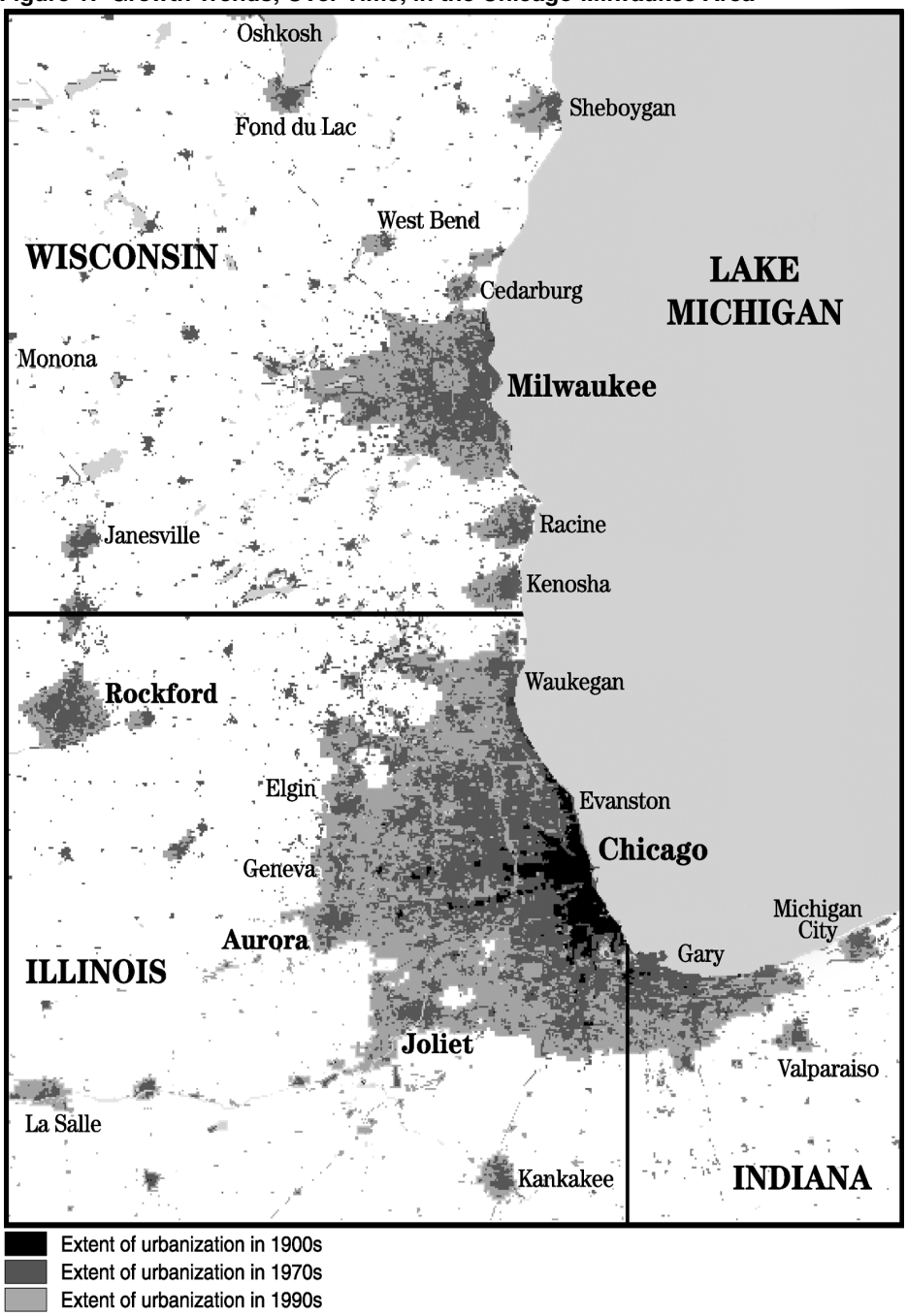
Agency Comments

EPA generally agreed with GAO's conclusions and recommendations and said that they would be helpful in guiding its future smart growth initiatives. The agency asked GAO to better describe the role of the Office of Policy in managing EPA's smart growth efforts. EPA also recognized the need to encourage its program and regional offices, as well as states and localities, to integrate their transportation, air and water quality improvement, and land use planning efforts, and assess the cumulative environmental impacts. DOT also generally agreed with GAO's findings and recommendations. In addition, the agency asked GAO to recognize the role of states and their legislatures in promoting environmentally beneficial land use.

Introduction

Following World War II, Americans, in increasing numbers, searched for the "American dream"—a single-family home on a large lot located close to the countryside—in a newly developed suburban community away from the urban core. In 1950, nearly 70 percent of the population in metropolitan areas lived in cities. By 1990, more than 60 percent lived in the suburbs, although data from the 2000 census suggest that some cities are beginning to regain population. In part, increased automobile ownership, the building of new highways to once remote areas, and less expensive land and housing helped encourage the population shift to the suburbs. Suburban expansion has also continued, in part, because of concerns about urban crime and poor school systems. In recent years, urban development in previously rural areas and increases in traffic volume have outpaced population growth. For example, from 1982 through 1997, developed land increased by 47 percent nationwide, while the population grew by only 17 percent. In addition, in the last 30 years, the total number of vehicle miles traveled grew by 125 percent, roughly 4 times faster than the rate of population growth, while, according to Department of Transportation (DOT) managers, the number of lane miles in the nation's road system grew by only 5 percent. Figure 1 demonstrates growth trends over time around Lake Michigan.

Figure 1: Growth Trends, Over Time, in the Chicago-Milwaukee Area



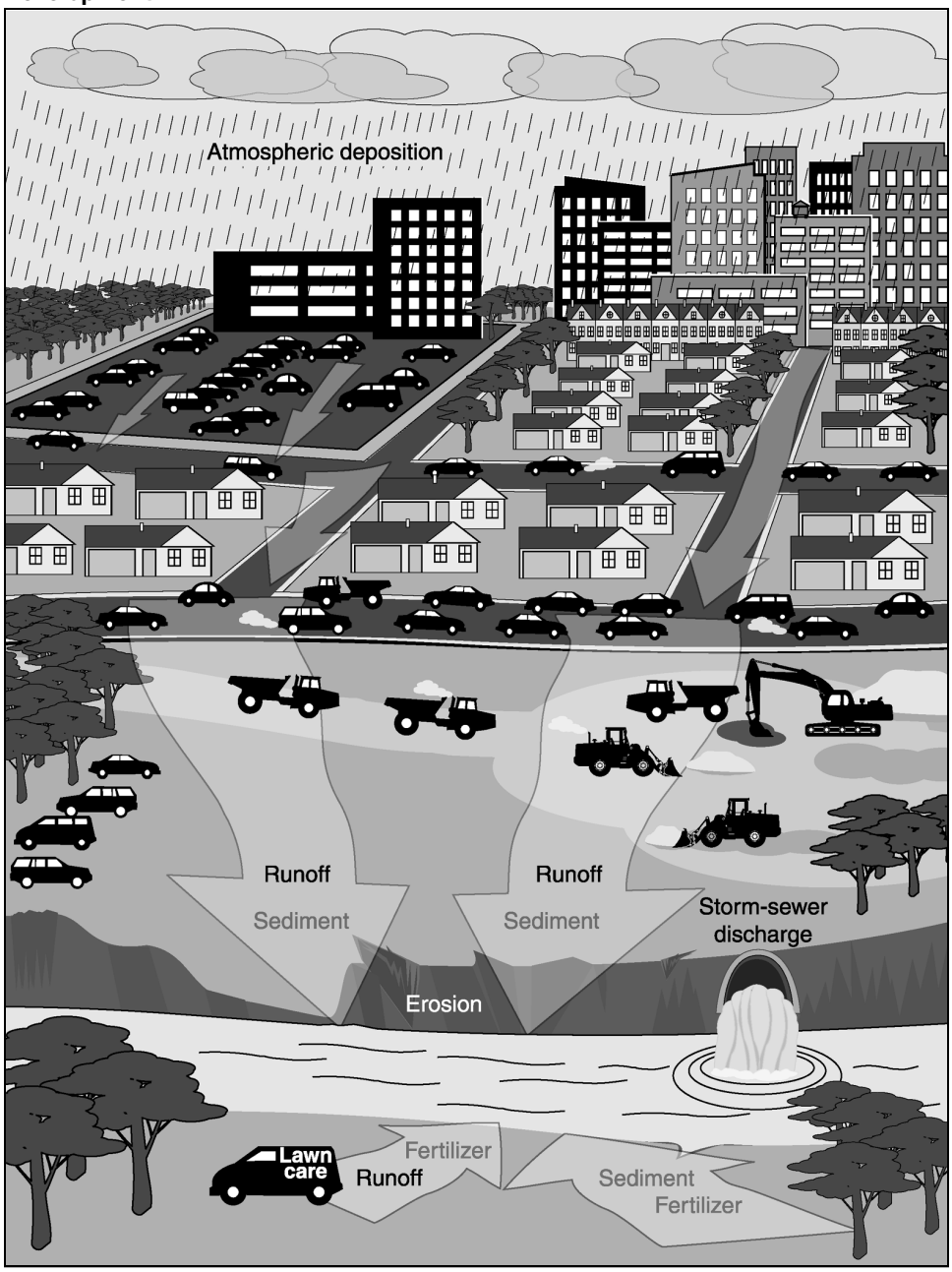
Source: United States Geological Survey.

The prevailing pattern of development, now often referred to as "urban sprawl," generally includes low-density development that does not cluster housing with schools, jobs, and stores and that therefore requires dependence on automobiles. In recent years, Americans have begun to recognize some downsides to this pattern—traffic congestion, loss of green space, and impaired environmental quality. For example, over the last 25 years, at least 20 of the nation's largest cities have seen increases of 30 percent or more in congestion. According to a 1998 federally sponsored study, traffic delays cause the average resident of the greater Washington, D.C., metropolitan area to spend 2 full work weeks a year stalled in traffic.[1]

Recently, the public has become concerned about this congestion, loss of open space, and deteriorating infrastructure, as well as certain environmental impacts associated with this pattern of growth. For example, this pattern impairs air and water quality through polluted emissions from increased traffic and polluted runoff from impervious surfaces, such as roads, parking lots, and rooftops. Impaired air and water can, in turn, result in human health problems and ecological degradation. Figure 2 illustrates how such development contributes to air and water pollution.

[1] See T. Lomax and D. Schrank, *Urban Roadway Congestion, 1982 to 1996* (College Station, Tex.: Texas Transportation Institute, 1998).

Figure 2: Contributions of Air and Water Pollution From Certain Patterns of Development



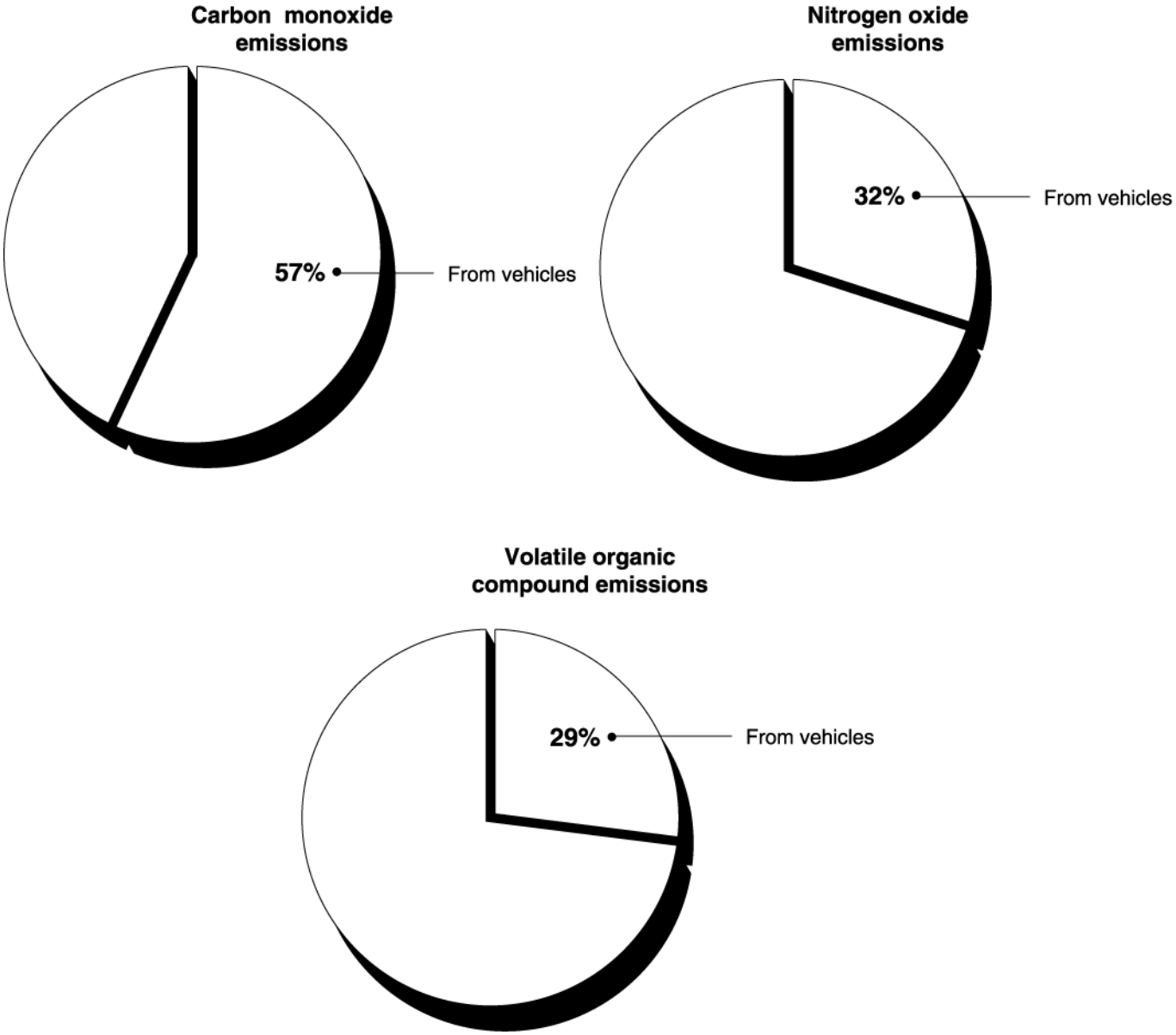
Source: GAO.

Air Pollution From Vehicle Emissions Poses Public Health and Environmental Risks

When automobiles, trucks, and other vehicles burn fuel, their exhaust emissions pollute the air we breathe. Over the past 50 years, epidemiological and other studies have consistently found that breathing certain pollutants from vehicle emissions contributes to respiratory and other health problems. As a result, the Environmental Protection Agency (EPA) has regulated these pollutants—referred to as "criteria pollutants": carbon monoxide, nitrogen dioxide, ground-level ozone, sulfur dioxide, particulate matter, and lead.[2] Figure 3 shows the percentages of vehicle emissions most associated with motor vehicles in 1998.

[2] Ozone is not directly emitted by mobile sources, but is formed by the airborne reaction of heat and sunlight with nitrogen oxides and volatile organic compounds, which, in turn, are emitted by cars and trucks. Also, much of the particulate matter contributed by motor vehicles is in the form of road dust. Vehicle emissions are not the primary source of sulfur dioxide and lead.

Figure 3: Proportion of 1998 Emissions From Motor Vehicles for Carbon Monoxide, Nitrogen Oxides, and Volatile Organic Compounds



Source: *National Air Pollutant Emission Trends, 1900-1998*, EPA (2000).

High atmospheric concentrations of ozone and particulate matter increase hospital admissions and premature deaths, damage lung tissue, and

aggravate respiratory disease. They also increase susceptibility to respiratory infection; compromise immune systems; and, in some cases, can increase cancer risks, according to EPA. These pollutants are especially harmful to those with heart and lung conditions and to other sensitive populations, such as children and the elderly. EPA estimates that such health problems cost Americans tens of billions of dollars annually. Table 1 describes the numerous public health problems associated with some of the criteria pollutants most closely associated with motor vehicle emissions.

Table 1: Health Impacts of the Criteria Pollutants Most Associated With Motor Vehicle Emissions

Pollutant	Health impacts
Carbon monoxide	Interferes with oxygen absorption. Lack of oxygen impairs the cardiovascular and nervous systems. Symptoms include chest pain, headaches, dizziness, nausea, fatigue, and slower reflexes. Impairs visual perception, work capacity, manual dexterity, learning ability, and the performance of complex tasks. Affects fetal growth and tissue development. Results in death at extremely high concentrations.
Ozone	May cause temporary lung irritation, minor eye irritation, coughing, and pain upon inhalation during short-term exposure. Heavy exercise becomes difficult. Long-term exposure to ground-level ozone may cause structural lung damage, leading to chronic lung disease, lung cancer, and increased susceptibility to respiratory infections, such as bronchitis and pneumonia. May interfere with the immune system. May be an agent for infectious disease, since it produces more receptors for viruses. Exacerbates allergies.
Particulate matter	May cause coughing, lung tissue damage, alteration in immune systems, and respiratory and cardiovascular diseases. Aggravates existing respiratory and cardiovascular diseases. Raises the risk of cancer because carcinogens may adhere to particulates.

Source: *Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality,* EPA (2001. EPA 231-R-01-002).

In addition to criteria pollutants, vehicle emissions contain other pollutants—referred to as toxic air pollutants—that can also cause cancer, reproductive disorders, or birth defects in humans and wildlife. One such group of pollutants, known as polycyclic aromatic hydrocarbons (PAH), is formed as a result of the incomplete combustion of hydrocarbons in oil, gasoline, and other fuels. PAH levels in sediments have increased over the last three decades, and the most rapid increases have been seen in watersheds experiencing rapid growth and increased motor vehicle activity. Of the 30 toxic pollutants in urbanized areas that pose the greatest threat to public health, 40 percent come from vehicle emissions, according

to EPA estimates. Moreover, pollutants emitted from vehicles can be carried hundreds of miles by air currents and form new compounds in the air that can be deposited on land and water when they fall back to earth. Several of these compounds, including some carcinogenic ones, can be taken up by plants or ingested by animals and eventually work their way up the food chain, thereby increasing the risk associated with human consumption of food contaminated with these pollutants.

Air pollution from vehicle emissions can also damage ecosystems in sensitive waters, such as bays and estuaries. The atmospheric deposition of pollutants is now recognized in many areas as a significant cause of coastal water quality problems, the acidification of streams and lakes, and the toxic contamination of fish and the birds and mammals that feed on them. Nitrogen oxides from vehicle emissions deposited into the Chesapeake Bay threaten this major fish hatchery by over stimulating the growth of algae, which contributes to the degradation of spawning habitat.[3] Nitrogen oxides also combine with other atmospheric pollutants to form acid deposition, which falls back onto land or flows into waterways with storm water.[4] Acid deposition can lead to declines in fish populations and other aquatic species. Additionally, air pollution, such as ozone and acid deposition, damage crops and building materials. According to EPA, air pollution from vehicle emissions annually causes about $2.5 billion to about $4.5 billion in crop damage.[5]

Finally, motor vehicles emit carbon dioxide, which traps heat within the earth's atmosphere. These greenhouse gas emissions are by far the single largest source of carbon emissions to the atmosphere. In 1999 alone, vehicle emissions, primarily from automobiles and light trucks, contributed to 60 percent of the total carbon emitted by the transportation sector, according to the Department of Energy.[6] The accumulation of greenhouse gases in the atmosphere from man-made sources is a factor in climate

[3] Nitrogen oxides generally refer to several compounds of nitrogen and oxygen.

[4] While "acid rain" is the commonly used term, "acid deposition" is more accurate. The latter encompasses both wet deposition (through rain, snow, sleet, and fog) and dry deposition (through gases, aerosols, and particles).

[5] 1990 dollars converted to 1999 dollars.

[6] Diesel fuel, jet fuel, and residual oil or heavy fuel oil, used largely for maritime use, account for the rest, at about 20 percent, 13 percent, and 4 percent, respectively.

change. Although the effect of this change on human health and the environment is uncertain, it is believed to be significant.

While Harmful Emissions Continue to Decline Nationwide, Certain Localities May Continue to Face Air Quality Problems

With the exception of nitrogen oxides, the total emissions of harmful air pollutants, especially those from mobile sources, have declined significantly since 1970, even as the number of vehicle miles traveled increased significantly. The decline has occurred primarily because of cleaner fuels, emissions-control technology for vehicles, and tighter controls on industrial emissions. Despite the progress, however, air quality problems in certain localities continue. For example in 1999, 62 million Americans lived in areas that did not meet federal air quality standards. In addition, over the last 25 years, at least 20 of the nation's largest cities have seen increases of 30 percent or more in congestion, thereby affecting air quality—cars can release more of certain pollutants under stop-and-go conditions. In addition, sport utility vehicles (SUV) have become very popular and currently are allowed to emit more pollutants than passenger cars. As a result, the growth of this vehicle market has increasingly contributed to vehicle emissions, exacerbating air quality problems in some areas. For example, local officials in the Washington, D.C., metropolitan area have recently expressed concerns about increasing emissions in the area because of the prevalence of SUVs.

In the future, emissions from harmful air pollutants, especially those from mobile sources, most likely will decrease nationwide for several reasons. For example, new more-stringent air quality standards for SUVs and light-duty trucks will take effect in 2004. More-stringent standards for heavy-duty vehicle engines will also be implemented in 2007 and are expected to further reduce emissions.[7] Further improvements in motor vehicle and fuel technology, including the use of alternative fuels and fuel cells, will most likely occur in the next 20 to 30 years, which could help to offset emissions from increases in the number of vehicle miles traveled and growth.

However, while more stringent emissions standards will help to improve air quality nationwide, it is unclear whether they will be able to compensate for increasing vehicle emissions, owing to increased vehicle miles traveled in certain geographic areas. For example, a study of projected volatile

[7] These standards are currently the subject of litigation.

organic compounds and nitrogen oxide emissions in Tennessee concluded that these regulatory changes would not be enough to sufficiently control emissions through 2030 in areas where the number of vehicle miles traveled increased more than 4 percent. Three cities, which lie at the center of the largest Tennessee metropolitan areas—Memphis, Nashville, and Knoxville—had increases in vehicle miles traveled that exceeded 4 percent from 1990 through 1998, the time period considered for this study.[8] In addition, EPA expects to implement two more-stringent air quality standards in the future, although currently under litigation, that will increase the number of counties in nonattainment for the standards. Therefore, certain areas may need to look for additional methods of limiting emissions, such as alternative ways to develop land that reduce dependence on the automobile.

More Paved and Other Impervious Surfaces Increase Polluted Runoff, Thus Threatening Public Health and the Aquatic Environment

EPA now identifies storm-water runoff in urbanized areas as one of the leading causes of impaired water quality in the United States, including sources of drinking water, such as streams, lakes, and underground wells. When urban storm water runs over paved and other impervious surfaces, it picks up pollutants, such as bacteria and viruses (pathogens), toxic chemicals, and heavy metals, that have been deposited on these surfaces and carries them into waterways. This runoff can threaten public health, degrade environmental quality, increase the risk of flooding, and impose economic costs on society. For example, pathogens in runoff—from pet waste deposited on streets and sidewalks, failing septic fields on residential properties, combined sanitary and storm sewer overflows, and other sources—are major contributors to water quality degradation. They can cause serious diseases, such as respiratory and skin infections, infectious hepatitis, gastroenteritis, and dysentery, in people exposed to contaminated water during swimming or other recreational activities, or through the consumption of contaminated drinking water or shellfish. EPA reported that states and localities issued advisories for or temporarily closed 459 beaches (24 percent of all reported beaches) in 1999, limiting recreational and other activities because of elevated bacteria levels in storm-water runoff. In addition, toxic contaminants contained in urban runoff—such as pesticides, metals, petroleum products and additives, and

[8] See Wayne T. Davis, Terry L. Miller, Gregory D. Reed, Prakash Doraiswamy, Anna Tang, and Pedro Sanhueza, "VMT Growth Rates in the U.S. and Their Effects on NOx and VOC Emissions," presented and published in the proceedings of the 94th Annual Conference of the Air and Waste Management Association (June 25-27, 2001).

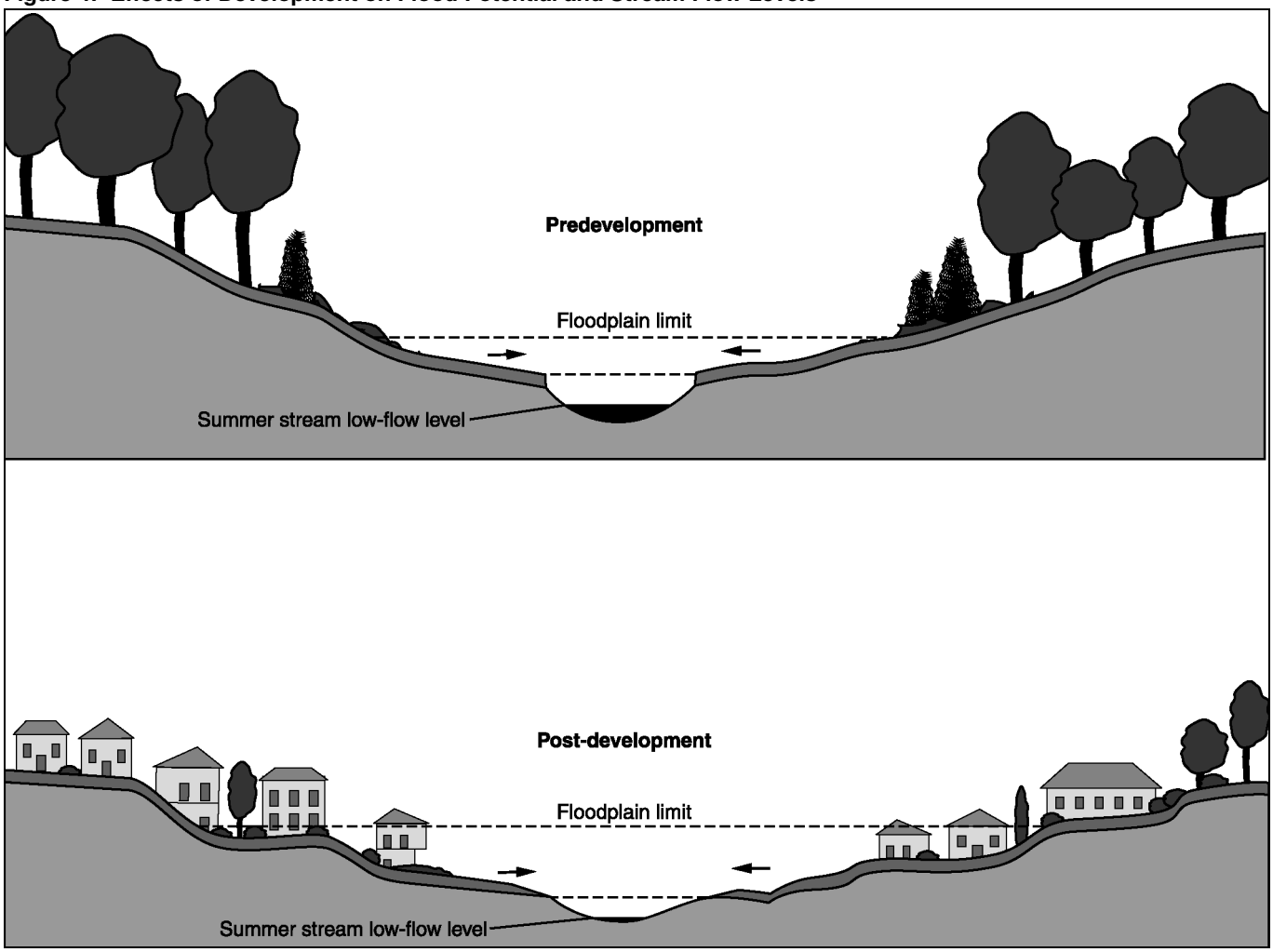
the by-products of vehicle fuel combustion—can result in advisories warning against consuming fish from affected waters.

In addition to these more immediate health risks, toxic chemicals in urban runoff may pose long-term risks, although the extent of these risks is unknown. There is usually more than one contaminant in runoff, and they often either combine into complex mixtures or break down into new, even more toxic chemicals. EPA does not have health-based standards for many of these contaminants. In addition, EPA standards are based on long-term exposures of single contaminants at a constant concentration and may not address the adverse health effects that may result from exposure to multiple contaminants for long periods at low concentrations, punctuated by brief incidents of high concentrations that typically occur during storms. Therefore, the risk to humans and the environment from exposure to low levels of complex mixtures of contaminants remains unclear.

Contaminated urban runoff also harms ecosystems. Toxic chemicals in urban runoff can reduce the overall biological diversity of aquatic systems. Urban runoff carries nutrients from lawn fertilizers and organic wastes into estuaries and lakes. These nutrients can over stimulate algae and plant growth, which can degrade coral reefs and important fish spawning habitats. In 2001, the U.S. Geological Survey (USGS) reported that in 70 percent of its sampled urban streams, the levels of phosphorus, a chemical found in lawn fertilizers, exceeded EPA's goals for preventing unwanted plant growth. Excess nutrients also contribute to toxic algae blooms, sometimes called "red tides," which kill marine wildlife and pose risks to humans who eat contaminated shellfish.

Certain patterns of growth can also contribute to flooding or increase runoff volumes and rates. Because the large areas of impervious surfaces associated with this growth do not absorb storm water, large volumes are rapidly discharged into waterways, which can increase the frequency and severity of flash flooding and result in stream channel degradation, water temperature changes, and the destruction of habitat. Also, when there is not enough open land to absorb this water, it runs off, causing water levels to decrease during dry periods and reducing some water supplies. Figure 4 shows how development increases flood levels and reduces stream flow levels.

Figure 4: Effects of Development on Flood Potential and Stream Flow Levels

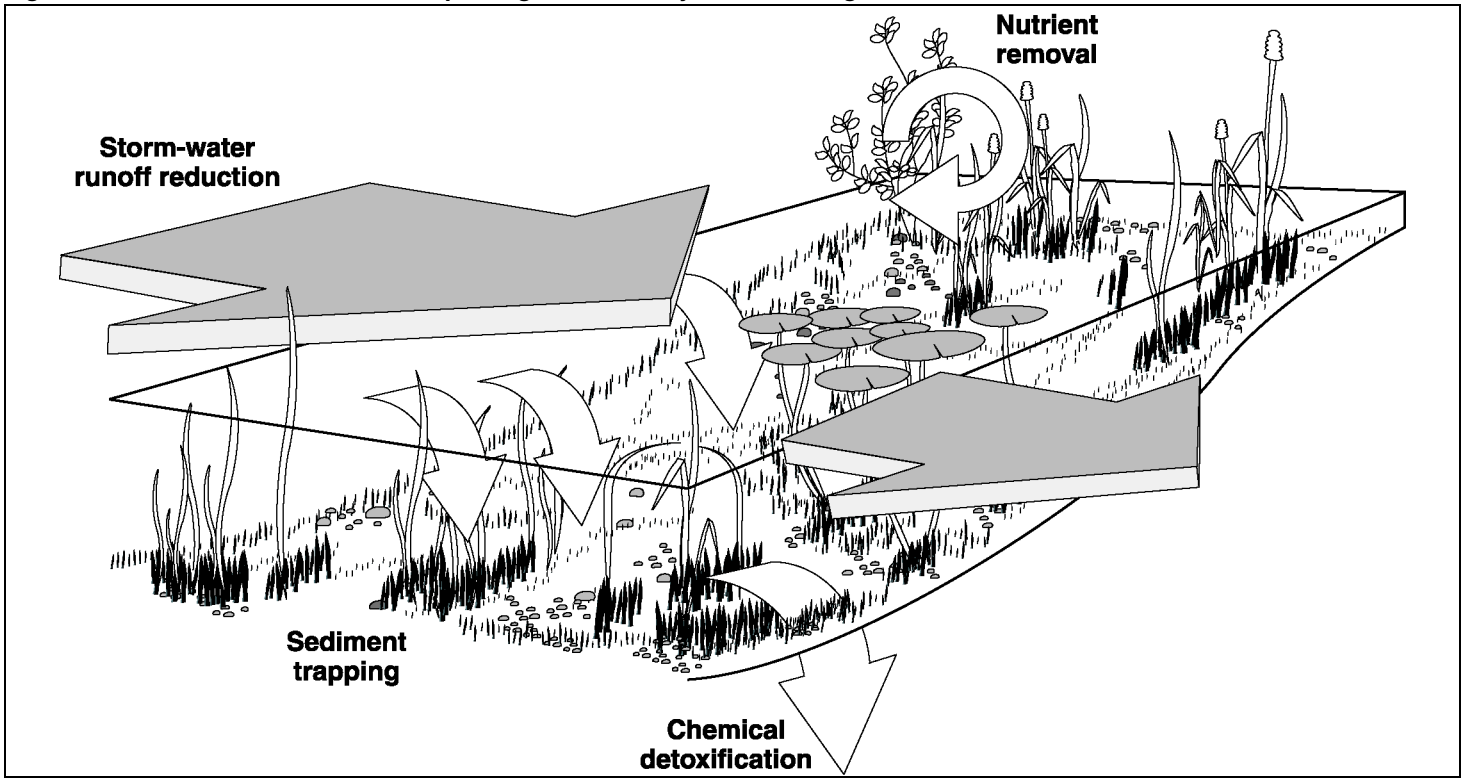


Source: Adapted by GAO from Schueler, *Controlling Urban Runoff* (1987).

Finally, large volumes of runoff increase erosion and carry large quantities of often contaminated sediment downstream, where it settles to the bottom of waterways. This sediment clogs harbors, reservoirs, streams, and navigable channels and degrades fish and shellfish habitat, thereby limiting commercial and recreational fishing opportunities. Dredging these waterways to remove contaminated sediment can be costly. For example, in 1997, EPA estimated that the U.S. Army Corps of Engineers alone spends $180 million annually to dredge 83 million cubic yards of polluted sediment.

While development, including the construction of highways, roads, bridges, and related physical infrastructure, contributes to runoff and its associated problems, it may also reduce the amount of wetlands, thereby destroying a natural system for preventing or controlling floods and erosion.[9] For example, wetlands can prevent floods by acting as natural sponges for water and can mitigate contaminated runoff by removing excess nutrients and some chemical contaminants from water. Figure 5 illustrates how wetlands can achieve these benefits.

Figure 5: Wetlands' Contribution to Improving Water Quality and Reducing Storm Water Runoff



Source: EPA.

[9] See *Water Quality: Better Data and Evaluation of Urban Runoff Programs Needed to Assess Effectiveness* (GAO-01-679, June 29, 2001).

Some States and Localities Are Implementing Alternatives to the Prevailing Growth Pattern That Could Help Limit Environmental Impacts

Some states and localities have begun to reevaluate their development patterns and explore alternative growth strategies. They are not considering an end to growth—recognizing that growth and development are inevitable with a growing U.S. population—they are just trying to limit its adverse effects. For example, the population is expected to increase by almost 50 percent in the next 50 years, from 273 million in 1999 to 404 million by 2050, according to the U.S. Census Bureau. This population growth, in turn, will increase the demand for residential, commercial, and industrial development.

To help limit the impacts of this development, communities are now reexamining development patterns, as reflected by a host of ballot measures in November 2000 that was aimed at setting limits to suburban growth. In response, some states and local governments are beginning to consider ways to accommodate future growth that take into account environmental as well as economic concerns. Commonly referred to as "smart growth," these new development patterns can take many forms, including the following:

- Transit-oriented development, which enables people to use public transportation to reach their jobs, homes, schools, and stores.
- Mixed land uses that locate housing, shopping, offices, and other amenities near each other.
- Compact development, including the development that fills in vacant or underused lands in cities, known as "infill development," or the redevelopment of underutilized or abandoned lands that may have been contaminated during previous use, known as "brownfields."
- Downtown redevelopment focused in central business districts.
- Pedestrian and bicycle projects along existing transportation routes or along new, direct routes between locations.
- Development practices that reduce impervious surfaces and increase water retention, such as using porous surfaces.
- The preservation of important environmentally sensitive lands and open space.

According to EPA, these development patterns can yield better environmental results than conventional growth patterns, although isolating the effects of each can be difficult because most of these development practices work together. For example, studies have shown that compact development and development that reduces impervious surfaces have reduced urban runoff volume by up to 40 percent and have

reduced pollutant levels by about 60 to 90 percent at individual sites.[10] Likewise, development that encourages people to walk, bike, or use public transit can improve air quality by reducing reliance on the automobile.

Federal Rules Aim to Control Harmful Automobile Emissions, Especially in Areas That Have Air Quality Problems

Several federal laws are designed to limit pollutants from vehicle emissions that pose adverse health risks, especially in those areas that are already experiencing poor air quality. The Clean Air Act requires EPA to establish air quality standards to protect public health and welfare. These standards—known as the "national ambient air quality standards"—establish limits on the amount of the six criteria pollutants that are allowed in the air. The states are required to develop strategies, called State Implementation Plans (SIP), for implementing, maintaining, and enforcing strategies to attain these standards. When pollution levels exceed the standards for any of the criteria pollutants in an area of the country, EPA may designate that area as being in "nonattainment" of the standard for that pollutant, and affected states must take measures to address the problem. Once the standard is reached and planning obligations achieved, the area is redesignated as being in attainment but must preserve this level of air quality under a maintenance SIP for 20 more years.[11]

State air quality managers are responsible for developing the SIP, among other things. SIPs include both estimates of future emissions and established limits on, or budgets for, the total amount of emissions that can come from on-road vehicles, such as cars, motorcycles, and trucks, and transit vehicles, such as buses. The air quality managers lay out the ways in which they expect the state to achieve the national ambient air quality standards and adhere to emissions budgets. For example, if a state implements a vehicle inspection and maintenance program, the manager can take credit for the amount of emissions reductions expected from this activity to help the state achieve the standards. Managers can also take credit for expected emissions reductions from certain transportation control measures, such as high-occupancy vehicle lanes or public transit improvements that communities plan to implement.

[10] Although low-density development generally allows more water to be absorbed in the soil than higher-density development, the greater total amount of land affected by low-density development, including land devoted to roads and parking lots, often produces a greater adverse impact on water quality.

[11] 42 U.S.C. § 7505a (a), (b).

The Congress further strengthened its efforts to limit the air quality effects of emissions from transportation sources with the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)[12] and its successor, the Transportation Equity Act for the 21st Century (TEA-21).[13] For example, the acts gave states and localities flexibility to apply certain federal transportation funds to either highway or transit projects, thereby making it easier for states to undertake projects that have air quality benefits.

The acts also increased the responsibility of metropolitan planning organizations (MPO), which are responsible for carrying out the transportation planning process in a metropolitan or regional area, and certain air quality protection activities.[14] MPOs often comprise (1) a policy board, which can include locally elected officials from the area; (2) a technical committee of professional staff from local, state, and federal transportation agencies; and (3) MPO staff. As part of the transportation-planning process, MPOs develop two key documents—the transportation plan and the transportation improvement program (TIP). The transportation plan specifies a 20-year vision for a metropolitan area's transportation system. In contrast, the TIP is a short-term, more-detailed document that specifies the priority projects to be implemented in the next 3 years and has to be updated every 2 years. In developing these two planning documents, MPOs are to collaborate with the public, other transportation stakeholders, and local officials in the area. These local officials could include those responsible for land use planning and decisionmaking. Under TEA-21, MPOs are also to consider seven broad factors when developing their plans, including one described in general terms as protecting and enhancing the environment, promoting energy conservation, and improving the quality of life.

The transportation plans and TIPs for areas in nonattainment or maintenance status are subject to additional Clean Air Act requirements. In these areas, transportation activities cannot result in total emissions that

[12] Intermodal Surface Transportation Efficiency Act of 1991, P.L. No. 102-240, 105 Stat. 1914 (1991).

[13] Transportation Equity Act for the 21st Century, P.L. No. 105-178, 112 Stat. 107 (1998).

[14] In 1970, federal policy required the creation of planning agencies in areas with populations of 50,000 or more to carry out cooperative planning at the metropolitan level. There are currently 341 MPOs in the United States.

cause new violations of air quality standards, worsen existing violations, or delay the timely attainment of the standards and provisions of a SIP. All areas in nonattainment and maintenance for any one of four criteria pollutants—ozone,[15] carbon monoxide, particulate matter, and nitrogen dioxide—must estimate the emissions of that pollutant from the planned transportation activities in the area. In those areas with a SIP that also contains a mobile source emissions budget, estimated emissions must be less than or equal to the budgets. In areas without an emissions budget, the estimated emissions are compared with other baselines, such as the emissions levels in 1990. Making these comparisons is known as the requirement to demonstrate conformity. MPOs are responsible for determining conformity at a minimum of every 3 years, or when they update their plans or TIPs, and must submit the results to DOT, which reviews them and determines that conformity has been achieved. If the plans and TIPs do not conform to the emissions budget, the MPOs cannot, with limited exceptions, spend any federal funds on highway or transit projects that will exacerbate existing air quality problems or lead to new violations of federal air quality standards. However, projects related to highway safety, transportation control measures included in an already approved SIP to improve air quality, or transportation projects already approved or funded by the federal government can move forward.

Federal Rules Aim to Protect the Nation's Water Bodies From Harmful Pollutants

The Clean Water Act requires states to establish water quality standards as a way of ensuring that the act's goals will be met. These goals include achieving and maintaining water quality to protect and propagate fish, shellfish, and wildlife and to provide for recreation in and on the water. To develop water quality standards, states classify waters according to how they will be used—for fishing, swimming, and other beneficial uses—and adopt water quality criteria to protect those designated uses. Water quality criteria—which can be numeric or narrative—indicate the acceptable levels of chemicals allowed, or physical or biological characteristics required, in a water body in order for it to meet its designated use. Waters that do not meet standards are often referred to as "impaired."

The Clean Water Act also established the National Pollutant Discharge Elimination System (NPDES), a program that controls pollutant discharges from industrial facilities and wastewater treatment plants, which are often

[15] These areas estimate emissions of hydrocarbons and nitrogen oxides—the precursors of ozone.

referred to as "point sources" of pollution. Under this program, EPA issues permits to facilities that discharge pollutants and imposes requirements for the mechanisms these facilities must use to reduce the amount and toxicity of the pollutants they discharge. Although the program did not initially address storm-water discharges, the Congress amended the act in 1987, directing EPA to also control storm water that enters municipalities' storm sewer systems. EPA's 1990 regulations implementing this change, established the NPDES Storm Water Program and described permit application requirements. The program's objective, in part, is to preserve, protect, and improve water quality by, among other things, controlling the volume of runoff from impervious surfaces and reducing the level of runoff pollutants to the maximum extent practicable using best management practices. [16]

The Clean Water Act also addresses nonpoint source pollution. Nonpoint sources of pollution include many different types of land use activities, including urban development, agriculture, and timber harvesting. The act required EPA to provide states with federal funds and technical and management assistance to implement nonpoint source management programs. In their nonpoint source assessments, states identified waters that, without additional controls over nonpoint sources, will not meet water quality standards. The states also developed management programs to deal with these problems.

The act calls for water quality goals and standards to be achieved through a variety of means, including the development of total maximum daily loads (TMDL)—that is, the maximum amount of a pollutant that a body of water can receive on a daily basis and still support its designated uses. Generally, states and localities develop TMDLs by analyzing the pollutants and their sources and determining how much the pollutants must be reduced to meet the standards. Under EPA regulations, the amount of required pollutant reduction is allocated among the point and nonpoint sources contributing to the water quality problem. Land use and associated runoff contribute to nonpoint source pollution. In July 2000, EPA promulgated a rule amending its regulations to strengthen the TMDL program. EPA subsequently postponed the rule's implementation and is reviewing the proposal because

[16] According to EPA, a best management practice is a device, practice, or method for removing, reducing, retarding, or preventing targeted storm-water runoff constituents, pollutants, and contaminants from reaching receiving waters.

of concerns about its potential costs and other impacts. This rule is also currently the subject of litigation.

In addition to the Clean Water Act, the Coastal Zone Amendments Reauthorization Act of 1990 outlines a process for states to deal with nonpoint source pollution that affects coastal waters.[17] It requires states to address significant sources of nonpoint source pollution from urban areas, agriculture, forestry, marinas, dams, and changes in the course of rivers. EPA and the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) jointly oversee the process.

Objectives, Scope, and Methodology

The Senate Smart Growth Task Force and the House Sustainable Development Caucus asked us to

- determine the extent to which MPOs and state air quality managers responsible for meeting federal clean air requirements consider the impacts of alternative land uses on their efforts to protect air quality;
- determine how, if at all, state and local officials responsible for water quality and land use consider the water quality impacts of alternative land uses and work together to limit any adverse impacts; and
- identify the actions that the federal government can take to help transportation, air quality, and water quality officials better link land use decisions with environmental protection.

To address these objectives, we obtained information on air quality issues by surveying the 341 metropolitan planning organizations recognized by the Federal Highway Administration's Office of Metropolitan Planning and Programs and the 51 state air quality agencies (including the District of Columbia).[18] We did not attempt to gain information from the state departments of transportation, which are responsible for transportation planning in those areas without a designated MPO. We had a high response rate for our surveys: 87 percent (295) of the 341 MPOs surveyed and 92 percent (47) of the 51 air quality agencies surveyed. For certain analyses, we merged the MPO survey data with survey data about counties'

[17] This program also includes states that border the Great Lakes.

[18] The list supplied to us had 345 listed MPOs; however, 5 subsequently contacted us to let us know that they are not the MPO for the area, and 1 contacted us to let us know that it had split into two separate MPOs.

anticipated growth from our previous study of local growth issues.[19] The results from the surveys of MPOs and state air quality managers are presented in appendixes II and III, respectively.

We also obtained information on water quality issues from a panel of 32 experts. To select our panel, we used a methodology that provided the maximum opportunity to obtain members representing the broadest possible range of expert views on the issues associated with land use and water quality. To collect data from the panel, we used a modified Delphi methodology—an alternative to in-person discussion that avoids certain biasing effects, such as the dominance of a few individuals. To obtain controlled feedback from the panel, we used two iterative sets of questionnaires on the Internet. We analyzed descriptive statistics on the data collected, which demonstrated a high level of agreement among the panel members, even across different areas of expertise, on virtually all of the items included in the second questionnaire. The questions posed to the panel and the statistical summary of their responses are presented in appendix V. The names and organizational affiliations of the panel members selected are in appendix VI.

In addition, we drew on our own prior work on related issues. A list of these reports can be found in the section entitled "Related GAO Products." We also interviewed responsible officials and collected documents from the federal agencies administering transportation, air quality, and water quality programs, as well as from relevant stakeholders. Specifically, we interviewed and gathered documentation from officials associated with the following federal agencies and organizations:

- *EPA*. Office of Air and Radiation; Office of Transportation and Air Quality; Office of Wetlands, Oceans, and Watersheds; and Office of Policy, Economics, and Innovation.
- *DOT*. Federal Highway Administration's Offices of Metropolitan Planning and Programs, Natural Environment, and Human Environment; and Federal Transit Administration's Office of Planning.
- *USGS*. Water Resources Division, including the National Water Quality Assessment Program, the National Mapping Information Division and its Urban Dynamics Research Program; and the Biological Resources Division.

[19] See *Community Development: Local Growth Issues—Federal Opportunities and Challenges* (GAO/RCED-00-178, Sept. 6, 2000).

- *NOAA*. National Ocean Service, including the Office of Coastal Management and the Coastal Nonpoint Pollution Control Program.
- *Representative stakeholders*. The Association of Metropolitan Planning Organizations, National Association of Counties, the Northeast-Midwest Institute, the National Association of Regional Councils, the National League of Cities, the National Governors' Association, the Center for Watershed Protection, the Low Impact Development Center, the Natural Resources Defense Council, the Nature Conservancy, the Environmental Law Institute, the State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials, and the Association of State and Interstate Water Pollution Control Administrators.

Appendix I contains a more detailed discussion of our scope and methodology. We performed our work from September 2000 to September 2001 in accordance with generally accepted government auditing standards.

Most MPOs and Air Quality Managers Do Not Assess the Emissions Impacts of Different Land Uses in Protecting Air Quality

While land use can affect air quality, most of the MPOs and state air quality managers that we surveyed do not assess the emissions that would be generated by different land use strategies when developing their transportation or air quality improvement plans. MPOs use localities' projections of growth to forecast future travel needs and design the longer-term transportation plan and shorter-term transportation improvement program (TIP) to meet those needs. However, most MPOs do not consider whether different land uses or patterns of growth would result in transportation plans that are more protective of air quality. Many MPOs and state air quality managers do not participate in land use assessments principally because they are not required to do so and because most believe they have limited influence, since land use decisions fall under the jurisdiction of local governments. As a result, they may be missing opportunities to limit emissions and, consequently, health and environmental risks.

Those MPOs that did estimate the vehicle emissions that transportation plans and TIPs would generate on the basis of different land use strategies were more likely to be in areas with air quality problems and under the obligation to demonstrate that emissions from the plan or TIP will not exceed established budgets. This suggests that the requirement to demonstrate conformity between transportation plans and TIPs and the emissions budget can influence MPOs to assess whether different land uses would help them to limit emissions. Those MPOs that did estimate emissions reported that their estimates sometimes influenced transportation plans and TIPs, for example, by adding more public transit. In a few instances, MPOs reported that the estimates also influenced land use plans. In other cases, the estimates did not have such an influence, perhaps because MPOs are not required to share the emissions results generated by the transportation plans and TIPs with local land use decisionmakers.

In the future, more MPOs and state air quality managers may find it useful to analyze the impacts of different land uses on air quality. The number of counties with air quality violations may increase if EPA implements more-stringent air quality standards as planned. MPOs and air quality managers face several barriers to conducting this analysis, however, such as the lack of a collaborative relationship with land use decisionmakers and the necessary technical capabilities.

Most MPOs and State Air Quality Managers Do Not Assess Whether Different Land Uses Would Result in Less Emissions

Most MPOs and state air quality managers have not considered the impact of different land use strategies on their efforts to improve air quality. Approximately 75 percent of the 295 MPOs responding to our survey reported that they had not estimated the impacts on emissions from the mix of transportation projects generated from different land use strategies when developing their plans and TIPs.[1] Similarly, 36 (approximately 76 percent) of the 47 state air quality managers responding to our survey reported that they have not yet assessed the effects of different land use strategies on air quality.

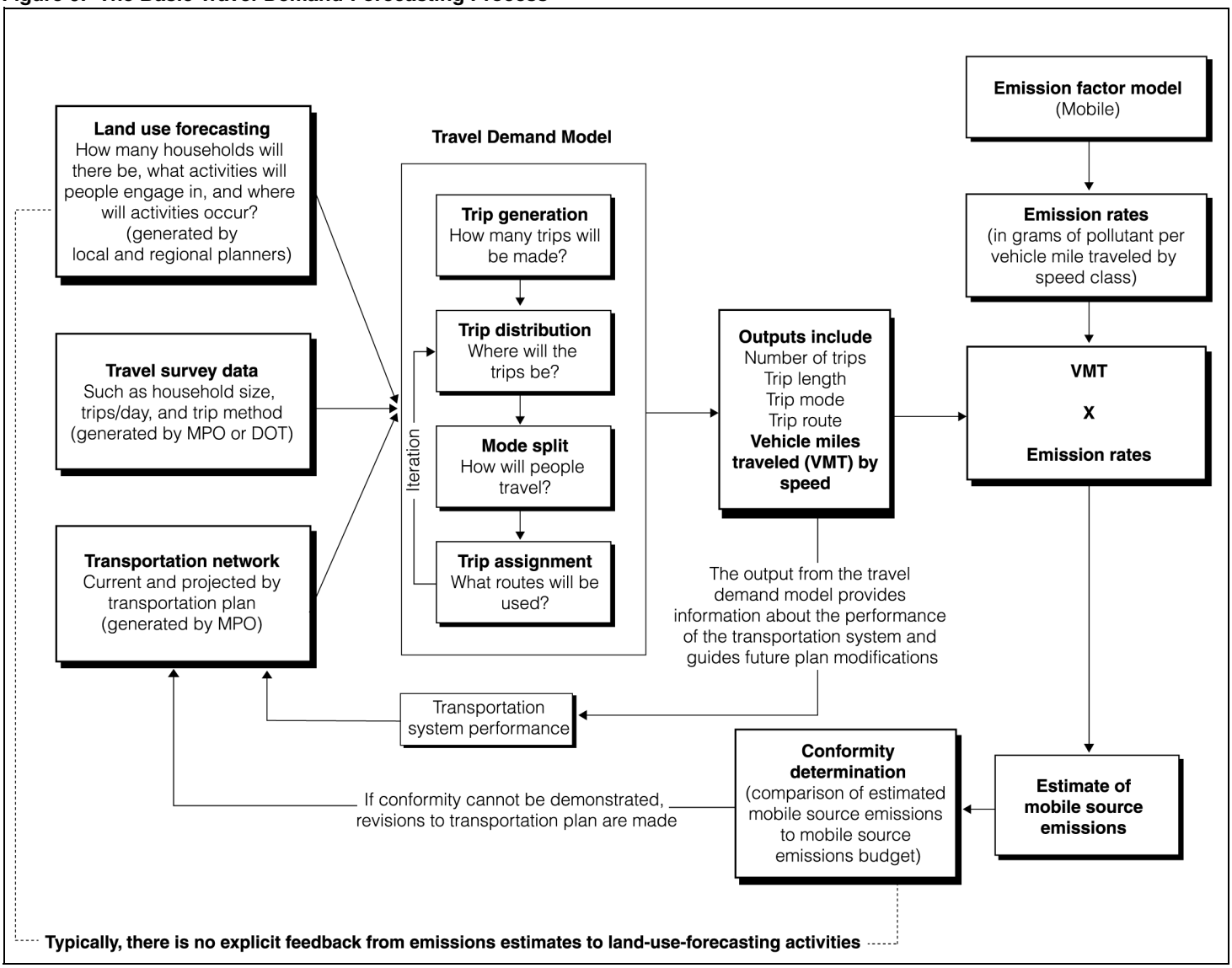
They are not assessing land use strategies partly because neither MPOs nor state air quality managers are required to conduct these assessments when selecting the mix of projects for the transportation plan or TIP, or when developing air quality improvement plans. In addition, most MPOs and state air quality managers reported that since land use decisions fall under the jurisdiction of local governments, they believe they have limited ability to influence them. Furthermore, state air quality managers felt they do not have a collaborative working relationship with local land use decisionmakers, which would enable them to participate in such assessments. Because they did not estimate emissions, they therefore may have missed opportunities to determine whether another transportation mix or land use strategy would generate less vehicle emissions and be more protective of air quality.

MPOs Consider Future Land Use as They Forecast Travel Needs

As part of the transportation-planning process, MPOs must, among other things, forecast travel demand and determine the mix of projects to meet the demand. The forecasting process is illustrated in figure 6.

[1] We surveyed all 341 MPOs in existence as of January 2001.

Figure 6: The Basic Travel-Demand-Forecasting Process



Source: Adapted by GAO.

As the figure shows, the travel-demand-forecasting process typically relies on three types of inputs—future land use data, travel survey data, and information about the transportation network.[2] MPOs first obtain data from local land use planners that predict where localities expect their future growth to occur. Most land use planners develop these predictions

by relying on the judgment of local government officials and planners, although some use a modeling process. According to 89 percent of the MPOs responding to our survey, these land use forecasts are beginning to reflect strategies considered more protective of air quality, such as redeveloping brownfield or infill sites instead of developing open space.[3]

Using the model to forecast travel demand, MPOs determine the mix of projects they will propose in the transportation plan and TIP. MPOs are required to collaborate on the final plans and projects with local stakeholders, including land use decisionmakers and transportation officials. They are also required to ensure that funding is available for all the projects included in the plans.

MPOs currently in areas with air quality problems—in nonattainment or maintenance status for either ozone, carbon monoxide, particulate matter, or nitrogen dioxide—must also add another step in their planning process and make a conformity determination. To do this, they must enter the estimates on the number of vehicle miles traveled that the plans will generate, as well as the speed of this travel, into another model—the emissions factor model.[4] This model estimates the expected emissions from the proposed transportation plan and TIP. Other data entered into the emissions factor model that can influence the projected emissions include average temperature, the composition of vehicles registered in an area (such as the percentage of SUVs, trucks, and cars), and the type of fuel used in the area. MPOs then compare the estimated emissions with their mobile source emissions budget to determine if the expected emissions are within the budget limits. If the estimated emissions do not conform to the budget, and the state air quality managers cannot increase the budget, the MPOs must take some action to control emissions, such as revising the mix

[2] Only MPOs in areas of either serious, severe, or extreme nonattainment for ozone, or serious nonattainment for carbon monoxide, and that have an urbanized population greater than 200,000 are required to use a travel demand model for their conformity analysis. Other MPOs must also use the travel demand model for conformity if they already use it to forecast travel demand. According to DOT officials in the Office of Metropolitan Planning and Programs, most MPOs use models to forecast travel demand.

[3] Brownfields are underutilized or abandoned lands that may have been contaminated during previous use. Infill is development that fills in vacant or underused land in cities and other already developed areas.

[4] MPOs must include forecasts of vehicle speed because the amount of emissions and pollutants varies according to the speed of travel. In general, emissions are greater at very low and very high speeds.

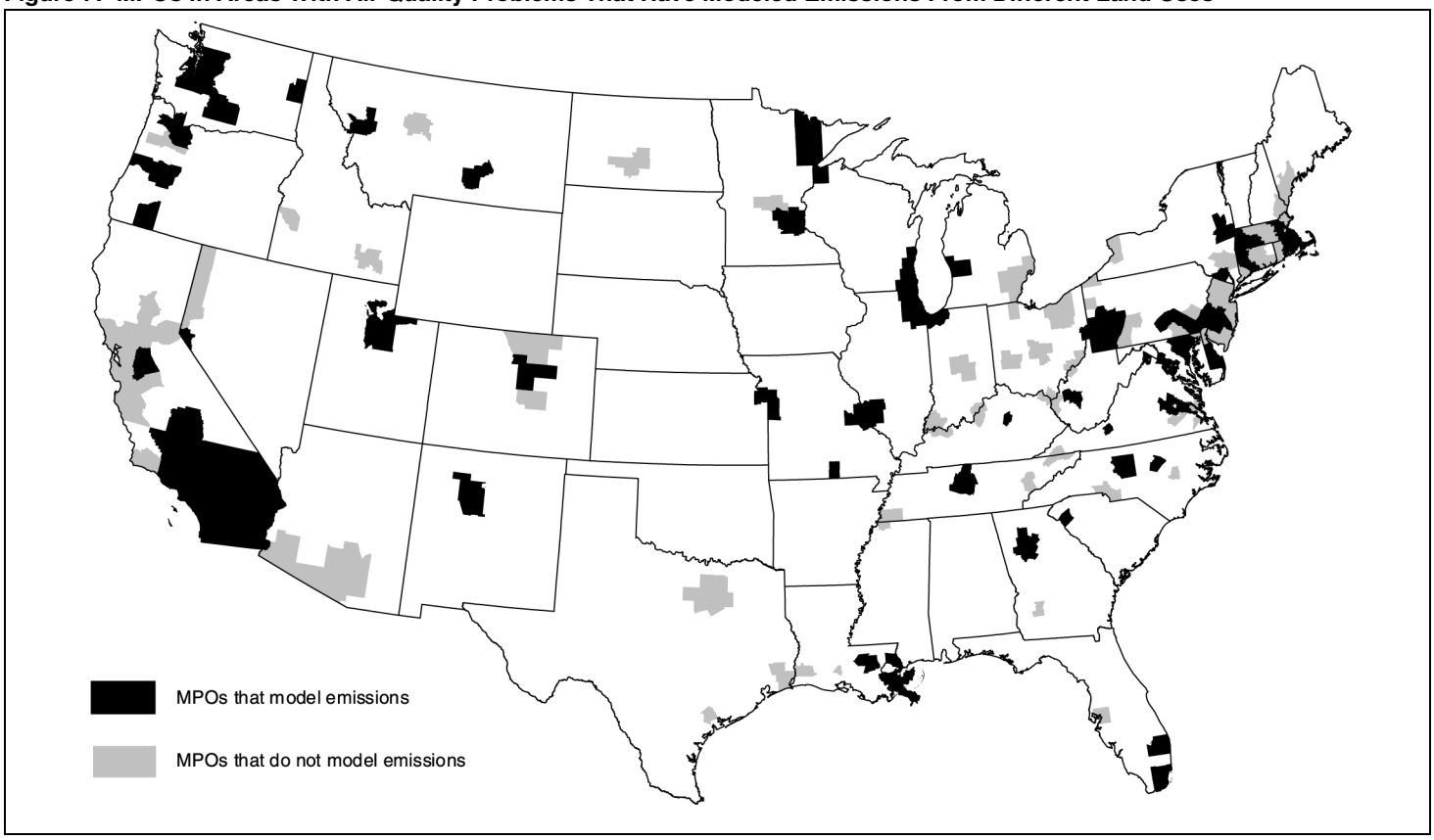
of projects they have included in their transportation plans and TIPs. MPOs are not required to share the emissions results generated by the transportation plans and TIPs with local land use decisionmakers to see if pursuing alternate development scenarios might be a way to control emissions.

MPOs in Areas With Air Quality Problems Are More Likely to Estimate Emissions From Different Land Uses

MPOs in areas with current or previous air quality problems, and that therefore must demonstrate conformity, are far more likely than MPOs in areas without such problems to estimate emissions from different land use strategies when developing transportation plans.[5] About 62 of the 134 MPOs (46 percent) in areas with air quality problems that responded to our survey reported assessing the emissions impacts from the mix of transportation projects generated from different land use strategies when developing their plan and TIP. In contrast, about 13 of the 155 MPOs (8 percent) in areas without air quality problems reported assessing emissions. Figures 7 and 8 show the differences in assessment efforts between areas with air quality problems and those without these problems.

[5] The classification of areas as being either with or without air quality problems was defined by response to survey question 7, which asks whether any portion of the geographic area covered by the MPO is in nonattainment, maintenance, or attainment for each criteria pollutant listed. Those responding "attainment" to all six pollutants were classified as being in an "area without air quality problems." Those responding "nonattainment" or "maintenance" for at least one of the pollutants were classified as being in an "area with air quality problems." Because conformity is only required of those areas in nonattainment for ozone, carbon monoxide, particulate matter, and nitrogen dioxide, we confirmed that those classified as being in an area with an air quality problem were in nonattainment or maintenance for at least one of these four pollutants.

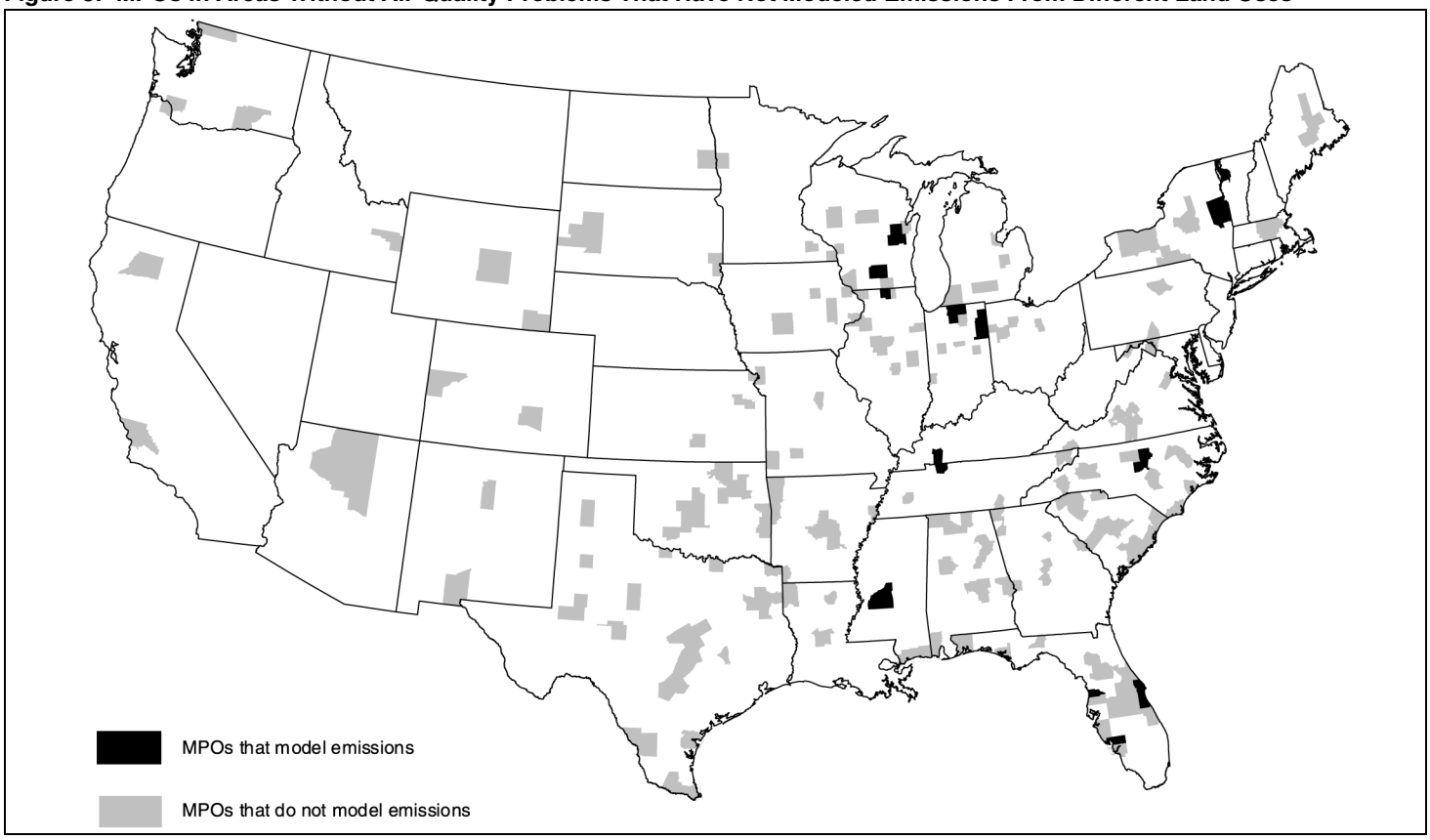
Figure 7: MPOs in Areas With Air Quality Problems That Have Modeled Emissions From Different Land Uses



Note: MPO boundaries are based on information supplied to us in the survey and may not reflect exact MPO borders, especially in the case of counties that are part of more than one MPO. If at least one county in an MPO is classified as being in nonattainment or maintenance for any of the criteria pollutants, then that MPO is considered to be in an area with an air quality problem for the purpose of our analysis, and the entire area covered by the MPO is shaded on the map. The results from Alaska are not included on the map for display purposes.

Source: GAO's analysis of survey data.

Figure 8: MPOs in Areas Without Air Quality Problems That Have Not Modeled Emissions From Different Land Uses



Note: MPO boundaries are based on information supplied to us in the survey and may not reflect exact MPO borders, especially in the case of counties that are part of more than one MPO. If at least one county in an MPO is classified as being in nonattainment or maintenance for any of the criteria pollutants, then that MPO is considered to be in an area with an air quality problem for the purpose of our analysis, and the entire area covered by the MPO is shaded on the map. The results from Alaska are not included on the map for display purposes.

Source: GAO's analysis of survey data.

As these data suggest, although not specifically designed to do so, the federal requirement to demonstrate conformity appears to serve as an incentive for MPOs in areas with air quality problems to consider land use as a means to improve air quality. Atlanta is a case in point. Atlanta's problems in demonstrating conformity led to new efforts to consider different land uses as a means to limit emissions. Atlanta's mobile source emissions did not conform to its budget from January 1998 until July 2000. As a result, DOT, in consultation with EPA, placed a moratorium on most federal funding for local transportation projects during this time. In

response to this moratorium, as well as public concerns about congestion and air quality and their impact on the city's economy, the governor took a number of actions, including the creation of the Georgia Regional Transportation Authority (GRTA). This authority has responsibility for the approval of both land use and transportation plans in the jurisdictions with air quality problems. These plans are initially developed by Atlanta's MPO—Atlanta Regional Commission (ARC). In June 2000, GRTA and ARC adopted the Joint Land Use Strategy. Under this strategy, all local governments in the Atlanta metropolitan region are required to develop transportation-efficient land use and development plans, subject to the authority's approval, in an effort to limit emissions. Because the joint strategy is relatively new, it is too early to determine its success.

The conformity process can also provide an incentive for MPOs to consider land use as a means to control emissions because the required time frame to demonstrate conformity is similar to the time frame needed to realize air quality benefits from land use strategies. Conformity needs to be demonstrated over the life of the transportation plan and TIP—at least 20 years. Similarly, it takes a long period to plan for and implement land use strategies and to achieve their emissions benefits, as well as to plan and develop major transportation projects. Therefore, using different land use strategies that can limit emissions may help MPOs meet conformity requirements in the later years. On the other hand, about half of the MPOs and state air quality managers were also concerned about the lengthy time frame over which conformity should be demonstrated. For example, several MPOs we spoke with said that they believe that estimating emissions so far into the future is too uncertain and difficult.

MPOs and State Air Quality Managers Reported That Assessments of Different Land Uses Had Some Influence on Transportation and Land Use Plans

MPOs that reported estimating emissions from different land use strategies reported that these estimates had some influence on the mix of transportation projects and, to a lesser extent, land use plans. Similarly, some of the air quality managers who reported assessing the effects of different land use strategies on air quality in their state also reported that these assessments had some effect on land use, transportation, or air quality plans in areas of their state.

MPOs Reported That Estimating Emissions Influenced Transportation and Land Use Plans

Of those 75 MPOs (about 25 percent) who reported estimating the level of emissions resulting from different land use strategies, 34 reported that the estimates had some influence on the mix of transportation projects they chose for their plans. For example, some MPOs added alternative projects, such as public transit, that produce lower emissions than the projects that promote the increased use of automobiles. Those 40 MPOs that did not change their plans frequently reported the following reasons for not doing so:[6]

- Because much of the transportation system is in place in their jurisdiction and DOT has already approved many future projects for construction, they have little ability to add or change projects to improve air quality.
- Even if they could add or change projects, they did not believe that the emissions reductions from such changes would be significant.

In addition to influencing transportation plans, emissions estimates from the assessments of different land use strategies had caused local land use plans or zoning to change, according to 23 of the 75 MPOs. Fifteen of these MPOs had also responded that the emissions estimates had some influence on both transportation and land use plans. For example:

- In response to air quality concerns in Rogue Valley, Oregon, the MPO is trying to implement transportation strategies that reduce reliance on automobiles and consequently reduce vehicle miles traveled and vehicle emissions. The MPO is working closely with local land use planners to ensure that different land use strategies, such as development in proximity to transit systems and mixed-use development, are included in the local comprehensive land use plan. According to requirements from Oregon's Department of Environmental Protection, in order for the MPO to use such projects as a means to demonstrate conformity, the projects must be included in the local plan. This effort is designed to ensure local commitment to these land use strategies and to provide a foundation for any needed changes to local zoning or other planning ordinances. As a result, the MPO is developing a transportation plan that is compatible with the local comprehensive land use plan and that has air quality benefits to help achieve mobile emissions budgets.

[6] One MPO did not respond to the question of whether emissions estimates influenced transportation plans.

- In Spokane, Washington—an area with serious carbon monoxide problems—state law requires the MPO to assess the transportation and air quality implications of different land uses under consideration. The MPO can help ensure that more protective land uses will be compatible with the planned transportation projects. For example, the city is planning to build a light-rail project, and the MPO has taken responsibility for developing four mixed-use sites that would be located along the transit line.

Some State Air Quality Managers Reported That Assessments of Different Land Use Strategies Influenced Plans

The air quality managers in the following 10 states reported assessing or participating in the assessment of the effects of different land use strategies on air quality in areas of their respective states: Colorado, Georgia, Illinois, Maryland, Minnesota, Montana, New Jersey, Oregon, Pennsylvania, and Texas.[7] These managers conducted their assessments primarily in conjunction with MPOs, regional and local land use planners, and external stakeholders, such as community groups. The involvement of regional organizations is beneficial because air quality issues often require solutions that cross local jurisdictions. For example, regional planning entities, such as the Wilmington Area Planning Council, have been able to integrate land use planning with efforts to attain air quality standards because of their relationships with both state and local governments. The 10 state air quality managers reported that they assessed a variety of land use strategies that are more protective of air quality, including infill development, bicycle and pedestrian facilities, open space preservation activities, and downtown redevelopment.

Air quality managers in four states—Colorado, Illinois, Minnesota, and Oregon—reported that the assessments had some effect on one or more of the following types of plans:

- *Land use and zoning*. In the four states, localities included, or designated by zoning, different land uses that were more protective of air quality. Land use plans did not change as a result of the assessments in some of the remaining states partly because other factors, such as the

[7] Although Washington, D.C., initially indicated that it participated in assessing the effects of different land use strategies, it subsequently reported that it is not assessing any of the strategies listed. Therefore, we did not include them in the group of states considered to be assessing the emissions impacts of land use.

need to promote economic development, had greater influence on land use plans.

- *Transportation*. In Colorado, Illinois, and Oregon, managers reported adding more public transit, carpool or high-occupancy vehicle lanes, or bicycle and pedestrian facilities to their transportation plans. Transportation plans did not change in some of the remaining states. For example, one manager believed that changing the mix of transportation projects did not significantly reduce emissions. Another believed that improvements in fuel and vehicle emissions technology would achieve the needed reductions in emissions.
- *Air quality.* Colorado and Oregon changed their air quality plans. For example, Colorado added more transportation control measures to the State Implementation Plan (SIP).[8] It also altered the SIP emissions budget by increasing the mobile source emissions budget and decreasing the budgets for other sources.

Expected Growth and Stricter Air Quality Standards May Increase the Need to Consider the Impact of Land Use on Efforts to Control Emissions

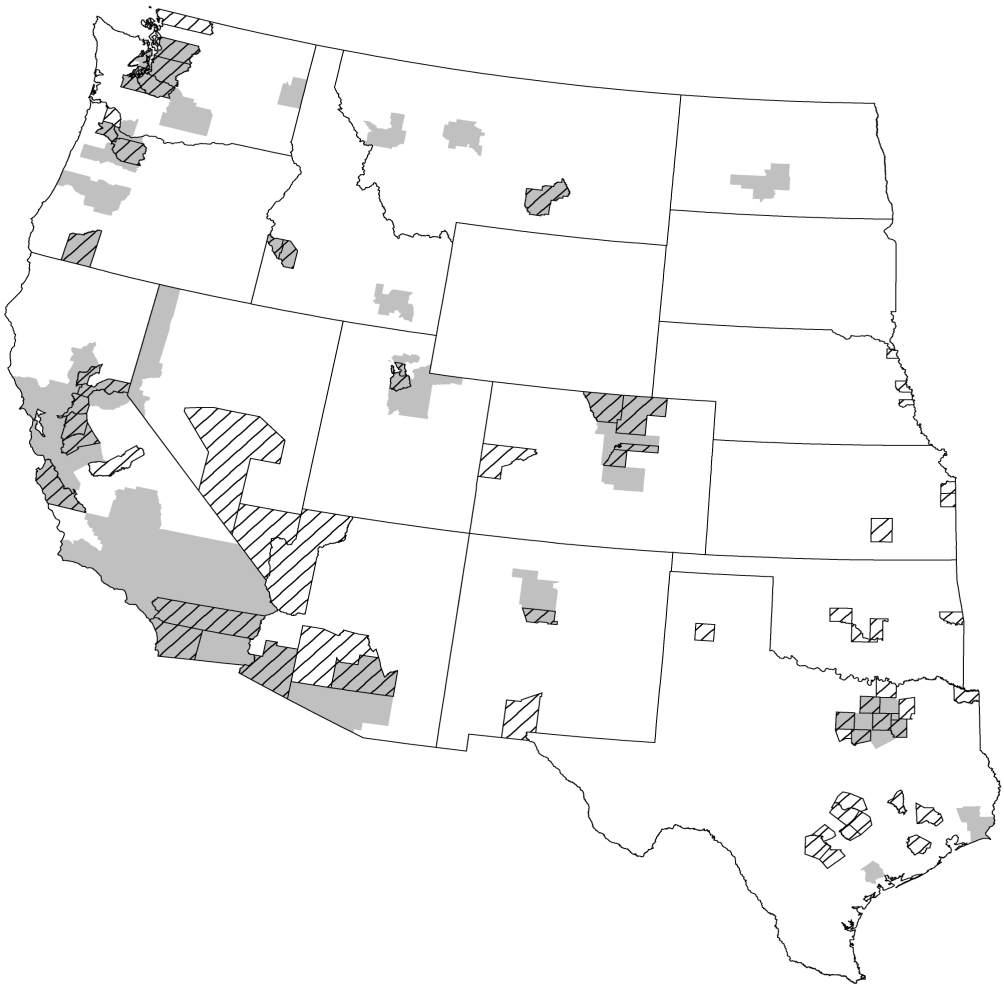
Many of the MPOs responding to our survey are in areas that include counties anticipating rapid growth in the future, making it even more important that the MPOs and state air quality managers consider how this growth may affect their efforts to improve or protect air quality.[9] Those MPOs in areas without air quality problems that anticipate rapid growth in the future might benefit the most from conducting emissions assessments and considering land use because their areas still have the opportunity to shape growth in ways that will also protect against future air quality degradation. However, because so few of them conduct assessments and are not required to do so, they may not realize these benefits. Figures 9 and

[8] Transportation control measures are policies, programs, and actions directed toward increasing the efficiency of transportation facilities and toward decreasing the use of single-occupant vehicles, including carpool programs, high-occupancy-vehicle lanes, and park-and-ride lots.

[9] We obtained data on expected growth from our survey of 768 of the 3,141 counties nationwide. For this survey, we obtained a list of metropolitan areas, as of 1999, from the Office of Management and Budget. From this list, we determined that 848 counties are located in metropolitan areas. Because many counties located in the New England area have no county government or perform very limited functions, they were removed from the list of counties surveyed, reducing the list of counties in metropolitan areas to 768. The counties included on the maps represent those responding that they expect their community's population to increase greatly over the next 10 years. We included a summary of the survey results in our report, *Community Development: Local Growth Issues—Federal Opportunities and Challenges* (GAO/RCED-00-178, Sept. 6, 2000), in appendix IV.

10 show the MPOs in areas with and without air quality problems, respectively, which expect significant future growth.

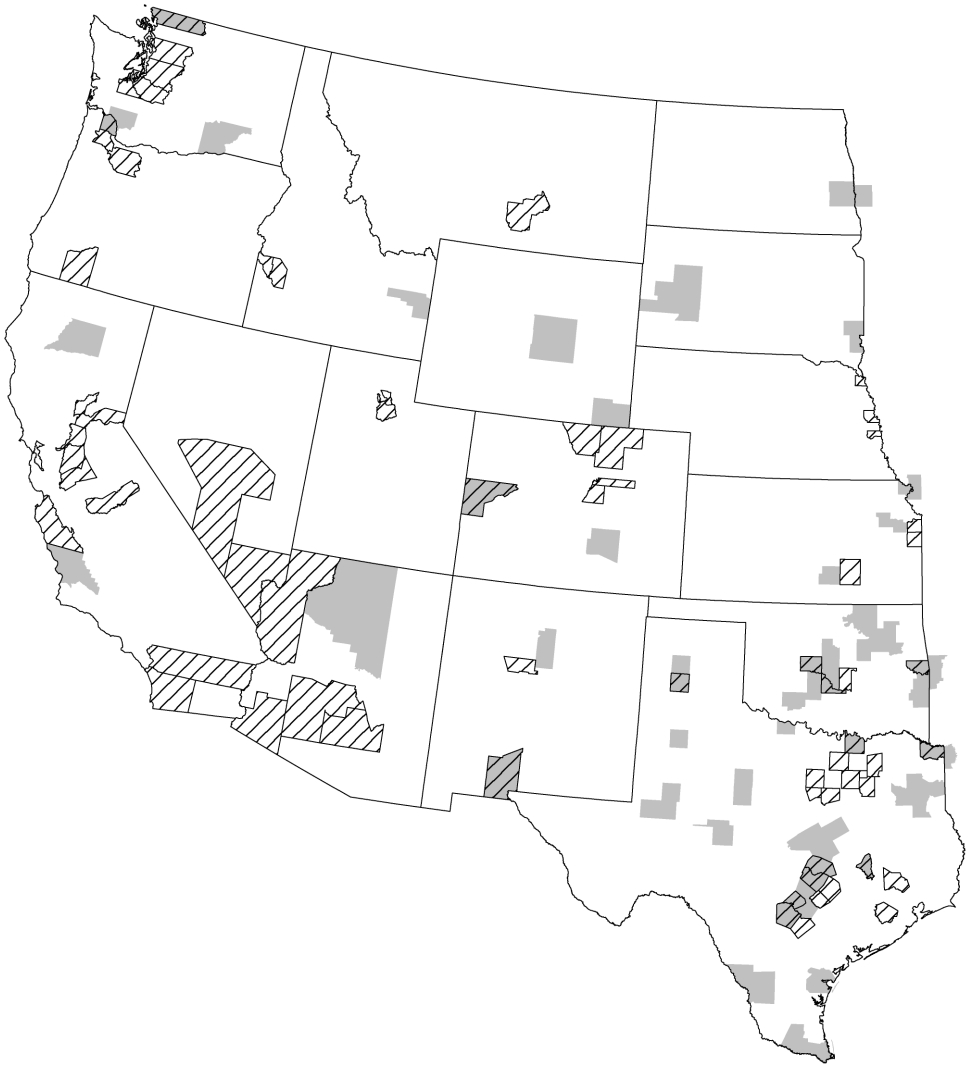
Figure 9: MPOs in Areas With Air Quality Problems That Expect Significant Future Growth

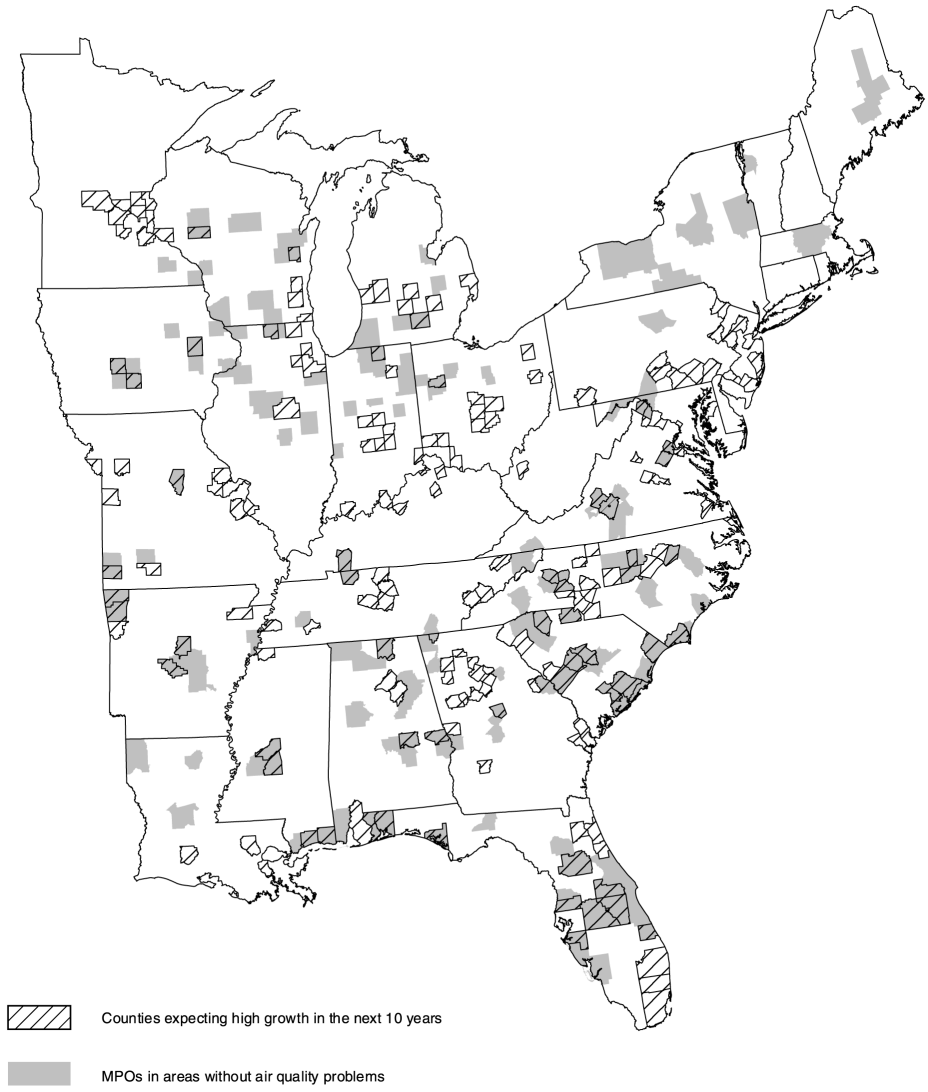


Note: The MPO boundaries are based on information supplied to us in the survey and may not reflect exact MPO borders, especially in the case of counties that are part of more than one MPO. If at least one county in an MPO is classified as being in nonattainment or maintenance for any of the criteria pollutants, then that MPO is considered to be in an area with an air quality problem for the purpose of our analysis and the entire area covered by the MPO is shaded on the map. The results from Alaska are not included on the map for display purposes.

Source: GAO's analysis of survey data.

Figure 10: MPOs in Areas Without Air Quality Problems That Expect Significant Future Growth





Note: The MPO boundaries are based on information supplied to us in the survey and may not reflect exact MPO borders, especially in the case of counties that are part of more than one MPO. If at least one county in an MPO is classified as being in nonattainment or maintenance for any of the criteria pollutants, then that MPO is considered to be in an area with an air quality problem for the purpose of our analysis and the entire area covered by the MPO is shaded on the map. The results from Alaska are not included on the map for display purposes.

Source: GAO's analysis of survey data.

In addition, in 1997, EPA introduced revisions to two air quality standards that it plans to implement that could increase the number of areas with air quality problems.[10] Previously, EPA had based one of these standards on the concentration of ozone allowed in the air over a 1-hour period that would still be protective of public health. EPA introduced, but because of litigation has not yet implemented, a new standard that will measure the amount of ozone allowed over an 8-hour period. Once this standard is implemented, EPA currently estimates that approximately 334 of the 3,141 counties nationwide will not meet it and will be designated as nonattainment areas, including at least 187 counties that are either in attainment or maintenance status for the 1-hour standard.[11]

The impact of the proposed standard is even greater, however, in terms of affected population. For example, in 1999, EPA estimated that more than twice as many people live in areas that are expected to violate the new 8-hour ozone standard than now live in areas that violate the current 1-hour standard—123 million compared with 54 million. These figures may be underestimated, however. For example, not all counties have air quality monitors or the data to indicate whether they will violate the 8-hour standard. However, the state governor or EPA can still designate these counties as nonattainment for the standard if the governor or EPA believes that these counties cause or contribute to the violation of the 8-hour standard. For example, one county without data could be contiguous to a county already found to be in violation of the 8-hour standard. The governor or EPA could designate the county without data to be in nonattainment of the 8-hour standard because it could be contributing to the pollution problems of a neighboring county.

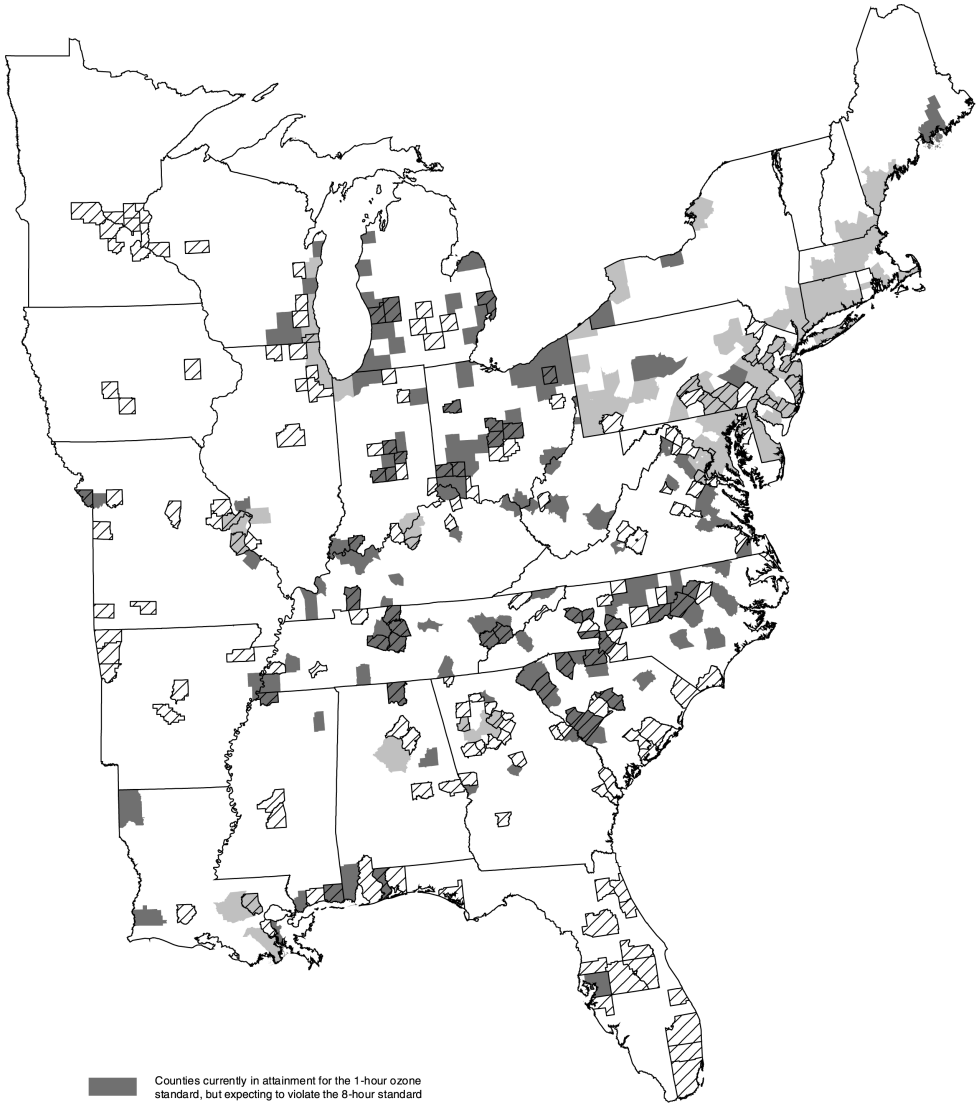
[10] In *Whitman v. American Trucking Ass'ns, Inc.*, 531 U.S. 457 (2001), the Supreme Court affirmed EPA's authority to set national air quality standards at levels necessary to protect public health and welfare, regardless of the economic costs of implementing the standards. However, the Court said EPA must reconsider its implementation plan for moving from the 1-hour standard to the revised standard and instructed EPA to develop a plan consistent with the Court's opinion.

[11] EPA's estimate is based on 8-hour monitoring during 1997 through 1999; these data will change from year to year. Because of uncertainty regarding the implementation date, EPA is not expected to use these data to make final designations since more current data will be available in the future. The 1-hour ozone maintenance and nonattainment data are as of January 29, 2001.

Local officials in 70 of the 334 counties likely to violate the 8-hour standard also expect to experience high population growth in the future, potentially influencing them to consider different land use strategies so as not to exacerbate their air quality problems. Additionally, counties currently in attainment for ozone standards located near metro areas in nonattainment, such as the counties around Dallas-Ft. Worth, also reported expecting a large increase in population over the next 10 years, which could threaten their air quality. To help ensure that their air quality does not degrade, these counties may also want to consider incorporating different land use strategies that are more protective of air quality. Figure 11 shows the counties currently in nonattainment for the 1-hour standard and expected to violate the 8-hour standard, counties currently in attainment for the 1-hour standard but expected to violate the 8-hour standard, and counties expecting high growth in the future.[12]

[12]EPA supplied the air quality data for this map. The map does not include counties designated as being in nonattainment for the 1-hour ozone standard, but for which there are no data to determine whether they will meet the 8-hour ozone standard. We gathered growth data from a previous survey of local growth issues in *Community Development: Local Growth Issues—Federal Opportunities and Challenges* (GAO/RCED-00-178, Sept. 6, 2000).

Figure 11: Counties Expecting to Violate the 8-Hour Ozone Standard and to Grow Significantly



Source: GAO's analysis of survey data and air quality data supplied by EPA.

In addition to the 8-hour ozone standard, EPA plans to implement a new standard for fine particulate matter that could add 100 new counties to those that violate the current standards. If both the ozone and particulate matter standards are implemented, more MPOs and state air quality managers may need to turn to different land uses as a means to help them achieve or maintain these standards.

MPOs and State Air Quality Managers Have Several Barriers to Overcome if They Want to Better Assess Emissions Impacts From Different Land Uses

MPOs and state air quality managers face a number of barriers that may limit their ability to assess the impacts of land use on air quality and factor this information into transportation and air quality improvement plans. In addition to the barriers identified earlier, such as the lack of an incentive to assess the impacts of land use, MPOs and state air quality managers lack the following technical capabilities necessary to conduct the assessments:

- According to survey results, MPOs lack modeling capability to determine (1) the emissions reductions from smaller-scale changes to their transportation plans, such as the implementation of bicycle and pedestrian facilities, and (2) the effect of various land use strategies, such as mixed-use or transit-oriented development, on transportation needs and emissions. For example, locating employment in close proximity to retail establishments and transit or pedestrian routes reduces the need for vehicles to accomplish errands typically completed on the way to or from work. Current models generally do not effectively predict how this type of development may affect travel behavior.
- MPOs also lack widespread access to land use models, especially ones that are also integrated with transportation or environmental assessment models, according to a DOT modeling official. The development of integrated models that would help MPOs to assess the emissions effect of different land use strategies has lagged behind other model improvement efforts. Therefore, the MPOs have limited ability to conduct trade-off analyses that would help them identify possible different land uses and supporting transportation systems that would generate the least emissions. Additionally, because many land use models are costly to run—they require a large investment in effort, technical staff, and data—smaller MPOs with limited resources may find it difficult to use these models.
- The difficulty of measuring and verifying the effect on emissions from different land use strategies can discourage interest in assessing the air quality impacts of such strategies, according to our survey results. MPOs subject to an emissions budget established by the SIP look for ways to reduce emissions and account for the amount of reductions.

Obtaining credit for the reductions, however, requires that the land use strategies proposed to limit emissions can be or have actually been implemented and that the amount of reduction can be measured. However, according to survey results, state air quality managers cannot typically regulate or enforce land use decisions and, therefore, cannot ensure that proposed land use changes will be implemented and emissions reductions realized. Also, according to DOT managers, this lack of land use control will be a challenge for MPOs as they try to ensure that proposed changes to land use plans are reasonable and enforceable. It is also particularly difficult to ensure reductions because implementation can occur over a relatively long period of time. If the managers base emissions credits on proposed land use changes and these changes are not implemented, the managers must make up the credit through some other means, and at a later period, which can be difficult.

Most States and Localities Do Not Fully Assess and Mitigate the Sources of Nonpoint Pollution but May Need to Do So in the Future

Most states and localities do not comprehensively assess the impacts of existing land use or future development on water quality and systematically factor such analysis into water quality protection and improvement plans, according to members of our expert panel and the studies we reviewed. They do not conduct these assessments and mitigation or protection efforts principally because nonpoint source pollution is difficult to identify and measure, and communities often lack the necessary resources and public support for land use solutions to water quality problems. Those relatively few jurisdictions that have the necessary resources and support from local decisionmakers and the public are more likely to comprehensively assess and mitigate water quality problems. In some cases, these efforts have included implementing land use and development strategies that protect water quality, such as updating zoning and other land use ordinances and reducing the amount of paved and other impervious surfaces in order to reduce polluted runoff.

More states and localities may need to assess the impacts of land use on water quality in the future, according to our panel members and other water quality experts. Pressure is growing to improve water quality through the use of the Clean Water Act's total maximum daily load provision. According to our panel, to conduct these assessments, states and localities will need help in reducing such barriers as the lack of data on the specific sources of water quality impairments and on the effects of land use on water quality.

States and Localities Have Generally Not Assessed and Mitigated Nonpoint Source Pollution for Technical, Legal, and Resource Reasons

Although EPA recognizes nonpoint source pollution as a serious problem nationwide, states and localities generally have not assessed and mitigated this pollution. Most states and localities have not done so because (1) the specific causes are difficult to identify and measure; (2) federal regulatory requirements, to date, have not adequately driven mitigation efforts; and (3) they often lack the resources and public and official support for assessments, mitigation, and prevention.

Extent of and Contributors to Nonpoint Source Pollution Are Difficult to Determine

EPA estimates that nonpoint source pollution is the principal reason that roughly 40 percent of the nation's assessed waters are too polluted for basic uses such as fishing and swimming. According to EPA's latest biennial National Water Quality Inventory, nonpoint source pollution from urban land use, including residential and commercial development and its associated roads, streets, parking lots, and other impervious surfaces, is a significant contributor to this impairment.[1] While agriculture, including grazing and concentrated animal-feeding operations, is generally regarded as the leading contributor of nonpoint source pollution nationwide from sediment, nutrients, pesticides, and certain other toxic chemical compounds, various pollutants resulting from urban land use and development can, in certain locations, equal or even exceed agriculture's contributions.[2]

The true extent of nonpoint sources' contribution to the impairment of water quality may be understated, however, because states have not been able to comprehensively assess the quality of all of their water resources. For EPA's 1998 report to the Congress, states assessed only 23 percent of the nation's river and stream miles, 42 percent of its total acres of lakes, ponds, and reservoirs; 32 percent of its square miles of estuaries; and 5 percent of its ocean shoreline miles. As we reported in March 2000 on our survey of 50 states and the District of Columbia, only 3 states indicated that they had the majority of the data needed to identify and assess nonpoint sources of pollution.[3] The states lack data partly because assessing nonpoint pollution is difficult. Runoff from nonpoint sources is caused by many types of activities, including urban land use and development, that take place over dispersed areas of land. In addition, nonpoint source runoff is episodic, primarily occurring as a result of rainfall or snowmelt,

[1] Pursuant to section 305(b) of the Clean Water Act, states, territories, tribes, and interstate commissions assess the health of their waters and the extent to which their waters support state water quality standards and the basic goals of the Clean Water Act. These jurisdictions submit their water quality reports to EPA every 2 years. EPA summarizes this information in a biennial report to the Congress, the *National Water Quality Inventory.* The most recent such report is the report for 1998, published in June 2000.

[2] See *Selected Findings and Current Perspectives on Urban and Agricultural Water Quality by the National Water Quality Assessment Program*, U.S. Geological Survey, U.S. Department of the Interior (Apr. 2001).

[3] See *Water Quality: Key EPA and State Decisions Limited by Inconsistent and Incomplete Data* (GAO/RCED-00-54, Mar. 15, 2000).

and, as a result, is more difficult to identify, measure, and control than point sources of pollution.

Federal Requirements Have Not Adequately Driven States and Localities to Mitigate Most Nonpoint Source Pollution

In part because nonpoint sources of pollution are hard to identify, assess, and control, they received little federal attention until the 1987 amendments to the Clean Water Act. Before 1987, federal and state clean water laws and regulations focused more on controlling point sources through permitting and the use of the best available technology to remove pollutants from discharges. In the 1987 amendments, the Congress directly addressed nonpoint source pollution through two new provisions. It created a new section 319 grant program and, for the first time, decided to regulate a portion of nonpoint pollution—pollution from municipal storm sewer systems and selected other nonpoint sources.

Section 319 Grant Program

To be eligible for grants under the section 319 program, states, territories, and tribes must inventory their known and suspected nonpoint source pollution problems and develop management programs to adequately address them. These programs can take almost any regulatory or nonregulatory approach. However, for the most part, they rely on voluntary measures to control the impacts of land use on water quality. Their approaches focus on providing polluters with technical and financial resources to encourage them to adopt land use and other management practices that protect water quality. These practices might include preserving or installing forested and vegetative buffers along streams, preserving or restoring natural wetlands, and educating the public on the proper use and disposal of substances harmful to water quality (e.g., fertilizers, pesticides, and other toxic chemicals).

While states and localities have successfully used the 319 grants to pursue land use solutions to water quality problems and reduce nonpoint source pollution in specific waters, these efforts, to date, have not been successful in producing broader controls on, or reductions in, nonpoint source pollution. Significant reductions may not have occurred, in part, because the program is relatively new and has had limited funding compared with efforts to reduce point source pollution. The section 319 program received its first appropriation—$37 million—in fiscal year 1990. Annual funding for the program remained at a similar level until fiscal year 1995, when the Congress increased it to $100 million. In total, the Congress has provided about $1.2 billion for the section 319 program through fiscal year 2001. However, as we have reported, this represents only a small fraction of the tens of billions of dollars that the public and private sectors have spent on controlling pollution from point sources.[4]

Regulation of Storm Water Runoff From Point Sources

In the 1987 amendments, the Congress decided to treat municipal storm-water discharges and erosion from construction activities as though they were point sources of pollution.[5] The Congress took this approach because the traditional means of managing these problems had a number of negative consequences. For example, communities traditionally built separate storm sewers to quickly collect and channel storm water and discharge it into water bodies to prevent local flooding. With more development, the quantity of storm-water runoff increased, and the storm water itself carried more pollutants—increasing downstream flooding, stream bank and bed erosion, and the destruction of aquatic habitat, and posing risks to public health. In the 1987 amendments, the Congress established a tiered approach for addressing certain industrial, municipal, and other storm-water discharges from point sources, those that enter the waters of the United States through a conveyance or system of conveyances, such as a storm sewer system. These amendments provided for a phased program to address the major contributors first (Phase I) and identify an appropriate second tier of sources at a later date. EPA published application requirements for Phase I for the categories of storm water recognized as the most damaging to the environment in 1990.[6] Generally, Phase I sources include storm-water discharges associated with

[4] See *Water Quality: Federal Role in Addressing—and Contributing to—Nonpoint Source Pollution* (GAO/RCED-99-45, Feb. 26, 1999).

[5] CWA, §402(p).

[6] 55 Fed. Reg. 47990 (Nov. 16, 1990).

certain industrial activities; medium and large separate, municipal, storm sewer systems (MS4); and large construction sites (those greater than 5 acres).

In developing regulations for this new provision, EPA recognized the close connection between urban development and polluted runoff by stressing that municipalities will need to minimize the impacts of future growth. Municipalities would need to manage residential, commercial, and industrial activities in ways that limit storm-water discharges and are, therefore, less damaging to water quality. In its first regulations for storm-water management (Phase I rules), EPA sought to limit discharges from two broad categories: (1) MS4s serving populations of 100,000 or more and (2) discharges associated with various industrial activities, including discharges from construction activities disturbing 5 acres or more of total land area. The core Phase I requirements include the use of permits, site-specific plans, and best management practices to better prevent and control polluted storm-water runoff. For example, vehicle maintenance facilities must have plans, including employee training, to ensure that oil, gasoline, and antifreeze do not enter storm-water systems.

In December 1999, EPA issued its second set of storm-water regulations (Phase II rules) for smaller MS4s and construction sites.[7] Small MS4s are defined in the Phase II regulation as any MS4 in an urbanized area not covered by the Phase I program. Two provisions of the Phase II rule are related to development. The rule requires permit coverage, including plans to prevent storm-water pollution, from construction sites 1 to 5 acres in size. In addition, the rule requires that small MS4s' storm-water plans include a program of post-construction runoff control for new development and redevelopment. Municipalities may decide to use these provisions as tools to address the link between their land use and water quality management efforts. While the provisions show promise, it is too early to tell how many municipalities will take full advantage of them.

[7] 64 Fed. Reg. 68722 (Dec. 8, 1999).

Many States and Localities Lack the Necessary Resources and Support to Assess and Mitigate the Impacts of Land Use on Water Quality

Our panel of experts identified several important reasons why land use considerations have not played a more prominent role to date in efforts to improve water quality: the lack of needed resources and of public and official support. (The panel also identified a number of technical and legal barriers that we discuss later.)[8] Several experts pointed out that state and local water quality officials primarily spend their time and resources on complying with existing federal and state requirements, such as ensuring compliance with point source permits and the new storm-water management regulations. In addition, like transportation and air quality officials, state and local water quality officials do not try to assess and mitigate the impacts of different land use strategies because they have little direct authority over land use and development decisions and therefore believe they cannot influence them.

Several experts also noted a number of difficulties in trying to achieve collaboration among water quality officials, land use decisionmakers, and other key stakeholders in conducting comprehensive water quality and land use assessments as well as developing water quality protection and mitigation plans. For example, one panel member pointed out that the responsibility for storm-water management, flood control, water quality, and development is often dispersed across a number of organizations. This makes it difficult for professionals in these organizations to pool their resources and work together on comprehensive assessments. Other members commented that such assessments are technically challenging, that they are resource-intensive, and that jurisdictions do not have or do not cooperate to share the staff resources and expertise needed to collect the necessary data, run models, and analyze the results.

Some local land use decisionmakers also do not support the assessment of land use impacts on water quality because they do not understand the relationship between their decisions and water quality impacts; they, therefore, give little attention to this issue, according to several panel members. This is especially the case if there is no observable evidence of serious water quality degradation in their areas and the public has not expressed concerns. Without such evidence or public pressure, local officials may be unwilling to institute land use controls for fear of legal

[8] See appendix V for a detailed listing of each of the impediments to further considering and mitigating land use impacts that the panel as a whole identified and the mean group rating for each impediment in terms of how important and how difficult it is to resolve. The impediments discussed here are identified as numbers 21, 30, and 35 in that listing.

challenges asserting that these officials have interfered with private property rights. Some of these decisionmakers also feel pressure to bring jobs and economic development into their communities, which they consider a higher priority than improving water quality.

Lacking resources and support, many localities are limited in the approaches they take to protect water quality. Panel members identified several of these limitations. For example, when localities have considered the impacts of land use on water quality, they typically have focused more on mitigating the impacts of an individual development or project, rather than on comprehensively assessing the impacts of land use and development. Moreover, these localities tend to rely on the developers' engineers or consultants to identify potential impacts rather than to conduct independent assessments. In addition, localities typically include in their subdivision and development regulations best management practices aimed at controlling erosion and sediment at construction sites primarily because these practices are generally accepted—not because their effectiveness has been verified. According to members of our expert panel, adopting these conventional "best management practices," often despite a lack of data on their effectiveness, is generally easier than adopting politically sensitive but more-effective restrictions on land use and development. For example, it is easier to mandate the use of erosion control techniques, such as straw bales and silt fences on construction sites, than it is to require limits on paved surfaces or street widths, or land conservation measures to protect environmentally sensitive areas from development.

Some States and Localities Have the Resources and Support to Comprehensively Assess Water Quality and Address Adverse Impacts of Land Use

Some states and localities have had the financial and technical resources and the support from the public and local officials needed to assess the impacts of nonpoint sources on water quality and implement a variety of measures to mitigate any adverse effects. These states and localities have identified federal, state, local, and private funding sources to support their efforts. Often, they have undertaken these initiatives to protect critical natural and economic resources threatened by pollution from encroaching development, such as drinking water sources, fisheries and shellfish beds, and lakes, rivers, and beaches used for recreational purposes.

Our expert panel identified a range of land management and development strategies that states and localities have employed. The experts ranked two broad areas of land use practices, in particular, as more effective in protecting water quality from the negative impacts of land use and

development and, at the same time, relatively easier to implement than other practices.

- *Land protection practices*—such as the purchase of environmentally sensitive land and the use of conservation easements to protect land from development; transfer of developments rights; and rural and natural resource zoning to preserve and protect prime farmland and other valuable resources, such as drinking water sources, from development.
- *Research, demonstrations, and innovative programs*—such as research on the effectiveness of best management practices and other pollution mitigation techniques; demonstrations of the effectiveness of nonconventional site development techniques that emphasize the preservation of natural patterns of water flow and infiltration; and innovative development strategies, such as low-impact and zero-impact development that incorporate on-site storm-water management measures that limit polluted runoff.

The experts also identified several relatively effective practices that they rated as somewhat more difficult to implement.

- *Management strategies*—such as adaptive management that involves implementing best management practices, continually evaluating their performance, and modifying them, as appropriate, to achieve the desired improvements in water quality; protecting and restoring stream banks and stream beds eroded by increased flows resulting from storm-water discharges; and limiting development in areas prone to flooding to minimize property losses and risks to public safety.
- *Site-level design techniques*—such as using alternative driveway and parking lot designs that reduce the amount of paved surfaces; paving materials that allow rainwater to infiltrate; and designs that cluster buildings to preserve more open space for common areas, recreation, and the on-site management of storm water.
- *Smart growth principles and strategies*—such as mixed-use and urban infill development; brownfields restoration and reuse; and comprehensive watershed assessment and planning to identify environmentally important areas that should be protected, as well as areas where future development should be concentrated.

The experts judged some of the most popular and prevalent practices in use today as somewhat less effective in protecting water quality than those

previously discussed, often because they are not tailored to the specific needs of an area or properly maintained.

- *Federally imposed regulations*—such as the requirement to conduct environmental impact assessments of individual transportation or development projects that use federal funds, as well as more traditional federal regulatory and enforcement approaches to water quality protection.
- *Nonstructural best management practices*—such as maintaining storm sewer drains and other storm-water infrastructure, street sweeping, the posting of antidumping warnings on storm drains, and public education campaigns to promote environmentally sound use of pesticides and fertilizers on residential lawns and in gardens.
- *Structural best management practices*—such as erosion and sediment control techniques at construction sites; the minimal treatment of storm water (e.g., skimming out oil and filtering out sediment and trash); and other storm water management structures, such as retention ponds and infiltration trenches.

The following case studies illustrate how communities have successfully implemented some of the more innovative and effective strategies:

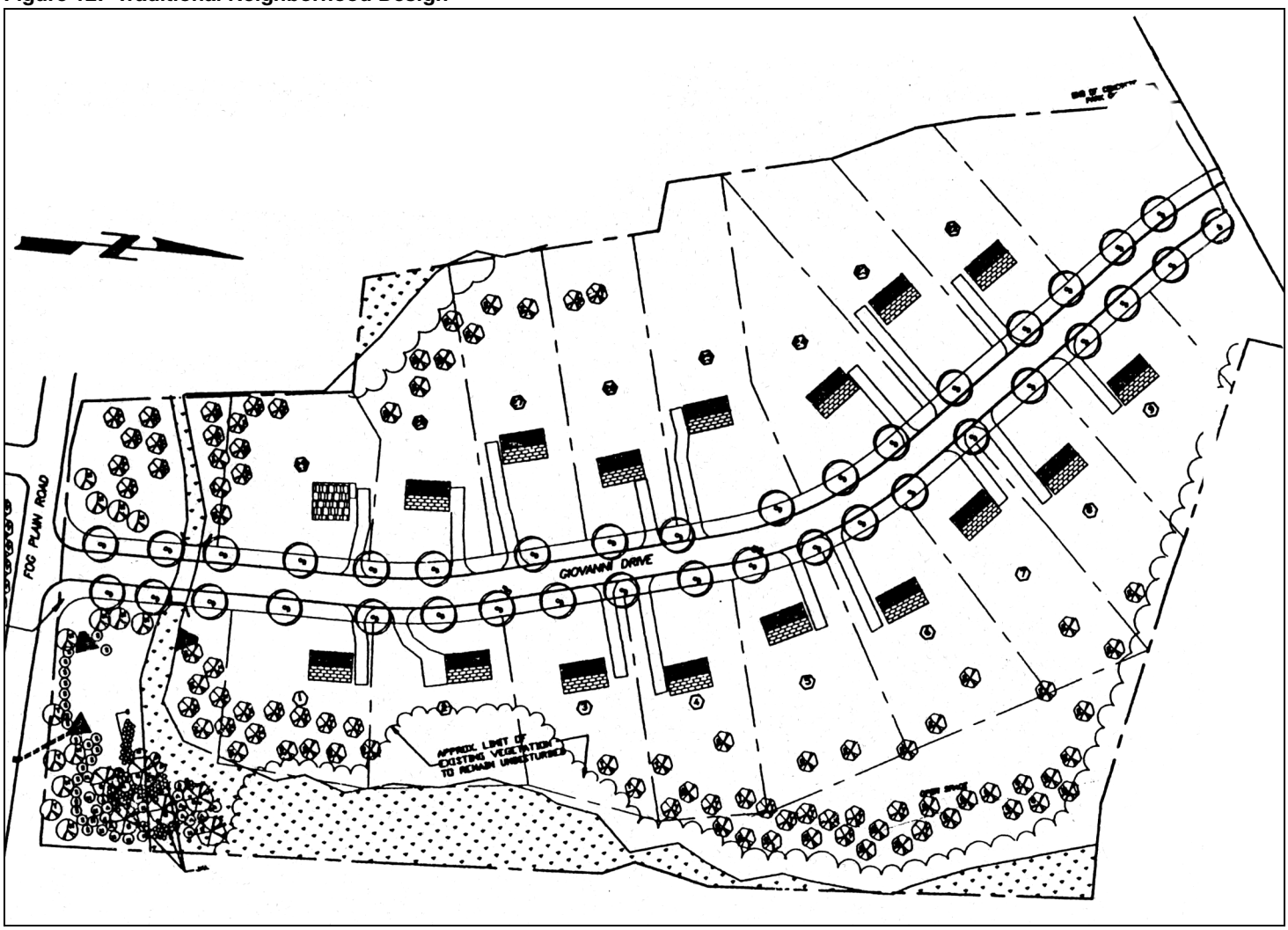
- *Maryland's efforts to protect the Chesapeake Bay.* To help protect this critical natural resource from increasing pollution, including that resulting from rapid urban development in the bay's multistate watershed, Maryland made a commitment to reduce the rate of growth of urban sprawl in the state by 30 percent by 2012.[9] To accomplish this goal, Maryland adopted several innovative strategies that have made it a recognized leader in smart growth. For example, it provides state funds for infrastructure, housing, and economic development only in already developed areas and those areas that local jurisdictions have designated as future growth zones. The state also has a number of programs to clean up and redevelop brownfields and to preserve farms, forests, wildlife habitats, and environmentally sensitive areas, partly to limit polluted runoff into the bay. Most recently, the state authorized its Department of Planning to challenge local land use decisions that the department determines would undermine the state's growth management objectives.

[9] The other states in the watershed, notably Pennsylvania and Virginia, also committed to this goal.

- *New York source water protection.* New York City, along with a number of upstate counties, local municipalities, and environmental groups, formed a watershed partnership to protect the water quality of several reservoirs that provide drinking water for about 9 million people. The reservoirs were threatened by agricultural land use and runoff from urban development. Among the innovative practices implemented were (1) a land acquisition program through which the city purchased properties or conservation easements on environmentally sensitive and undeveloped land to prevent development and polluted runoff; (2) a regulatory program to ensure that new construction followed certain practices that protect the watershed; and (3) a partnership in which the city, among other things, pays for upgrades to municipal wastewater treatment systems to reduce pollution from this source.
- *Jordan Cove watershed study.* Waterford, Connecticut, with the support of the University of Connecticut and the Connecticut Department of Environmental Protection, and partial funding from a Clean Water Act section 319 program grant, has constructed two contrasting sections of a subdivision and is monitoring their water quality impacts over time. One section uses a traditional neighborhood design that includes a half-acre residential zoning pattern with curbs, storm drains, storm sewers, and asphalt streets that are 24 feet wide. The other, more-innovative section, among other things, clusters the housing on smaller lots and uses grassy drainage areas and rain gardens to detain storm water on site.[10] It also incorporates narrower driveways and streets made of porous materials that allow for the infiltration of rainwater and snow melt, and uses the latest storm-water treatment innovations. Researchers will monitor and sample water in the drainage area over time to measure the impacts on runoff quantity and quality from each section to determine if the innovative "green development" techniques are more protective of water quality. Figures 12 and 13 illustrate these two subdivision designs.

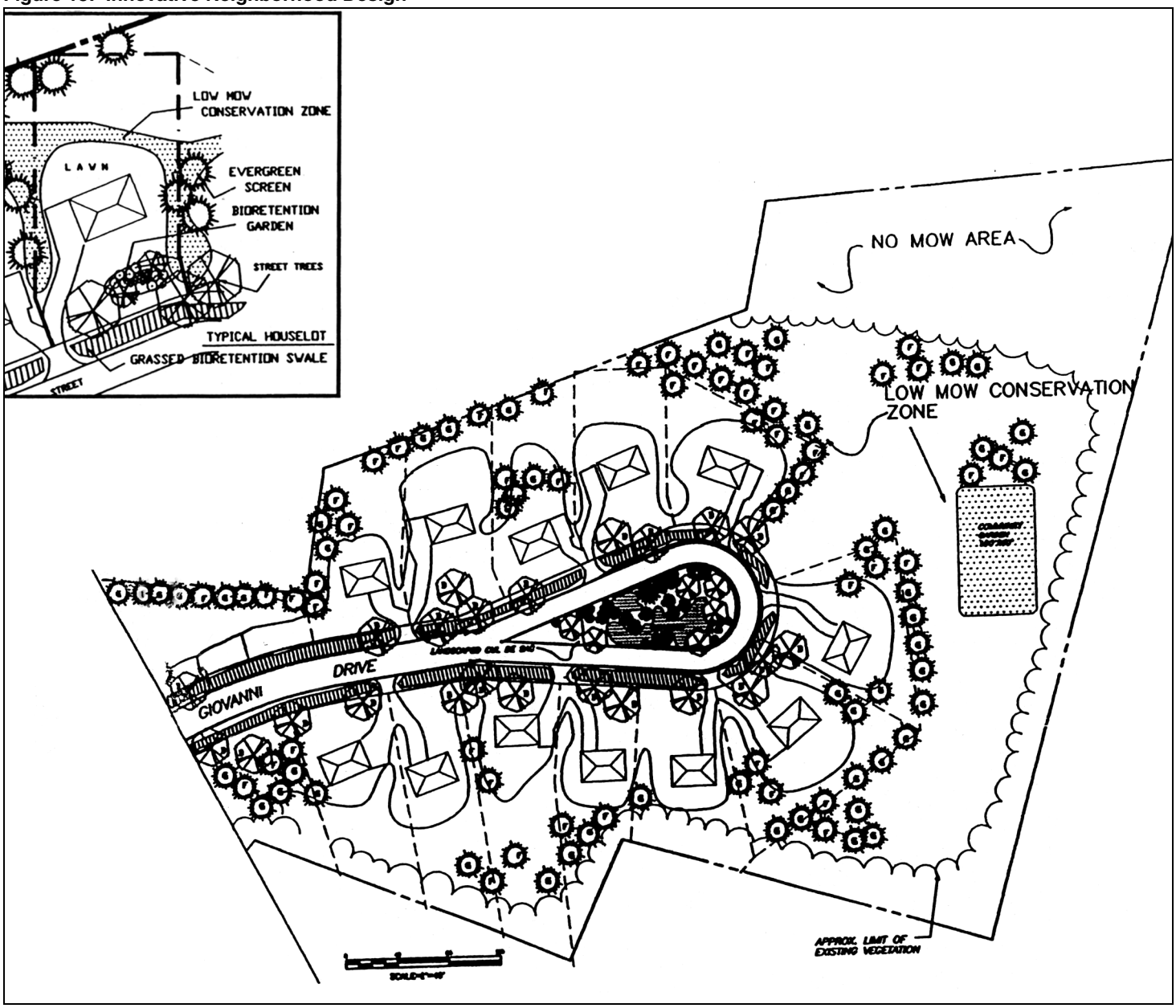
[10] Rain gardens are vegetated landscaping features, also known as "bioretention areas," to which rooftop runoff is diverted instead of being connected to a conventional drainage system. When properly designed, they do not require supplemental water.

Figure 12: Traditional Neighborhood Design



Source: Jordan Cove Urban Watershed Project at the University of Connecticut.

Figure 13: Innovative Neighborhood Design



Source: Jordan Cove Urban Watershed Project at the University of Connecticut.

- *Spragues Cove storm water cleanup.* The community of Marion, Massachusetts obtained funding from several sources, including a

program grant under section 319 of the Clean Water Act, and technical assistance from an interdisciplinary team of experts to help it build an artificial wetlands system. The system is intended to manage polluted runoff that contributed to the closure of shellfish beds and threatened nearby beaches. The wetlands, which were designed to store 1 inch of storm-water runoff with an average detention time of 14 days, dramatically reduced the amount of fecal coliform bacteria in the cove. This is expected to lead to a reopening of the shellfish beds for harvesting and provide long-term protection for the economic and recreational value of nearby beaches. Figures 14 and 15 illustrate the area before and after the wetlands project, respectively.

Figure 14: Spragues Cove Before the Wetlands Project

Source: EPA.

Figure 15: Spragues Cove After the Wetlands Project

Source: EPA.

States and Localities May Need to Give More Consideration to Land Use Impacts Because of Renewed Emphasis on Improving Water Quality and Revised Regulations Governing It

In response to citizens' concerns about persistent water pollution problems, EPA and the states are paying increasing attention to a provision of the Clean Water Act that has not been emphasized in the past three decades. During this period, EPA and the states have focused on controlling point source pollution. The greater emphasis on the role of nonpoint sources in the impairment of water quality could increase the need to improve land use practices to protect and improve water quality. The emphasis has led to a renewed interest in using the provision of the Clean Water Act, which requires states to identify and assess impaired waters, establish a priority ranking for them, and determine the total maximum daily load of contaminants that the water bodies can sustain.

Under EPA's TMDL regulations,[11] states are to identify any water bodies in which pollutant levels continue to exceed states' water quality standards, even after cities, towns, and factories have complied with technology-based standards and used the best available control technologies to limit discharges of pollutants from point sources. States are to set priorities for cleaning up these impaired waters and establish TMDLs for them. States can then implement the TMDLs and require permitted point sources, municipalities, individual landowners, and others to take actions to address chronic water quality impairments.[12] These actions can include tightening control requirements for point sources and establishing management measures for nonpoint sources, including runoff from urban areas, construction sites, and agricultural lands.

Beginning in the late 1980s and intensifying in the 1990s, citizens groups filed lawsuits against EPA and states, claiming that they had failed to comply with the act's requirement to protect and improve water quality by identifying and setting priorities for cleaning up impaired water bodies and for implementing TMDLs. As a result of these lawsuits and nearly 20

[11] The TMDL provision is contained in section 303(d) of the act. A TMDL represents an upper level, or ceiling, on specific pollutant loads that can enter a water body (or an entire watershed) so that the water body will meet and continue to meet the states' water quality standard. TMDLs can also be used to allocate pollutant loads and necessary reductions in pollutant loadings, among contributing pollutant sources in a watershed.

[12] A state can implement a TMDL to control nonpoint sources only if the state has enforceable legal authority upon which it can rely. States lacking such authority can enact laws providing for enforceable mechanisms to implement TMDLs. Where feasible and effective, states can also employ a variety of voluntary, incentive-based programs to control nonpoint source pollutants.

consent decrees or court orders, some states have had to accelerate the development of their inventories of impaired waters and other states have had to greatly increase the number of impaired water bodies in their inventories that are candidates for TMDLs.

Concerned that court orders rather than a coherent national policy would increasingly drive the implementation of the TMDL program, EPA launched several TMDL-related initiatives. For example, in 1996, it convened a 20-member federal advisory committee that evaluated, and made recommendations for improving, the implementation of the TMDL requirements. In response to the panel's recommendations, EPA revised its regulations governing TMDLs, acknowledging that the revision was necessary because the provision's implementation to date had not achieved sufficient water quality improvements. In its revised regulations, EPA laid out an overall timetable for developing TMDLs and required states to devise their own expeditious time tables for establishing their TMDLs and action plans for implementing them. EPA issued the final regulations in July 2000.[13]

However, the revised TMDL rule met with considerable controversy and resistance. States, affected businesses, and others protested the rule because of its technical challenges and costs. States may have to develop thousands of TMDLs to cover the more than 20,000 impaired water bodies and lack data on nonpoint sources and cost-effective ways to control them. Moreover, the process of devising TMDLs can be expensive because they can require the use of complex models, often costly to develop, to analyze the dynamics of a pollutant. EPA recently estimated that implementing the control actions that may be included in the TMDLs will cost between $900 million and $3.2 billion if the most cost-effective approaches are relied upon to achieve necessary reductions.[14] Because of these factors, the Congress delayed implementing the rules, and subsequently, in July 2001,

[13] 65 Fed. Reg. 43585 (July 13, 2000).

[14] Cost-effective reductions could include the trading of pollution allowances between point and nonpoint sources. However, EPA also noted that if states determine that all pollution sources should adopt sweeping controls, TMDL implementation costs could reach as high as $4.3 billion.

EPA itself proposed to delay implementation for at least 18 months in order to further review the rules and consult with affected parties.[15]

Despite the uncertain future of EPA's revised TMDL rules, states and localities, along with business and industry, will increasingly need to respond to pressure from citizens for water quality protection and improvement and focus on controlling nonpoint source pollution, especially when, as is often the case, this source provides the greatest remaining potential for reducing pollution. Because urban runoff is an important component of nonpoint source pollution, states and localities are likely to find it increasingly necessary to improve land use practices to reduce polluted runoff and protect and improve water quality.

According to a recent study by the Environmental Law Institute, the primary federal and state responses to nonpoint source pollution—providing financial and technical assistance to encourage voluntary action—have not succeeded in preventing the pollution of the nation's rivers, streams, and other water bodies.[16] Paying landowners not to pollute, providing free technical advice, and relying on voluntary adherence to best management practices have proven, in many cases, to be an incomplete strategy. Gradually, states are turning to enforceable mechanisms, including discharge prohibitions, the direct enforcement of water quality standards, pollution abatement orders, required operating practices, nuisance and misdemeanor prosecutions, and civil and administrative penalties, to supplement and complement other approaches for controlling nonpoint sources. The need for such action has been demonstrated by highly visible fish kills, endangered species listings, unacceptable fecal coliform levels in drinking water supplies, nutrient pollution of major estuaries and lakes, and pollution effects on beaches and waterfronts. Concerns from point source dischargers that other polluters share some pollution prevention obligations are also beginning to have some effect. As states develop TMDLs to clean up their impaired waters identified under section 303(d) of the Clean Water Act, the Institute's study notes, many will need to use enforceable mechanisms to achieve more

[15]On October 12, 2001, the U.S. Court of Appeals for the District of Columbia Circuit granted EPA's motion to hold the TMDL lawsuit in abeyance for 18 months while the agency reviews the rule and considers possible revisions. On the same date, the EPA Administrator signed a rulemaking that suspends the effective date of the TMDL rule until April 30, 2003.

[16] See *Putting the Pieces Together: State Nonpoint Source Enforceable Mechanisms in Context*, Environmental Law Institute (2000).

effective control over the nonpoint source pollution discharges that comprise a significant source of the impairments.

States and Localities Face Additional Barriers to Better Assessing and Mitigating the Impacts of Land Use and Development on Water Quality

In addition to the lack of funding and support from the public and local officials, our experts identified a number of other barriers that they believe impede efforts to better assess, mitigate, and prevent the adverse impacts of land use on water quality. Rated among the most important and easiest of these barriers to overcome are the following:

- *Lack of data.* The lack of sound, scientific data collected over time impedes states' and localities' ability to determine the quality of their water bodies, the major pollutants and their sources, and the most effective ways to reduce them. The lack of such data also impedes the ability to effectively characterize the water quality impacts of prevailing and projected land uses and the ability to educate the public and local decisionmakers about these impacts. Several experts pointed out that it is therefore difficult to design, target, and market land use management practices and smart growth development strategies to improve and protect water quality. The panelists thought that the solution to this barrier was relatively clear—have the federal and state governments recognize the critical need for better data and provide more funds and technical support to collect it. Individual panelists pointed out, however, that because of competing needs, water quality monitoring, research, and data collection efforts are often not funded or are among the first activities to be cut, especially if the benefits are perceived to be in the future. Nevertheless, the renewed emphasis on using TMDLs to improve water quality most likely will result in the need to collect more of these data.
- *Lack of information on cumulative land use impacts.* Similarly, the lack of information on (and in some cases, the understanding of) the cumulative impacts of land use and development on water quality makes it difficult for state and local officials to implement protective land use and development strategies. As we have noted, urban development can have a number of adverse impacts on, for example, the surrounding ecology and aquatic habitats, and on the temperature, flow, and geological stability of waterways. Communities lack information on the cumulative effect of these diverse impacts for a number of reasons. Conducting a cumulative assessment can be difficult and costly, especially since needed data and easy-to-use assessment tools are not readily available. In addition, most water quality monitoring to date has focused on only one indicator of impairment, the levels of specific

chemicals in water bodies, and not on other, equally important indicators, such as the presence and health of certain fish and other aquatic organisms in the water bodies. Greater recognition of the importance of gathering and understanding all data relevant to the cumulative impacts of land use and greater cooperation among local jurisdictions in a watershed would begin to address this barrier, the experts agreed.

- *Legal barriers*. Many local development codes, zoning laws, and building ordinances, as well as much state-planning legislation, are outdated, are not based on a consideration of the need for environmental protection, and do not allow for more innovative land use practices that protect water quality. Many of these legal provisions date from the 1920s, when the environmental impacts of land use were not well understood or of particular concern, and when the preference was to segregate single-family homes from other types of residences, such as apartments, and from commercial and retail activities. These laws often pay little or no attention to the importance of preserving trees, native vegetation, and existing topography or to avoiding excessive clearing, grading, and paving, which can alter the natural flow of water and encourage erosion.

  As a result, roadways and parking lots are often over-designed, creating far more impervious surface than is necessary and magnifying the problem of damaging runoff from these surfaces. Minimum lot-size requirements, building-setback requirements, and on-street parking requirements in these laws limit the ability to preserve open space and take advantage of site features that could retain storm water, remove pollutants, and allow for the infiltration of storm water into the soil to recharge underground aquifers.

Barriers rated as important by our experts but relatively more difficult to overcome include the following:

- *Lack of technical tools*. Water quality officials and communities lack access to user-friendly models, comprehensive land use data, and water-quality-monitoring equipment and methods. These would aid in accurately diagnosing water quality problems, including the impacts of land use and development. Communities would need to identify additional funding sources and access to technical staff to help them run the models, however, and collect and analyze consolidated water quality and land use data to develop water quality improvement plans that incorporate protective land use.

- *Weak regional authorities*. Although watersheds and the impacts of land use cross local jurisdictional boundaries, few regional organizations have the authority to take a more comprehensive approach to assessing water quality and influencing land use to protect it. According to several experts, appropriately empowered regional authorities—such as regional councils that include MPOs, clean air agencies, water quality planning agencies, and land use planners—could coordinate air and water quality planning efforts, enhance water quality data collection, promote sound land use and water quality management across local jurisdictions, and guide development in ways that are more protective of water quality. Otherwise, it is difficult for individual jurisdictions to share data and resources and to collaborate on watershed management and land use. Because jurisdictions tend to undertake planning, zoning, and development independently of each other, the consequences for water quality are less than optimal. For example, the siting of a large commercial mall in one area within a regional watershed versus another area, to better protect water quality, is difficult to achieve without some regional authority to support such a location decision.

  A number of experts noted, and studies that we reviewed confirmed, that a few jurisdictions, including the Atlanta, Portland, and Minneapolis-St. Paul metropolitan regions, have recognized the need for, and have created regional bodies with, authority over planning for land use, transportation, and environmental improvement on a regionwide basis. More widespread adoption of these types of regional bodies could help to promote the use of land use practices and development strategies that are more protective of water quality, the panelists agreed.

Finally, our panelists ranked several barriers as relatively important but also relatively among the most difficult to overcome. These include (1) a focus on short-term water quality or land use planning and the lack of clear organizational responsibility for protecting water quality in state and local governmental agencies; (2) the fragmentation of organizations at the federal, state, and local levels on the basis of subject matter and geographic jurisdictions with often conflicting missions; and (3) federal, state, and local policies (e.g., on taxes and subsidies) that do not facilitate or encourage innovative development practices that are protective of water quality.

Federal Agencies Could Take Actions to Help States and Localities Better Consider the Environmental Impacts of Land Use

The MPOs, the state air quality managers, and our panel of experts proposed federal actions in several key areas to help states and localities that want to consider the impacts of land use on their environmental protection efforts: (1) financial incentives to promote collaboration among transportation, environmental, and land use decisionmakers on protective land management strategies; (2) technical assistance, such as access to staff, data, methods, and models, to assess and mitigate the impacts of different land uses on air and water quality; and (3) the education of local governments and the public on ways to limit these impacts.

EPA, DOT, and several other federal agencies responsible for air and water quality protection have a number of initiatives in these areas, and the Congress is considering several actions that address some of these proposals. Some of the agency efforts, however, have not been widespread. Respecting the limits of its existing authorities and funding, EPA has generally let its program and regional offices decide the extent to which they could undertake these initiatives. As a result, some of the agency's efforts have been limited in scope and it has not coordinated them under an agencywide strategy. Such a strategy could help EPA leverage its limited resources more effectively and provide MPOs, environmental officials, and communities interested in limiting land use impacts with broader assistance. While DOT's initiatives were designed to encourage MPOs and communities to consider transportation alternatives that reduce emissions, some were not designed to encourage the consideration of different land use strategies that could further limit emissions. To remove barriers to the further consideration of land use impacts, both agencies, as well as the Congress, could consider ways to improve the programs they already have and provide states and localities with additional incentives, technical support, and help with public outreach.

MPOs, State Air Quality Managers, and Our Expert Panel Identified Federal Actions to Help Reduce the Barriers to Linking Land Use and Environmental Protection

The MPOs, the state air quality managers, and our panel of experts identified federal actions in several key areas that could help remove some of the barriers to assessing and limiting the adverse impacts of land use on air and water quality. (In general, we report those actions on air quality that a majority of MPOs and state air quality managers thought would help them to assess the emissions impacts of different land use strategies. We report those actions on water quality for which there was considerable agreement among the experts that these actions are moderately or highly important and effective, relative to all other actions the panel considered.):

- *Financial incentives*. Federal funding could be allocated in ways that help promote a more collaborative working relationship among MPOs, environmental officials, and land use planners on land management strategies that are more protective of air and water quality. To protect air quality, for example, more federal funding could be provided for those transportation projects that were developed collaboratively and that considered opportunities to limit adverse environmental effects. To better protect water quality, some funding could be targeted to (1) encourage greater state and local investment in water quality planning that aims to reduce or better manage urban runoff; (2) encourage the implementation of protective land use strategies, such as land conservation; and (3) promote collaborative water quality and land use plans that take a regional focus on environmental impacts and involve the relevant local jurisdictions within a watershed.

  The MPOs and environmental officials also suggested that federal funding should be consistent with state and local growth management initiatives and environmental needs. For example, consideration could be given to whether federal transportation funds are providing incentives to build additional roads and highways rather than to determine if transit systems would be more protective of air quality. Similarly, the panel of experts said that communities need more funding for water infrastructure; however, the funds should not be used on new infrastructure at the expense of repairing existing infrastructure that would allow for redevelopment in urban areas. In addition, the experts said that implementation of the TMDL rule, and any federal funding to support it, should not be undertaken at the expense or exclusion of developing more comprehensive watershed protection programs.

- *Technical assistance*. Federal agencies could provide tools to help remove the technical barriers preventing greater consideration of the

impacts of land use on air and water quality. For air quality improvements, MPOs and state air quality managers most frequently identified the following tools: (1) access to technical staff to help MPOs and air quality managers conduct analyses and modeling efforts to determine land use and related air quality impacts; (2) guidance, successful case studies, and more flexible funding for general research on how to design, implement, and measure the benefits of land use strategies that reduce vehicle miles traveled; and (3) improved modeling capabilities to better account for the impact on travel patterns from small-scale land use projects, such as bicycle and pedestrian facilities.

For water quality improvements, the experts identified (1) support for local efforts to collect and analyze data on the physical, chemical, and biological changes in a water body that indicate the quality of that water; (2) funding for, or access to, technical staff and improved models to determine and measure the water quality impacts of different land uses and development strategies; and (3) basic scientific research on ecology and hydrology.

- *Public outreach*. Federal agencies could better educate local land use decisionmakers and the general public about the relationships between air and water quality and their land use and transportation decisions. This could help to (1) overcome one of the barriers that a number of experts identified—the lack of public and official support for protective land use strategies—and (2) encourage a more collaborative working relationship among transportation, environmental, and land use decisionmakers.

The panel of experts identified an additional role for the federal government in promoting protective land use strategies.

- *Legal and regulatory reforms*. The federal government could encourage states and localities to reform outdated planning laws that hinder efforts to conduct comprehensive land use planning, especially planning that considers environmental impacts.
- *Support for comprehensive planning*. Agencies could also help to promote comprehensive land use planning that considers environmental impacts and involves all key stakeholders, such as local government officials and the public. Furthermore, agencies could encourage communities, as they devise comprehensive watershed plans, to incorporate measures to gauge actual progress in reducing pollution

rather than focusing on the number of activities accomplished, such as the number of permits issued.

EPA's Initiatives Promote Consideration of Land Use Impacts on the Environment, but the Agency Could Take a More Strategic Approach to Leverage Its Resources

Aware of states' and communities' increasing interest in better managing future growth and limiting its adverse environmental impacts, EPA has a number of initiatives that provide MPOs and state and local environmental officials with some of the federal financial incentives, technical support, and public outreach they had suggested. Nevertheless, partly because of limited resources, these are one-time initiatives or not sufficient to reach the number of interested localities. EPA's efforts to better link environmental concerns with land use planning, while showing promise, are not likely to have a more widespread impact unless they are part of a more strategic approach.

EPA Has Promoted Consideration of Land Use Impacts on the Environment

Table 2 summarizes EPA's major initiatives directly intended to encourage states and localities to consider land use impacts on air and water quality. We grouped the initiatives into the same categories of federal support that the MPOs, state air quality managers, and environmental officials identified. These initiatives are within the Air, Brownfields, Policy, and Water offices.

Table 2: Major EPA Initiatives That Link Environmental Protection and Land Use

Type of initiative	Purpose
Financial incentives	
Brownfield Assessment Grants	• $12.5 million in fiscal year 2001 to help communities assess abandoned urban sites for contamination in order to promote their cleanup and reuse
Brownfield Cleanup Revolving Loan Funds	• $31 million in fiscal year 2001 to provide communities with seed money to generate funds for brownfield cleanup
Clean Air Transportation Communities Projects	• $1.3 million in fiscal year 2001 to fund pilot projects, including growth management initiatives, that limit transportation-related emissions
Mobile Source Outreach Assistance	• $770,000 in fiscal year 2001 to educate communities on transportation choices that reduce vehicle miles and emissions
Innovative Communities Partnership Projects	• Provide communities with seed money for pilots that, for example, promote revitalization of urban areas and development practices that are environmentally sound[a]
Smart Growth Grants[b]	• $300,000 in fiscal year 2001 to build the capacity and incentives for the development of smart growth alternatives across organizations
National Estuary Program Smart Growth Pilots	• Provide funds in six pilot estuaries to, among other things, give localities analytical tools to assess the impacts of various growth scenarios and factor these data into comprehensive watershed protection or land use plans[c]
Clean Water and Drinking Water State Revolving Funds	• Continue to provide communities with the flexibility to use funds for land use initiatives, such as purchasing land or easements to control runoff and taking a watershed approach to infrastructure planning
Nonpoint Source Implementation Grants	• $237.5 million in fiscal year 2001 for states and tribes to implement nonpoint source programs; a few communities used portions of the funds to implement protective land management practices
Water Quality Cooperative Agreements	• $19 million in fiscal year 2001 to promote more innovative ways of managing stormwater and sewers
Watershed Assistance Grants	• $200,000 in fiscal year 2001 to encourage communities to work with other organizations in watershed protection partnerships
Chesapeake Bay Program Grants	• Provide funds for efforts to protect the bay, including an assessment of regional land use impacts; this is a joint project with state and local governments and key stakeholders
Source Water Protection Grants	• $1.5 million in fiscal year 2001 for grants to such organizations as the National Rural Water Association to help communities and water suppliers develop and implement protection plans for sources of local drinking water. EPA expects the plans to include land management tools, such as zoning ordinances

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Type of initiative	Purpose
Wellhead Protection Grants	• $4 million in fiscal year 2001 for a grant to the National Rural Water Association to help rural water systems develop and implement programs to protect groundwater sources of drinking water
Technical assistance	
Guidance	• Promote methods to account for the air quality benefits of certain land use practices in the SIP or conformity determination processes • Summarize current research on the impacts of certain land use trends, and the transportation supporting them, and ways in which new development designs can limit these impacts, including a study showing the travel and transportation benefits of infill development • Issue a guide and fact sheets, post information on a Web site, and sponsor roundtables and workshops on development designs that have a low impact on water quality; EPA is also working to promote low-impact development practices on federal lands or at federal facilities • Provide communities with assistance on ways to successfully develop and implement the TMDLs to restore impaired water bodies
Water quality and land use data	• Develop Web-based tools to provide communities with access to water quality information that is linked to specific geographic land areas • Develop tools to help communities estimate the pollutant loads from various sources; this is a joint effort with the U.S. Geological Survey
Better assessment methods and models	• Develop methodologies to quantify the emissions and water quality benefits of various land use alternatives, starting with urban infill or brownfield redevelopment projects, followed by transit-oriented and mixed-use development • Evaluate land use models to publicize those that may be currently available or under development to help assess land use impacts • Provide communities with a watershed assessment model • Distribute the Smart Growth Index, a tool that communities can use to estimate the vehicle miles and emissions generated by different land use scenarios

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Type of initiative	Purpose
Clearinghouse for best practices	• Participate in the Smart Growth Network, a consortium of key stakeholders formed in response to increasing community concerns about the need for new ways to grow while also promoting economic development and environmental protection • Sponsor the Clean Air Act Advisory Committee, which has a subcommittee to address issues related to land use, transportation, and air quality, such as the granting of SIP credits for land use measures or promoting clean air and sustainable communities • Sponsor conferences; host Web sites; and publish reports on best practices, successful grant projects, and smart growth initiatives that protect the environment, such as source water protection practices • Sponsor several projects under the National Nonpoint Source Monitoring Program to evaluate new technologies to control nonpoint source pollution • Maintain the Nonpoint Source Partnership with states, as well as a working group, to identify best practices for managing runoff • Support the National Storm Water Best Management Practices database • Maintain the National Storm Water Management Center
Professional development	• Sponsor the Watershed and Drinking Water Academies, which provide training, including Web-based courses, and materials on watershed and source water management and protection practices • Support the Center for Watershed Protection, which provides local water quality officials with technical assistance to help them develop and implement their water quality protection and restoration programs

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Type of initiative	Purpose
Public outreach	• Host several local government workshops on how to use zoning, tax incentives, and land preservation to promote smart growth initiatives that reduce runoff • Sponsor the "Linking Land Use to Water Quality" program for local land use decisionmakers that uses satellite and other data to assess land cover, among other things • Electronically provide examples of ordinances that localities can adopt for different land use practices that protect water quality, such as open space conservation, and erosion and sediment control • Provide effluent guidelines for construction and new development in order to educate the construction industry on requirements for limiting polluted discharges into water bodies • Host workshops on how communities can find alternative funding sources for their water quality protection programs and achieve self-sufficient programs • Produce, along with the National Governors' Association, the electronic "Smart Growth Toolkit," which provides local officials with information to help them, for example, set a vision for future growth; assess the effects of different transportation, housing, and revitalization strategies; and consider methods to limit sprawl • Fund the development of a course entitled the "National Smart Growth Leadership Program" for policy makers at all levels of government and in the private sector who will study, among other things, the contributors to sprawl and smart growth alternatives • Develop smart growth principles that communities wanting to protect water quality through better growth management can adopt • Promote the use of more comprehensive watershed approaches to water quality protection when possible through EPA's grant and assistance activities

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Type of initiative	Purpose
Interagency coordination	• Work with DOT on several joint research projects addressing transportation, air quality, and land use, such as those discussed in table 4 on DOT initiatives • Along with other federal agencies, continue to implement the Clean Water Action Plan; under this plan, the agencies developed a unified federal policy for watershed management on federal lands that incorporates smart growth components, better coordinated their water quality protection programs, and issued a catalogue of available federal funding for water quality protection • Work with a number of other federal agencies and professional associations, such as the Department of the Navy, U.S. Army Corps of Engineers, and the National Association of Counties, on water quality initiatives linked to land use • Work with the nine federal agencies that are part of the Mid-Atlantic Federal Partners for the Environment consortium, under a memorandum of understanding, to help interested communities better protect environmentally sensitive areas, such as wetlands, and redevelop brownfields
Regulatory innovation	• Under the Project XL program,[d] work with Atlanta on a method to quantify that the emissions from redeveloping an urban brownfield would be less than the emissions from developing in open space (as a result, Atlanta could move forward with a transportation project that was stalled because of the city's air quality problems but that was critical for providing access to the brownfield site) • Also under this program, work with the city of Chicago to identify development zones, including brownfields, low-income areas, and other industrial sites, and provide businesses that locate in these zones with economic benefits and easier ways to meet Clean Air Act requirements

[a] The predecessor to this program was EPA's Sustainable Development Challenge Grants program, funded at approximately $5 million per year from fiscal year 1996 through fiscal year 1999. When funding for the program was canceled, EPA reconfigured and refocused it into the pilot program for Innovative Community Partnership Projects. EPA reprogrammed about $480,000 for grants in fiscal year 2000. EPA did not receive new funding for the program in fiscal year 2001 and instead used the discretionary funds it had available to issue grants that year.

[b] According to EPA's manager for smart growth initiatives, these are grants awarded by the agency's policy office for smart growth initiatives, although individual program offices may also have grant initiatives that could be characterized as smart growth efforts. The manager added that this effort is not a formal program. Rather, EPA can annually decide if it has discretionary funds available to award these types of grants, so the amount of funds and number of grants each year can vary.

[c] We were unable to determine the amount of funds specifically devoted to integrating land use and water quality decisions for several programs.

[d] EPA created the Project XL program to allow pilot projects flexibility in meeting regulatory requirements that may hinder innovation.

One of the initiatives listed is most directly related to encouraging MPOs to consider the environmental impacts of land use when devising transportation plans. EPA provided the Association of Metropolitan

Planning Organizations with a grant to be used as seed money, as well as staff assistance, to support the efforts of six different MPOs that had expressed an interest in better integrating smart growth into their transportation-planning and travel-modeling processes. These MPOs are, for example, enhancing the travel demand model to capture the effects of different land use strategies, integrating watershed and transportation-planning processes, and developing regional strategies for collaboration with local governments. When the project is completed, EPA and the association plan to report on the lessons learned, including modeling and planning innovations, as well as collaborative strategies, that can be adopted more widely.

In addition to EPA's efforts, the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) provide communities with technical assistance to help them consider the impacts of land use on water quality. USGS is responsible for conducting a significant amount of water quality monitoring nationwide. NOAA, under its Coastal Zone Management and Coastal Nonpoint programs, helps up to 35 coastal states (including the Great Lakes states) as well as territories develop programs for controlling coastal nonpoint pollution, including the incorporation of land use controls to limit water quality impacts. The major initiatives for both of these agencies are summarized in table 3.

Table 3: USGS' and NOAA's Major Water Quality and Land Use Initiatives

Type of initiative	Purpose
USGS technical assistance	• Under the National Water Quality Assessment program, continue to characterize water quality conditions in more than 50 river basins and aquifer systems, helping to understand the impacts of land use • Assess the chemical, physical, and biological factors affecting streams and aquifers in selected metropolitan areas • Fund a cooperative program that interested states, tribes, counties, and municipalities can use to, among other things, help them collect and analyze hydrologic data needed for their watershed protection efforts and implementation of TMDLs • Under its land use trends initiative, identify and analyze land use patterns and changes over the past 30 years and attempt to identify the causes and environmental consequences of these changes • Under its Urban Dynamics Research Program, use satellite data, historic maps, and aerial photographs to assess the effects of growth over time in specific major metropolitan areas, then use this information and models to forecast future alternative growth scenarios and their impacts on pollution[a]
NOAA technical assistance	• Provide a total of $5 million in fiscal year 2001, under the Sea Grant program, to promote research, outreach, and education to address coastal resource problems, including growth issues as they relate to water quality • Issue a guide on practices that coastal and lake states could use to achieve their established measures of water quality, by, for example, (1) limiting runoff and pollution from new development and construction, (2) determining the location of new roads and bridges to limit impacts on water quality, and (3) protecting watersheds through the use of local zoning or open space preservation in ways that will guide development away from areas that protect against runoff and erosion; this is a joint effort with EPA • Monitor water quality for about 25 estuaries nationwide • Through its Coastal Services Center, provide states with tools and training, such as how to use global information systems, which incorporate satellite data, to manage their water quality activities • Work with EPA to demonstrate the best approaches for redeveloping coastal brownfields

[a] According to USGS program managers, as of July 2001, funding for these assessments was discontinued for fiscal year 2002.

EPA Could More Strategically Target and Better Leverage Its Land Use Initiatives and Investments

While EPA's efforts to address the linkage between land use and environmental protection have been commendable, some have not been comprehensively implemented, and have not reached a broad enough audience to have an impact nationwide. The manager of EPA's smart growth initiatives acknowledges that the agency took a more cautious approach because it realized that with its limited resources, it would only be able to directly support a small portion of the hundreds of thousands of communities nationwide. Therefore, it decided to use its funds as seed money and look for pilot projects that had the greatest potential for serving as successful case studies that other communities could adopt. The agency also wanted to be sure not to exceed its existing authorities and to respect localities' primary authority for land use decisions. Given these considerations, the agency decided to task the Development, Community, and Environment Division within the Office of Policy, Economics, and Innovation with the mission of looking for opportunities to help states and localities with their smart growth initiatives to the extent possible with the limited resources provided. The agency did not define a similar mission for program and regional offices, but left it up to them to determine the extent to which they could assist states and localities. The division was to provide program and regional offices with any assistance they requested and keep informed of the offices' activities. As demonstrated in table 2, the division as well as the offices undertook a number of initiatives. Some of the activities, such as the Smart Growth Network, publications, conferences, and partnerships with other organizations, have reached a more widespread number of local decisionmakers and communities, while the extent and impact of other activities have varied.

Financial Initiatives

EPA has had limited resources for some of its programs that link land use and environmental concerns, which, in turn, limits the programs' impact and reach. For example, under its Innovative Community Partnership Projects initiative—one of the programs most closely linked to promoting the wider use of environmentally protective development practices—EPA could support only 11 projects with the $480,000 in funding it made available for the program. Furthermore, EPA does not expect to get funding for the initiative in fiscal year 2002. In contrast, since 1995, the Congress has provided EPA with a total of about $90 million to provide communities with grants to assess contamination at sites. As of August 2001, the agency had used this to provide 399 communities with grants to assess brownfields in order to promote their cleanup and redevelopment.

In other cases, EPA could better leverage the funds it has available to provide communities with a stronger incentive to assess and mitigate the environmental impacts of land use. For example, while communities can use EPA's water quality grants to implement alternative land use practices, and several have done so, the agency did not design the grants specifically for this purpose. Making consideration of different land uses and their water quality impacts a criterion in the grant awards process could promote the more widespread use of its grants for land use activities.

Technical Assistance

EPA's technical initiatives show promise but may have a limited impact unless the agency obtains more resources or provides more outreach, assistance, and marketing. These initiatives include the following:

- *Obtaining water quality data*. EPA, USGS, and NOAA have each conducted monitoring to obtain the data needed for water quality improvements, but the agencies have only been able to focus on a sample of watersheds because of limited resources. As a result, many communities do not have the data needed to pinpoint the sources of urban runoff.
- *Developing analytical methods*. EPA's efforts to develop methods and models to help communities assess the environmental benefits from different land use strategies, as well as to comprehensively assess watersheds, will be very useful to transportation and environmental planners. However, they will be useful only if EPA makes them widely available and provides planners and communities with assistance in using the tools. As an EPA water quality manager pointed out, the agency's watershed model may be too complex for smaller communities with fewer resources, unless they have access to staff with technical expertise who can help them run the models.
- *Providing guidance*. EPA has published guidance on how to account for the air quality benefits of certain land use practices in SIPs or conformity determinations. However, only a few MPOs and state air quality managers reported that they were more than somewhat aware of or were certain that they would use the guidance. They may have been unaware of the guidance partly because it was relatively new. Nevertheless, EPA conducted only a limited number of workshops on the guidance, such as a regional conference to introduce it, and program managers said the agency did not plan to spend resources on additional training or outreach.

Individual Offices' Efforts

EPA lacks a comprehensive, strategic approach to its initiatives that would help it better coordinate them and leverage its resources to achieve a more widespread impact, as illustrated in the following cases:

- Even though land use can impair both air and water quality, and mitigation measures can produce benefits for both, the program offices we spoke with were not always aware of the scope of each other's initiatives. This lack of communication limits their ability to coordinate initiatives to take advantage of possible cumulative benefits. Similarly, air quality managers in one region reported that they had tried to establish a working group with the region's water quality managers but had not been successful.
- The level of activities that regions initiated to help communities seek land use solutions to environmental problems varied. This is of concern because states and localities most likely first contact regional offices for assistance in solving air and water quality issues, and these environmental problems often require a regional, rather than individual locality, focus and solution. For example, one EPA region in a highly developed area has drafted a plan to address state and local development issues that affect the environment, coordinated teams across its program offices, and conducted outreach with local jurisdictions. However, air quality staff in another EPA region in a highly developed area told us they have lost staff and have had to reduce their activities. Therefore, they have not had the resources to respond to more than a few communities' requests for assistance in using smart growth and land use strategies to improve air quality.

Although states' and localities' interest in pursuing protective land use strategies is increasing, EPA will not be able to respond unless it develops a more strategic approach. Such an approach would include a more clearly defined agency role in providing states and localities with the assistance they need and the outcomes the agency wants to achieve in terms of environmentally protective land use practices. This approach would also include a plan specifying how best the agency could organize its ongoing and new projects among its program and regional offices and leverage its available resources to achieve the desired outcomes. Presenting and justifying this strategy to the Congress could help EPA to try to garner the support, authority, and funding the agency would need to implement its strategy.

DOT Has Initiatives to Link Transportation and Air Quality Protection but Could Better Promote Consideration of Different Land Use Strategies

Like EPA, DOT has several funding programs and technical assistance activities that can help encourage MPOs, state air quality managers, and communities to consider how their transportation choices can maintain or improve air quality. Most of these initiatives generally focus on reducing congestion and vehicle miles traveled, and, in some cases, modifying land use, such as adding bicycle and pedestrian facilities. However, few of the initiatives have served as an incentive for MPOs, state air quality managers, and communities to collaboratively assess different land uses and the transportation networks to support these uses, and consider choosing the network that offers the most air quality protection.

Table 4 describes DOT's initiatives to help localities select transportation plans that are more protective of air quality and that, to some extent, consider the impacts of land use.

Table 4: Major DOT Initiatives That Link Transportation, Air Quality, and Land Use

Type of initiative	Purpose
Financial incentives	
Congestion Mitigation and Air Quality Improvement	• $1.385 billion in fiscal year 2001 to fund transportation projects that reduce emissions in areas with air quality problems
Transportation and Community and System Preservation Pilot	• $50 million in fiscal year 2001 to provide seed money for projects that begin to link transportation and different land use strategies with the intention of developing best practices that other communities can adopt
Surface Transportation Program	• Communities can use federal transportation funds to take pollution abatement and cleanup activities on certain types of projects
Transportation Enhancements	• $545 million in fiscal year 2001 to fund nontraditional transportation projects that help to make communities more livable; about 50 percent of the funds are spent on bicycle and pedestrian facilities and related projects, which help to reduce automobile use and congestion; about 1 percent of funds are used to mitigate the impacts of highway runoff
Bicycle and Pedestrian Program	• Promote and facilitate the increased use of nonmotorized transportation, including developing facilities for the use of pedestrians and bicyclists[a]

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Type of initiative	Purpose
Transit-Oriented Development	• Promote this type of development by providing that federal funding under the transit capital program can be used for projects such as transit parks and redevelopment of historic facilities into transportation terminals
Technical assistance	
Guidance	• Clarify the required modeling for areas that need to demonstrate conformity; this is a joint effort with EPA • Issue a policy clarifying how states and localities can use federal transportation funding to assess and clean up brownfields
Research	• Assess the impact of neighborhood design on travel behavior and air quality to build better travel-forecasting techniques; this is a joint project with EPA • Determine the impact of impervious surfaces from transportation systems in a watershed
Model improvement	• In the short-term, improve the travel demand model to account for changes, including (1) smaller-scale modifications to transportation plans, such as bicycle and pedestrian paths, and (2) ways in which various transportation projects encourage or reduce the number of trips people make; this is a joint project with EPA • Over the long-term, develop a new travel demand model that will better simulate travel patterns and needs; this is a joint project with EPA • Improve the capability to predict the contaminants in storm water and their impacts on the quality of receiving waters
Professional Development	• Every 3 years, certify those MPOs that cover areas with more than 200,000 people to ensure that the transportation planners are implementing requirements, including the requirement to consider projects that "protect and enhance the environment, promote energy conservation, and improve quality of life" • Develop and implement training courses on erosion and sediment control; this is a joint project with EPA
Public outreach	• Continue the campaign, "It All Adds Up to Cleaner Air," designed to educate the public about ways to protect air quality, including ways to choose more protective transportation options; this is a joint effort with EPA

[a]While this program does not receive its own funding, states and localities can use funds from almost all federal highway funding categories for these projects, and each state is required to fund a Bicycle and Pedestrian Coordinator position in its state DOT to promote this program.

Few of DOT's initiatives have served as an incentive for MPOs, state air quality managers, and communities to collaboratively assess the protectiveness of different land uses as a means to achieve air quality. Four initiatives illustrate this issue. First, the Transportation and Community and System Preservation Pilot program has the most potential to foster such assessments. It was designed to encourage collaboration among

governmental, developer, and other private-sector interests, as well as transportation planners, to identify land use alternatives that, among other things, reduce the effects of land use on the environment. The program has resulted in a number of successful pilots. For example, Florida used its funds to develop a planning method to estimate the effects of land use strategies and alternative transportation improvements on travel choices. Tennessee used its funds to revise outmoded land use regulations to support bicycle, pedestrian, and transit projects. However, the agency might be able to better target funds for land use initiatives if fewer funds were dedicated, or "earmarked," beforehand. For example, funds provided in fiscal years 2000 and 2001 for most of the projects were earmarked and, according to the program manager, many of the projects were not reviewed in the competitive selection process.

Second, DOT provides states with billions of dollars annually for new transportation projects. One of the criteria for funding under its New Starts transit program is demonstrating that land use plans will be compatible with the proposed transit project and will help contain sprawl.[1] However, communities are not similarly required to address the containment of sprawl for highway and other projects.

Third, the Congestion Mitigation and Air Quality Improvement Program provides a financial incentive for communities with air quality problems to alleviate them by designing transportation projects that reduce congestion and therefore improve air quality. However, the program does not encourage these communities to design land use projects as a means to achieve these goals. For example, the program's guidance specifies a list of 17 eligible projects or activities that fall into two general categories; but these do not include projects that try to improve air quality by altering transportation-related land development. According to the program manager, however, several communities have proposed land use projects under the program's provisions for experimental pilots. Under one of these proposals, the Minneapolis-St. Paul MPO requested program funds to purchase land adjacent to new light-rail stations for commercial development—mixing high-density housing and commercial activities. Although DOT ultimately approved the project for funding—stating that the project was related to transportation and could reduce emissions by

[1]This program provides grants for construction of new fixed guideway systems—such as light rail, heavy rail, and commuter rail systems and bus or high-occupancy vehicle lanes—or an extension to an existing system.

reducing reliance on the automobile—the Department had some initial questions about the appropriateness of using transportation funds for land development activities. Additionally, the program was designed to provide a majority of the available funds for areas that already are in nonattainment or maintenance status. Therefore, it does not provide an incentive to communities in attainment to consider alternative development or redevelopment strategies as a means to preserve air quality. Yet, these communities may still have significant potential to grow and, therefore, the opportunity to guide development in ways that limit congestion and vehicle emissions.

Finally, DOT and EPA efforts to improve travel-demand-forecasting models may help MPOs and communities determine the effects of transportation improvements on congestion and air quality. However, according to a DOT modeling expert, these efforts currently do not call for integrating land use or environmental components into the travel demand model, although a new land use simulation model under development may offer this opportunity in the longer-term. Without such integrated models, communities cannot consider the likely effects that their transportation decisions will have on land use, future growth and development, and air quality.

The Congress Is Considering Actions to Support State and Local Growth Management Efforts

The Congress is considering several legislative proposals that would better coordinate federal efforts to support state and local growth management initiatives and remove barriers to these initiatives.

- The Urban Sprawl and Smart Growth Study Act (H.R. 1739) calls for the Council on Environmental Quality to review how well federal agencies are considering the impact of their actions on urban growth and sprawl.
- The Community Character Act (H.R. 1433 and S. 975) is intended to provide funding to promote improved state and regional planning, including the updating of outmoded state planning laws that pose barriers to considering and implementing different land use strategies that are more protective of the environment.
- The Brownfields Revitalization and Environmental Restoration Act of 2001 (S. 350) would provide funding and changes to federal liability laws for hazardous waste cleanup in order to promote the cleanup and redevelopment of brownfields. The Senate passed the measure by a vote of 99-0. The House of Representatives is considering incorporating the Senate's bill with its own bill on liability relief—the Small Business Liability Protection Act (H.R. 1831).

In addition, 14 senators have requested that the President establish an interagency smart-growth working group, for example, to promote open space and farmland preservation, and to better link federal funds for highways and other development to state and local smart growth initiatives.

Conclusions

The general public may be more immediately concerned about the traffic congestion, long commutes to work, and the loss of open space that result from traditional patterns of development than about the impact of land use on air and water quality, but the issues are clearly interrelated. Alternative land use patterns—such as development around public transit or more pedestrian access to jobs and shopping—could help alleviate congestion (and emissions) and provide more open space, thereby improving air and water quality and reducing public health risks.

Nevertheless, even the localities most interested in better integrating land use decisions with environmental concerns may find this to be a daunting task. Collaboration among the different decisionmakers—MPOs, transportation planners, land use planners, and environmental officials—and taking a needed regional approach to solutions may be difficult to achieve. These officials often have few incentives to assess the environmental impacts of land use. The assessments are technically difficult, especially for smaller localities with limited resources. Some local land use decisionmakers may not be open to greater collaboration or to regional land use solutions to environmental problems that cross jurisdictional boundaries. Some states' and localities' outdated planning and other laws hinder the consideration of different land uses. In addition, some localities may not be interested in integrating land use and environmental decisions because they have not yet experienced the effects of uncontrolled growth. On the other hand, these localities stand to benefit the most from an integrated approach because they can still influence future growth in ways that address quality-of-life concerns while protecting the environment. Given these barriers, forging a stronger and more effective link between land use and environmental protection may not happen on a more widespread basis without additional federal support and incentives.

To some extent, federal laws and rules have served as an incentive for some states and localities to assess land use impacts. For example, requiring that transportation plans conform to vehicle emissions budgets appears to have served as an incentive for a number of MPOs to consider

land use. Future federal rules for controlling ozone, particulate matter, and nonpoint source water pollution, if implemented, may provide similar incentives. Beyond rules, however, the federal government has other mechanisms, such as financial incentives and technical support, that it can use to encourage collaboration on protective land use strategies.

To its credit, EPA has looked for ways within its existing authority and budget to provide states and localities with the assistance they need, and DOT has implemented a number of funding and technical initiatives to better link transportation and air quality protection. However, EPA's initiatives generally have not been comprehensive and have not reached a broad audience nationwide. DOT's initiatives generally have not provided an incentive to assess the impacts of different land uses on air quality as part of the transportation-planning process. By integrating its initiatives into a more cohesive strategy and better defining its approach and intended outcomes, EPA could better leverage its resources and achieve more progress. By better integrating land use considerations into its transportation-planning process, DOT could better promote air quality improvements. The Congress could also consider a number of financial incentives and legislative initiatives that would help to encourage greater assessments of the relationship between land use and environmental protection.

Recommendations for Executive Action

To better assist states and localities in considering and limiting, when possible, the environmental impacts of their land use decisions, we recommend that the Administrator, EPA, devise a more comprehensive and cohesive strategy for providing this assistance. This strategy should more clearly define the agency's role and the outcomes it will achieve in terms of environmentally protective land use practices. The strategy should also specify how the agency will use its program and regional offices and leverage its available resources to achieve the specified outcomes. The agency should use this strategy as the basis for justifying needed authority and funding to the Congress.

In devising this strategy, the agency should consider the following components:

- *Financial incentives*. These incentives should be targeted to help MPOs and environmental officials collaborate with local decisionmakers to limit the adverse environmental impacts of land use. The incentives could either be funding criteria that explicitly require the

consideration of the environmental impacts of land use or higher shares of funding for projects designed through a collaboration of MPOs, environmental officials, and communities that limit land use impacts. EPA should also provide financial incentives to encourage regional land use solutions to environmental problems—ones that take advantage of organizational structures already in place that include the transportation, air quality, water quality, and land use agencies necessary for this regional perspective. In providing these financial incentives, EPA should target a portion to those localities that have the most potential to achieve air and water quality benefits, such as localities that anticipate significant future growth.

- *Technical assistance*. If MPOs and environmental officials are expected to assess land use impacts, the agency should provide them with additional technical tools, such as more access to (1) technical staff, especially in the regions; (2) simpler and more user-friendly models, such as watershed models that better assess the cumulative impacts of land use, as well as land use models; and (3) water-quality-monitoring equipment, methods, and data, including data on biological indicators of water quality. The agency should also plan to better market these tools and educate the officials about them.
- *Public education*. If land use decisionmakers and the general public are to collaborate on new transportation and land use strategies that are environmentally sound, the agency should better educate them about these strategies. In doing so, the agency could expand its efforts to work with other organizations, such as federal housing and economic development or private-sector agencies that already outreach to local communities.

In addition, we recommend that the Administrator, EPA, review key rules and program activities—such as water infrastructure funding programs and TMDL requirements—to determine if they conflict with states' and localities' growth management efforts. The rules and programs might conflict by encouraging sprawl or by consuming disproportionate shares of available resources so that few are available to assess and mitigate land use impacts. The agency should also review these rules to determine if there are additional opportunities for states and localities to use land use as a means to comply with these rules.

Furthermore, we recommend that the Secretary of Transportation consider undertaking the following actions to encourage MPOs to assess the air quality impacts of different land uses when devising their transportation plans to help improve and preserve air quality:

- *Emissions data.* To help inform local land use decisionmakers of the air quality impacts of their plans and increase opportunities for collaboration on more protective land use strategies, the agency should encourage all MPOs to assess the emissions impacts of their transportation plans and provide these decisionmakers with the results. Smaller MPOs may need assistance from DOT or other sources to conduct these assessments.
- *Technical assistance.* To increase MPOs' technical capacity to assess land use impacts, the agency should provide them with tools, such as more access to (1) technical staff, especially for the smaller, less well-financed MPOs, and (2) transportation models that integrate land use planning and environmental protection.

Matters for Congressional Consideration

The Congress may wish to consider the following strategies for better assisting those states and localities that want to limit the environmental impacts of their land use decisions:

- Provide EPA with an explicit mission, necessary authority, and additional funding, if possible, to implement the strategy that it devises to more completely and effectively assist states and localities.
- In reauthorizing TEA-21, look for opportunities to use federal transportation funding as a means to encourage greater consideration of the environmental impacts of different land use strategies by (1) requiring such considerations as a part of the process to develop the transportation plan and TIP; (2) continuing but modifying funding programs already established to better link transportation and air quality so that they also integrate the consideration of impacts from different land use strategies, where appropriate; and (3) setting aside portions of federal transportation funds for projects that make this link, as well as helping to ensure that federal transportation funding does not conflict with efforts to control sprawl.
- Provide additional financial incentives: (1) provide federal agencies with greater discretion over a portion of their transportation or environmental funds to encourage assessment and mitigation of land use impacts on the environment; (2) provide states and localities with additional funds when possible to obtain the technical expertise, data, and analyses they need to assess land use impacts and mitigate adverse effects, as well as develop and implement TMDLs; and (3) use funds to encourage collaboration among transportation, environmental, and land use planners, especially in developing plans that consider regional land use impacts and solutions.

- Look for opportunities to encourage and assist interested localities to revise outmoded laws and ordinances that limit the consideration of more protective land uses, as the Congress proposes to do for states under the Community Character Act.

Agency Comments and Our Evaluation

We provided EPA and DOT with a draft of this report for review and comment. We subsequently met with or received comments from representatives of the following EPA offices:

- The Development, Community, and Environment Division within the Office of Policy, Economics, and Innovation.
- The Office of Air Quality, Planning, and Standards.
- The Office of Transportation and Air Quality.
- The Office of Wetlands, Oceans, and Watersheds.
- The Office of Wastewater Management.
- The Office of Ground Water and Drinking Water.

In general, EPA agreed with our conclusions and recommendations and said that they would be very helpful in guiding the agency's future smart growth initiatives. Representatives of the policy office suggested that we clarify that the Development, Community, and Environment Division has a defined mission to promote smart growth, both within and outside of the agency, as well as some dedicated but limited resources for this mission. As a result, the division has been able to have a somewhat more widespread or nationwide impact with some of its initiatives, such as its Smart Growth Network, publications, conferences, and partnerships with other organizations, than some of the program and regional offices. These offices do not have a similarly defined mission and resources, so they have pursued their own smart growth initiatives to varying degrees, resulting in more limited and nonstrategic efforts. We made this distinction where possible in the report.

Representatives of the air offices made the point that in addition to the effects discussed in the report, urban sprawl increases air pollution by (1) increasing commuting times, (2) clogging rural roads that were not built large enough to handle increasing traffic, and (3) resulting in dispersed population that makes it harder to take advantage of public transportation. Representatives of the water office pointed out that it is very important for EPA to encourage its program offices, as well as states and localities, to integrate their transportation, air quality, and water quality planning efforts. This is because land use can have a cumulative impact across both air and

water quality that states and localities need to consider and address in a more integrated manner. Each EPA office also suggested some technical changes throughout the report, which we have incorporated as appropriate.

Furthermore, we received comments from representatives of the Federal Highway and Transit Administrations within DOT, who generally agreed with our conclusions and recommendations. The DOT representatives also asked if we could provide additional examples of where MPOs were able to quantify or give the magnitude of the environmental benefits achieved from particular land use scenarios that they considered, but we do not have this type of anecdotal data from our nationwide survey results. In addition, the representatives suggested that the report should include a more in-depth discussion of the role of state governments and legislatures in promoting environmentally beneficial land use. While we acknowledge this role, an in-depth analysis of all 50 state governments was beyond the scope of our audit work for this assignment. However, we did include a discussion of how outmoded state planning laws can serve as a disincentive to pursuing protective land uses, as well as examples of where a few state governments have promoted such uses. Finally, the representatives also suggested some technical changes throughout the report, which we incorporated as appropriate.

Objectives, Scope, and Methodology

The Senate Smart Growth Task Force and the House Sustainable Development Caucus asked us to

- determine the extent to which metropolitan planning organizations (MPO) and state air quality managers responsible for meeting federal clean air requirements consider the impacts of alternative land uses on their efforts to protect air quality;
- determine how, if at all, state and local officials responsible for water quality and land use consider the water quality impacts of alternative land uses and work together to limit any adverse impacts; and
- identify the actions that the federal government can take to help transportation, air quality, and water quality officials better link land use decisions with environmental protection.

To address the first objective, we surveyed the 341 MPOs recognized by the Federal Highway Administration's Office of Metropolitan Planning and Programs.[1] MPOs are the entities responsible for transportation planning in areas with more than 50,000 people. (The Office of Metropolitan Planning and Programs is responsible for regulations, guidance, and policies pertaining to metropolitan transportation planning.) The survey included questions addressing transportation planning, land use assessments, and federal actions that could help MPOs assess alternative land use strategies when conducting transportation planning. In general, either the transportation planner or the executive director in each of the MPOs responded to the survey. The projects included in these plans contribute to the level of emissions from mobile sources in the area. We did not attempt to gain information from the state departments of transportation, which are responsible for transportation planning in those areas without a designated MPO. We also surveyed the 51 state air quality agencies (including the District of Columbia). To identify the most qualified person within the state air quality agencies to contact, we obtained a list from the Environmental Protection Agency's (EPA) Office of Transportation and Air Quality of those state officials responsible for preparing the State Implementation Plan (SIP). A SIP is a detailed description of the programs that a state will use to carry out its responsibilities under the Clean Air Act to reduce air pollution. The Office of Transportation and Air Quality is responsible for carrying out laws to control air pollution from motor vehicles. If the list did

[1] The list supplied to us had 345 listed MPOs; however, 5 subsequently contacted us to let us know that they are not the MPO for the area, and 1 contacted us to let us know it had split into 2 separate MPOs.

not identify a contact for preparing the SIP, we mailed the survey to the chief of the state's air quality division or other appropriate official.

To obtain the maximum number of responses to our survey, we mailed a prenotification postcard to all survey recipients about 1 week before we mailed the surveys. We also sent a reminder letter to nonrespondents about 4 weeks after mailing the initial survey and a replacement survey to those who had not responded about 8 weeks later.

We pretested the questionnaire with three state air quality agencies and nine metropolitan planning organizations in the states of Georgia, Maryland, Massachusetts, Pennsylvania, and South Carolina, as well as the District of Columbia. During these visits, we administered the survey and asked the officials to fill out the survey as they would if they had received it in the mail. After completing the survey, we interviewed the respondents to ensure that (1) the questions were clear and unambiguous, (2) the terms we used were precise, (3) the questionnaire did not place an undue burden on the agency officials completing it, and (4) the questionnaire was independent and unbiased. We had a high response rate for our surveys: 87 percent (295) of the 341 MPOs surveyed and 92 percent (47) of the 51 air quality agencies surveyed.[2] The states not responding were Arizona,[3] California, Massachusetts, and New York. The results from the surveys of MPOs and the state air quality managers are presented in appendixes II and III.

To analyze those MPOs in the areas that expect significant growth in the future, we merged the MPO survey data with data from our previous study of local growth issues, conducted from January through March 2000.[4] In that study, we identified 768 counties of the 3,141 nationwide as being located in metropolitan areas.[5] These counties were asked to provide information on the expected change in their community's population over the next 10 years. Using 1990 Federal Information Processing Standards

[2] The Nevada Division of Environmental Protection, Bureau of Air Quality, has air quality authority over the state, except for Clark and Washoe Counties, and responded accordingly. These two counties have established air quality programs they control independent of the state.

[3] Arizona chose not to respond to the survey because the Department of Environmental Quality doesn't have authority to prepare the SIP in all nonattainment areas.

[4] See *Community Development: Local Growth Issues—Federal Opportunities and Challenges* (GAO/RCED-00-178, Sept. 6, 2000).

codes, we ascertained that 546 of these counties were also counties represented by MPOs responding to our current survey.[6] We were therefore able to compare for each of these counties how it responded to our survey on the air quality impacts of growth and whether it expected future growth. For the purpose of this report, we included only those counties responding that they expect their community's population to increase greatly over the next 10 years. The questionnaire item used from the local growth survey is reproduced in appendix IV.

In classifying MPOs as being in areas of "attainment" or "nonattainment" for air quality standards, we referred to their responses in our questionnaire, asking whether any portion of the geographic area covered by the MPO is in nonattainment, maintenance, or attainment for each criteria pollutant listed. MPOs responding "attainment" for all six pollutants were classified as being in an "area without an air quality problem." Those responding "nonattainment" or "maintenance" for at least one of the pollutants were classified as being in an "area with an air quality problem." Because conformity is required of only those areas in nonattainment for ozone, carbon monoxide, particulate matter, and nitrogen dioxide, we confirmed that those classified as being an area with an air quality problem were in nonattainment or maintenance for at least one of these four pollutants. If the MPO responded "uncertain" to the classification for any of the four pollutants, we classified the MPO on the basis of EPA's designations as of January 29, 2001.

For our analysis of the anticipated impact of the 8-hour ozone standard, we used a database containing the counties currently violating the 1-hour standard and expected to violate the 8-hour standard supplied by EPA's Air Quality Strategies and Standards Division. We did not independently verify these data. EPA's estimate of the number of counties likely to be in violation of the 8-hour ozone standard is based on 3 years of 8-hour monitoring data during 1997 through 1999. The 1-hour ozone data include counties in violation of the standard as of January 29, 2001.

[5] Initially, 848 counties were identified as being located in metropolitan areas, however because some counties were part of combined city/county governments that operated as cities, have no county government, or perform very limited functions, they were removed from the list of counties surveyed. Many of the counties eliminated were located in the New England area.

[6] Federal Information Processing Standards codes provide unique codes for U.S. states, counties, populated places, primary county divisions, and other locational entities, as well as for other countries.

To address this objective, we also interviewed cognizant officials and collected documented studies from the federal agencies administering air quality and transportation programs, as well as from relevant stakeholders. Specifically, we interviewed and gathered documentation from (1) EPA program managers in the Office of Air, Office of Transportation and Air Quality, and Office of Policy, Economics, and Innovation; (2) the Department of Transportation's (DOT) program managers in the Federal Highways Administration, including the Office of Metropolitan Planning and Programs, the Office of Natural Environment, and the Office of Human Environment, and in the Federal Transit Authority's Office of Planning; and (3) relevant stakeholders, including the following—the Association of Metropolitan Planning Organizations, National Association of Counties, Northeast-Midwest Institute, National Association of Regional Councils, National League of Cities, National Governors' Association, and the State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials.

To address the second objective, we identified and solicited information from a panel of experts. We used an iterative process (often referred to as the "snowball" technique) to identify potential members for the panel. We first contacted water quality program managers from EPA's Office of Wetlands, Oceans, and Watersheds; senior officials with organizations that specialize in urban development and policy issues, such as the American Planning Association and the Urban Land Institute; and environmental law and urban policy experts from universities and policy think tanks, such as George Washington University's Law School and the Brookings Institute. We spoke with these people first because, according to our literature reviews and agency contacts, they had principal responsibility for or major interest in addressing water quality and/or land use issues. We asked them to identify three to five nationally recognized experts each in the fields of water quality management and land use planning. We then asked each of these experts to also identify three to five experts. We also conducted extensive searches of the relevant literature to identify candidates. At the conclusion of this process, we had identified 126 individuals.

To select individual panelists from this pool, we applied a predetermined set of criteria. These criteria included (1) area of expertise—to provide adequate coverage of representatives from the major disciplines, such as water scientists and managers, land use planners, legal specialists, and economists; (2) the number of times an individual was recommended as an indicator of how well the person was known as a recognized expert in a particular field; and (3) professional affiliation—to ensure adequate

coverage of the key stakeholder groups that we identified, including federal agencies, academic institutions, state and local practitioners, private consulting firms, and nongovernmental organizations. This process resulted in the selection of 38 experts for the panel that included a cross section of the various stakeholder groups and specialties. The selection process maximized the chances of selecting panelists that represent the broadest possible range of expert opinions and perspectives associated with urban sprawl and smart growth. The names and professional affiliations of the individuals selected can be found in appendix VI.

To collect data from the panel, we used a modified Delphi technique. This method allowed us to systematically gather the experts' views by using an iterative controlled feedback process.[7] An alternative to in-person discussion, Delphi avoids biasing effects, such as the dominance of a few individuals as well as group pressure for conformity that can occur in live group settings.[8] As part of the controlled feedback process, we employed an iterative set of questionnaires using Internet-based technology. This technique allowed us to examine the opinions of more experts than logistically possible from a live panel.

During the first iteration, we obtained each expert's responses to an open-ended questionnaire. We asked panelists the following:

- What strategies and practices do states and localities use to assess and mitigate impacts of land use on water quality in their decision making processes?
- What were the barriers that limited this sort of consideration, and what incentives might there be to promote consideration?
- What could the federal government do to promote the linkage between land use and water quality protection?

After the first iteration was completed, we performed a content analysis on the responses to the open-ended questions in order to (1) summarize the responses for the second iteration and (2) identify unique responses or positions relevant to the issues involved. To maintain standards of methodological integrity, we performed a content reliability check on a

[7] See Harold A. Linstone and Murray Turoff, eds., *The Delphi Method: Techniques and Applications* (Reading, Mass.: Addison-Wesley Publishing Co., 1975).

[8] See James Wright, "Delphi--Systematic Opinion-Gathering," *The GAO Review* (1972).

random set of these summaries. This process resulted in a list of items that best represented the range of expert views derived from the open-ended responses of the first iteration.

We presented these results to the experts in a second questionnaire and asked them to evaluate and score the list of items on several dimensions. These dimensions, arrayed along a five-point scale, included feasibility, importance, and effectiveness. We analyzed descriptive statistics (means, medians, standard deviations, and frequencies) on each item in order to assess the relative cohesiveness of group opinion on each response to the second questionnaire. This analysis demonstrated a high level of agreement on virtually all of the items. Furthermore, there was no significant difference among experts on the basis of their professional affiliation. Because of the high level of agreement, we determined that it was unnecessary to conduct additional iterations in order to achieve consensus. We determined the group position on each item by calculating the average response. We chose not to use the median to identify the group opinion on each item because there was very little differentiation among responses on the basis of the median, and our analysis showed that the substantive conclusions would not change, in any case. The response rate for the first and second iterations was 84 and 76 percent, respectively. The number of experts not responding to the questionnaires was relatively evenly distributed across both the categories of professional affiliation and area of expertise; thus, the nonresponses do not diminish the representativeness of expert opinions across these groups. (See tables 5 and 6.)

Table 5: Numbers of Experts Who Participated in Each of the Survey Iterations, by Professional Affiliation

Affiliation	Number of experts selected and who agreed to participate	Number of experts who responded to iteration 1 of the survey	Number of experts who responded to iteration 2 of the survey
Federal agencies	7	7	5
Academic institutions	11	9	9
Practitioners (state and local agencies, and private organizations)	13	10	10
Nongovernmental organizations	7	6	5
Total	**38**	**32 (84%)**	**29 (76%)**

Table 6: Numbers of Experts Who Participated in Each of the Survey Iterations, by Area of Expertise

Specialization	Number of experts selected and who agreed to participate	Number of experts who responded to iteration 1 of the survey	Number of experts who responded to iteration 2 of the survey
Water quality	24	20	18
Land use planning	6	5	4
Economics	6	5	5
Law	2	2	2
Total	**38**	**32 (84%)**	**29 (76%)**

To address this objective, we also obtained information on nonpoint source water pollution and related matters as well as on state and local nonpoint source control activities from officials of EPA, the U.S. Geological Survey (USGS), and the National Oceanic and Atmospheric Administration (NOAA) and from state government agencies; and from representatives of a range of associations and nongovernmental organizations. We also obtained information from documents, case studies, and reports prepared by federal and state agencies, environmental organizations, associations of state and local environmental officials, universities, research organizations, and other relevant stakeholders concerned with watershed and water quality protection issues. Specifically, we interviewed and gathered documentation from the following:

- EPA's program officials in the Office of Wetlands, Oceans, and Watersheds and the Office of Policy, Economics, and Innovation.
- USGS officials in the Water Resources Division, including the National Water Quality Assessment Program; in the National Mapping Information Division, including the Urban Dynamic Research Program and the Land-Use Trend Program; in the Biological Resources Division; and with the Mid-Atlantic Federal Partners for the Environment.
- NOAA program managers in the National Ocean Service, including the Office of Coastal Management and the Coastal Nonpoint Pollution Division.
- Relevant stakeholders, such as the Center for Watershed Protection, Northeast-Midwest Institute, National Governors' Association, and the Association of State and Interstate Water Pollution Control Administrators.

To address the third objective, we included in our survey of MPOs and state air quality managers questions concerning federal actions that could help them assess alternative land use strategies when developing transportation or air quality plans. For water quality, we used information derived from the relative rankings of items in the second iteration questionnaire completed by the expert panel. In addition, to determine what federal actions were already under way to promote the linkage between land use and environmental quality, we conducted interviews with and collected documentation from the relevant federal agencies about current programs and initiatives. These agencies included DOT, EPA, NOAA, and USGS. We recognize that other federal agencies may have activities related to land use and environmental quality, such as the Department of Agriculture; however, these activities were outside the scope of this report. Additionally, we collected and reviewed a wide range of documents from organizations, including independent research institutions, universities, nongovernmental organizations, and public policy organizations. We also drew on our own prior work on related issues. A list of these reports can be found in the section entitled "Related GAO Products." To address relevant legislative requirements, we reviewed applicable sections of the Clean Air Act, Clean Water Act, Coastal Zone Management Protection Act, and Transportation Equity Act for the 21st Century, as well as related implementing regulations.

In addition, to determine the human health and environmental effects resulting from air and water quality impairments linked to the prevailing patterns of growth and development, we conducted interviews with, and collected documentation and studies from, federal agencies. In addition, we reviewed published studies and other information on growth-related

issues and articles from the scientific literature on air and water quality impacts from land use. For example, we reviewed key studies, such as *Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality* (231-R-01-002) by EPA, *The Practice of Watershed Protection* by the Center for Watershed Protection, and various USGS National Water Quality Assessment program reports. We did not independently assess the validity of the research.

We performed our work from September 2000 to September 2001 in accordance with generally accepted government auditing standards.

Results From Survey of States on Air Quality Planning

This appendix includes the questions and responses from our survey of metropolitan planning organizations. Responses are expressed as the number of states responding to the survey.

United States General Accounting Office

GAO

Survey of States on Air Quality Planning

INTRODUCTION

The U.S. General Accounting Office is an agency that gathers and analyzes information for the Congress. We are currently reviewing what effects certain patterns of land development have on air quality and whether states consider these effects when they conduct their air quality planning. As part of our review, we are surveying state officials who are responsible for preparing the State Implementation Plan (SIP).

Your participation in our study is essential for us to provide the Congress with a complete, national summary of state activities. Please complete and return your survey within 10 days of receiving it, if at all possible. This will help us provide a timely report to the Congress. We have provided a postage-paid, return-mail envelope for your convenience. If the envelope is missing or misplaced, please return your completed survey to

Elizabeth Erdmann
U.S. General Accounting Office
441 G Street, N.W. Room 2T23
Washington, D.C. 20548

If your response will be delayed or you have any questions, please call Elizabeth Erdmann, tollfree, at 1-877-711-8101 (email: erdmanne@gao.gov).

Thank you for your cooperation.

1. Please identify the person who completed the questionnaire and should be contacted in the event that we need to clarify responses.

Name_____

Title _____

Address _____

City, state, zip _____

Telephone _____

Email _____

1

AIR QUALITY PLANNING

2. Please answer two questions about each of the types of programs listed below:

A. Is this type of program in use or being implemented in your state? *(Check one for each.)*

B. Did your state obtain emissions credit for this type of program in a SIP through one of the listed SIP credit mechanisms? *(Check one for each.)*

1(4-41)

	A. Implemented			B. SIP Credit Mechanism			
Type of Program	Yes (1)	No (2)	Do not know (3)	Trans-portation Control Measures (4)	Voluntary Mobile Source Reductions (5)	Economic Incentive Program (6)	No SIP credit (7)
1. Mass transit improvement	35	10	1	9	1	0	25
2. Commuter choice or transit subsidy	23	18	4	4	3	0	16
3. High occupancy vehicle (HOV) lanes	16	31	0	5	0	0	11
4. Carpool or shared ride services	37	10	0	5	2	0	30
5. Telecommuting	20	21	5	1	3	0	16
6. Ozone action program or other episodic emissions control	29	17	0	1	6	0	22
7. Roadway tolls	14	33	0	0	0	0	13
8. Accelerated vehicle retirement programs	4	40	3	0	2	0	1
9. Bicycle and pedestrian programs	35	11	1	6	0	0	29
10. Congestion pricing	1	39	6	0	0	0	1
11. Intelligent transportation systems (e.g., electronic toll collection; synchronized traffic signals)	34	12	1	7	1	0	25
12. Traffic flow improvement (e.g., converting 2-way streets to 1-way to improve corridor travel times; on-ramp metering)	26	13	7	4	2	0	19
13. Inspection/maintenance (I/M) programs	29	18	0	20	3	0	4
14. Reformulated fuel usage	23	24	0	16	2	0	3
15. Vehicle emissions technology (e.g., retrofits for buses)	18	23	5	3	2	0	13
16. Low or zero-emissions equipment	16	25	6	5	1	0	10
17. Alternative fuel vehicles	35	10	1	3	3	0	29
18. Public education or outreach programs	40	6	0	3	4	0	33
19. Other *(Please specify.)*							

2

3. Consider the types of programs listed in Question 2 that are in use or being implemented in your state, but for which you did not obtain SIP credit. Which, if any, of the following reasons explains why you did not obtain emissions credit in a SIP for these types of programs? *(Check all that apply.)*

(42-56)

22 We do not need SIP credit.

6 It is unclear how we can get credit for these programs using the Voluntary Mobile Source Emissions Reductions Program.

4 It is unclear how we can get credit for these programs using the Economic Incentive Program.

24 Emissions reductions are difficult to quantify for inclusion in a SIP.

3 We do not have the technical capability to perform the analyses required in order to obtain SIP credit.

17 Potential emissions reductions are too small to make a difference.

13 We are concerned about the consequences if we fail to achieve the projected emissions reductions.

17 We are not able to regulate or enforce the use of these types of programs so that projected emissions reductions are achieved.

10 We do not have the resources to commit to these programs.

16 We are reluctant to include in a SIP a program that would require a funding commitment that continues indefinitely.

9 We are reluctant to take credit now because we might have a greater need to take credit for these programs in the future.

7 Other *(Please specify.)*

4. How likely or unlikely is it that your state will seek emissions credit in future SIPs for the types of programs listed in Question 2? *(Check one.)*

(57)

6 Very likely

22 Somewhat likely

5 Just as likely as not

5 Somewhat unlikely

6 Very unlikely

2 No basis to judge

DEMONSTRATING CONFORMITY

5. How concerned is your state, if at all, about demonstrating conformity when you prepare a SIP? *(Check one.)*

(58)

14 Extremely concerned →Skip to Question 7.

11 Greatly concerned →Skip to Question 7.

4 Moderately concerned →Skip to Question 7.

7 Somewhat concerned →Skip to Question 7.

10 Not at all concerned →Please continue.

6. Which, if any, of the following reasons explains why demonstrating conformity is not a concern when you prepare a SIP? *(Check all that apply.)*

(59-62)

9 Our state is in attainment for all National Ambient Air Quality Standards (NAAQS) criteria pollutants and we do not have to demonstrate conformity.→Skip to Question 11

2 Conformity is the responsibility of the metropolitan planning organizations.

0 Our mobile source emissions are significantly below the mobile source budget.

0 Other *(Please specify.)*

3

7. Listed below are statements that, if true, could interfere with your state's ability to demonstrate conformity. Please indicate whether or not the situation is true in your state. Then, if true, rate how much, if at all, each interferes with your state's ability to demonstrate conformity. *(Check if true or not true; then, if true, check one rating for each statement.)*

(63-80)

				Interferes with Conformity					
	True in our state (1)	Not true in our state (2)	Do not know (3)	Little or not at all (4)	Somewhat (5)	Moderately (6)	Greatly (7)	Very greatly (8)	Do not know (9)
1. Changing the mix of transportation projects does not significantly reduce emissions.	14	9	13	5	5	2	0	1	0
2. We expect mobile source emissions to increase at some point after the air quality attainment date, but our mobile source emissions budget is not allowed to increase beyond that date.	16	14	8	1	6	3	2	2	1
3. The requirement to quantify emissions reductions discourages consideration of innovative programs whose air quality benefits cannot be quantified.	13	16	7	6	4	2	0	1	0
4. Mobile emissions model assumptions used to develop the SIP (e.g., vehicle registrations or population) differ from those used in the most recent conformity determination.	14	17	6	1	3	5	1	1	1
5. Knowledge or concern among the general public about the air quality effects of their transportation choices is limited.	28	5	4	5	7	8	4	1	1
6. Our communication with state and/or regional transportation planners is poor.	4	34	0	0	2	0	1	0	0
7. Certain land uses can negatively affect regional air quality, but land use decision makers are not systematically involved in the conformity process.	26	8	4	3	6	11	3	0	2
8. Controlling emissions requires a regional focus, but land use decision makers primarily consider local needs.	26	5	7	4	3	12	4	1	1
9. Other *(Please specify.)*	4	0	0	0	1	0	0	2	0

4

8. In your opinion, how much, if at all, would each of the following help your state demonstrate conformity? *(Check one for each.)*

2(4-10)

	Hardly or not at all help (1)	Somewhat help (2)	Moderately help (3)	Greatly help (4)	Very greatly help (5)	No opinion (6)
1. Relax the requirement to quantify emissions reductions for innovative programs whose emissions are difficult to quantify.	12	10	7	4	1	4
2. Provide technical assistance and training to help transportation planners understand the mobile emissions model.	8	13	6	7	2	2
3. If the mobile emissions model assumptions used to develop the SIP (e.g., vehicle registrations, population data) are not the same as those used in the most recent conformity determination, require that state air quality planners assess whether the mobile source emissions budget should be revised.	12	9	4	2	2	8
4. Provide public education about the relationship between air quality and transportation choices.	6	11	10	6	4	1
5. Provide an incentive for improved communication between air quality and transportation planners.	8	11	9	3	4	3
6. Increase the involvement of land use decision makers in the conformity process.	4	10	10	10	3	1
7. Other *(Please specify.)*	0	0	0	0	3	1

5

9. Currently, MPOs are required to demonstrate conformity for the duration of the long-term transportation plan. If there was an opportunity to change this requirement, which of the following would you prefer? *(Check one.)* (11)

14 Match the time frame for which conformity must be demonstrated to the time frame an area is given to attain or maintain air quality standards.

5 Make the time frame for which conformity must be demonstrated equal to the time frame an area is given to attain air quality standards plus a period of _____ years. *(Enter number of years preferred.)* (12-13)

4 Reduce the time frame for which conformity must be demonstrated to _____ years. *(Enter number of years preferred.)* (14-15)

13 Keep the current requirement.

1 Other *(Please specify.)* (16)

1 No preference

10. In your experience, how effective or ineffective has the conformity process been in helping your state achieve air quality standards? *(Check one.)* (17)

3 Very effective

8 Generally effective

11 Equally effective and ineffective

4 Generally ineffective

8 Very ineffective

4 No basis to judge

ASSESSING AIR QUALITY IMPACTS FROM LAND USE

11. Although you are not required to, has your state air quality office participated or do you expect to participate in assessing the effects of alternative land use strategies (such as mixed-use, infill, or transit-oriented development) on air quality? *(Check one.)* (18)

15 Yes →Skip to Question 16.

32 No →Please continue.

12. Which, if any, of the following reasons explains why your state has not participated in assessing the effects of alternative land use strategies on air quality? *(Check all that apply.)* (19-33)

General Reasons

9 We are in attainment for all NAAQS criteria pollutants and do not need to assess the impacts of land use strategies.

18 We are not required to assess land use strategies.

0 Land use in our area is established for years into the future and few alternative land uses are possible.

21 Land use is a local decision and we have limited ability to influence it.

19 We do not have collaborative working relationships with land use decision makers.

2 We only assess the strategies under consideration by land use planners and they are not considering these alternative land use strategies.

12 We have limited or no funding for transportation projects related to the alternative land use strategies.

3 Vehicle emissions are not a primary contributor to our air quality attainment problems.

Technical Limitations

12 We are unable to quantify the impacts of alternative land uses on vehicle miles traveled, congestion, or travel time.

16 We do not have staff with the technical expertise needed to analyze the impacts of alternative land uses on vehicle miles traveled, congestion, or travel time.

10 We do not have the modeling capability needed to assess the impacts of alternative land uses.

2 Other *(Please specify.)*

6

13. In your opinion, which, if any, of the following changes would provide an incentive for your state to assess the potential impacts on air quality from alternative land use strategies? *(Check all that apply.)* (34-40)

15 Opportunity to take credit in the SIP for emissions reductions from alternative land uses.

16 Requirement that states assess alternative land use strategies when they develop air quality plans

16 More direct working relationships between the state air quality office and land use decision makers

18 Additional technical assistance in quantifying emissions reductions directly from alternative land use strategies

22 Additional resources to analyze air quality impacts from alternative land use strategies

0 Other *(Please specify.)*

4 None of the above

14. In January 2001, the Environmental Protection Agency (EPA) issued guidance entitled "Improving Air Quality Through Land Use Activities" that explains how the emissions benefits of alternative land use strategies can be used to obtain SIP credit. How familiar is your state air quality office, if at all, with this guidance? *(Check one.)* (41)

16 Hardly or not at all familiar

13 Somewhat familiar

1 Moderately familiar

0 Greatly familiar

0 Extremely familiar

15. In your opinion, how likely or unlikely is it that your state will begin to consider the effects of alternative land use strategies on air quality because of the opportunity to take credit in your SIP for resulting emissions reductions? *(Check one.)* (42)

0 Very likely

1 Likely

5 Just as likely as not

14 Unlikely

8 Very unlikely

2 No opinion

16. Who, if anyone, among the following have participated with your office in assessing the effects of alternative land use strategies on air quality? *(Check all that apply.)* (43-53)

36 Have not yet assessed alternative land use strategies →Skip to Question 28.

7 Other staff in the state air quality planning department

8 Regional land use planners

7 Local land use decision makers

9 Metropolitan planning organizations

7 State department of transportation

6 U.S. Environmental Protection Agency (EPA) or EPA regional office

7 External stakeholders, such as community groups

2 Other *(Please specify.)*

0 None of the above

7

17. Which, if any, of the following land use strategies has your state had a role in assessing for their effects on air quality? *(Check all that apply.)*

(54-66)

5 Transit-oriented development (i.e., encourage transit travel by increasing housing, retail, and employment density along or around a regional transit system)

8 Infill development, including brownfields (i.e., new development in already developed areas, some of which are underutilized or abandoned industrial lands that require cleanup)

5 Mixed-use development (i.e., colocate complementary land uses, such as housing, retail, office, services, and public facilities within walking distance of each other)

6 Downtown redevelopment (i.e., make central business districts areas of concentrated activity)

3 Jobs/housing balance (i.e., encourage new businesses to locate in areas with housing and vice versa)

7 Pedestrian/bicycle projects (i.e., provide more direct routes between locations, thus encouraging pedestrian and bicycle travel)

5 Strategic parking (i.e., encourage nonautomobile travel by limiting the parking supply, creating park-and-ride lots, etc.)

6 Open space preservation (i.e., use conservation easements and/or tax incentives; purchase development rights)

5 Concentrated corridor development (i.e., focus development along major existing transportation corridors)

1 Other *(Please specify.)*

1 None of the above →Skip to Question 28.

18. Has your state ever changed a SIP as a result of assessments of the effects of alternative land use strategies on air quality? *(Check one.)*

(67)

2 Yes →Please continue.

8 No →Skip to Question 20.

0 Do not know →Skip to Question 21.

19. In which, if any, of the following ways did a SIP change as a result of assessments of the effects of alternative land use strategies on air quality? *(Check all that apply.)*

(68-72)

1 We added more transportation control measures to allow for growth in vehicle miles traveled.

1 We altered SIP emissions budgets by increasing mobile source emissions budgets and decreasing point and area source budgets.

1 We attempted to take credit for emissions reductions from alternative land uses.

0 Other *(Please specify.)*

0 Do not know

20. Which, if any, of the following reasons explains why SIPs did not change as a result of assessments of the effects of alternative land use strategies on air quality? *(Check all that apply.)*

(73-80)

0 The process for changing SIPs was too cumbersome.

3 We were not able to enforce land use decisions to achieve the projected emissions reductions.

3 We wished to avoid the consequences of not achieving the projected emissions reductions.

3 The time frame needed to realize emissions reductions from land use strategies is longer than the time frame to achieve attainment in SIPs.

1 We were unable to quantify the emissions reductions from alternative land use strategies.

5 Emissions reductions achieved by different land use strategies were too small to make a difference.

2 Other *(Please specify.)*

0 Do not know

8

21. To the best of your knowledge, has a transportation plan ever changed as a result of assessments of the effects of alternative land use strategies on air quality? *(Check one.)*

3(4)

___3___ Yes →Please continue.

___5___ No →Skip to Question 23.

___2___ Do not know →Skip to Question 24.

22. In which, if any, of the following ways did a transportation plan change as a result of assessments of the effects of alternative land use strategies on air quality? *(Check all that apply.)*

(5-12)

___2___ More public transit projects (e.g., buses, train, light rail) were included.

___2___ More carpool, high occupancy vehicle (HOV) lanes, and/or shared ride services were included.

___2___ Traffic flow improvement projects were added.

___3___ Pedestrian/bicycle programs were added.

___2___ Intelligent transportation systems were included.

___2___ Public education or outreach programs were included.

___0___ Other *(Please specify.)*

___0___ Do not know →Skip to Question 24.

23. Which, if any, of the following reasons explains why transportation plans did not change as a result of assessments of the effects of alternative land use strategies on air quality? *(Check all that apply.)*

(13-21)

___3___ Changing the mix of transportation projects did not result in significant decreases in emissions.

___1___ SIP emissions budgets were altered by increasing mobile source emissions budgets and decreasing point and area source budgets.

___2___ Improvements in vehicle emissions technology achieved the necessary emissions reductions so transportation plans did not have to change.

___2___ Improvements in fuel technology achieved the necessary emissions reductions so transportation plans did not have to change.

___1___ Political considerations prohibited changing transportation plans.

___1___ There was a lack of public support for the transportation options associated with the alternative land use strategies.

___0___ The cost of the mix of projects from the alternative land use strategies was too high for us to pursue them.

___2___ Other *(Please specify.)*

___2___ Do not know

24. To the best of your knowledge, has a land use plan or local zoning ever changed as a result of assessments of the effects of alternative land use strategies on air quality? *(Check one.)*

(22)

___4___ Yes →Please continue.

___4___ No →Skip to Question 26.

___2___ Do not know →Skip to Question 27.

9

25. Which, if any, of the following alternative land use strategies were substituted, included, or designated by zoning as a result of assessments of their effects on air quality? *(Check all that apply.)*

(23-35)

2 Transit-oriented development (i.e., encourage transit travel by increasing housing, retail, and employment density along or around a regional transit system)

1 Infill development, including brownfields (i.e., new development in already developed areas, some of which are underutilized or abandoned industrial lands that require cleanup)

1 Mixed-use development (i.e., colocate complementary land uses, such as housing, retail, office, services, and public facilities within walking distance of each other)

1 Downtown redevelopment (i.e., make central business districts areas of concentrated activity)

1 Jobs/housing balance (i.e., encourage new businesses to locate in areas with housing and vice versa)

2 Pedestrian/bicycle projects (i.e., provide more direct routes between locations, thus encouraging pedestrian and bicycle travel)

2 Strategic parking (i.e., encourage nonautomobile travel by limiting the parking supply, creating park-and-ride lots, etc.)

1 Open space preservation (i.e., use conservation easements and/or tax incentives; purchase development rights)

2 Concentrated corridor development (i.e., focus development along major existing transportation corridors)

1 Other *(Please specify.)*

0 Do not know →Skip to Question 27.

26. Which, if any, of the following reasons explains why land use plans or zoning did not change as a result of assessments of the effects of alternative land use strategies on air quality? *(Check all that apply.)*

(36-44)

1 There was a lack of public support for the alternative land use strategies.

2 Political considerations prohibited changes in land use plans.

3 Land use is a local decision and we have limited ability to influence it.

3 We do not have collaborative working relationships with land use decision makers.

1 Land use in certain areas of our state is established for years into the future and few alternative land uses are possible.

5 Factors other than air quality, such as economic development needs, have greater influence on land use plans.

0 We are unable to quantify the effects of alternative land use strategies on air quality.

1 Other *(Please specify.)*

1 Do not know.

EMISSIONS CREDIT FOR LAND USE

27. In January 2001, the Environmental Protection Agency (EPA) issued guidance entitled "Improving Air Quality Through Land Use Activities" that explains how the emissions benefits of alternative land use strategies can be used to obtain SIP credit. How familiar is your state air quality office, if at all, with this guidance? *(Check one.)*

(45)

0 Hardly or not at all familiar

4 Somewhat familiar

1 Moderately familiar

2 Greatly familiar

1 Extremely familiar

10

28. In your opinion, how likely is it that you will seek emissions credit for each of the following land use strategies in future SIPs as a result of EPA's January 2001 guidance? *(Check one for each.)* (46-55)

	Will definitely use for credit as a result of EPA's guidance (1)	Will definitely use for credit, but not as a result of EPA's guidance (2)	Will probably use for credit as a result of EPA's guidance (3)	Will probably use for credit, but not as a result of EPA's guidance (4)	Unsure if we will use for credit (5)	Will probably not use for credit (6)	Will definitely not use for credit (7)
1. Transit-oriented development (increase housing, retail, and employment density along or around a regional transit system)	1	2	3	1	24	9	7
2. Infill development, including brownfields (new development in already developed areas, including underutilized or abandoned industrial lands that require cleanup)	0	2	4	2	22	10	7
3. Mixed-use development (colocate housing, retail, employment, etc. within walking distance of each other)	0	2	3	2	24	10	6
4. Downtown redevelopment (make central business districts areas of concentrated activity)	0	1	3	3	25	10	5
5. Jobs/housing balance (encourage new businesses to locate near housing and vice versa)	0	1	3	1	24	10	7
6. Pedestrian/bicycle projects	0	3	2	9	19	11	2
7. Strategic parking	0	1	2	9	22	8	4
8. Concentrated corridor development (focus development along major existing transportation corridors)	0	1	1	1	26	11	5
9. Other *(Please specify.)*							

29. Have you ever tried to seek emissions credit in a past SIP for emissions reductions from land use strategies? *(Check one.)* (56)

3 Yes

38 No

11

30. To what extent, if at all, would each of the following federal actions help your state to assess alternative land use strategies when conducting air quality planning? *(Check one for each.)* (57-64)

	Help little or not at all (1)	Somewhat help (2)	Moderately help (3)	Greatly help (4)	Very greatly help (5)	Uncertain (6)
1. Provide flexible sources of funding for research on the relationships among land use, transportation, and air quality.	3	10	10	15	2	7
2. Document and publicize case studies and best management practices that show how changes in land use, such as infill or mixed-use development, have affected vehicle emissions.	6	7	16	9	4	4
3. Develop programs to educate local governments and the general public on the relationships among land use, transportation, and air quality.	1	15	10	13	4	4
4. Provide incentives (e.g., financial, regulatory flexibility, technical assistance) to encourage land use and transportation planners to collaborate on projects that convey air quality benefits.	3	7	11	14	6	6
5. Ensure that federal funding (e.g., transportation, housing, community development) and activities (e.g., location of federal facilities, such as post offices) are consistent with state and local growth management initiatives.	4	7	11	11	7	7
6. Assume a higher share of the costs for transportation projects that minimize environmental effects when it is difficult for local governments to cover their share.	3	2	13	13	8	8
7. Develop guidance on how to design and implement land use strategies that reduce vehicle miles traveled and/or congestion.	2	10	7	19	4	5
8. Other *(Please specify.)*					2	

12

STATE AIR QUALITY

31. In your state, approximately what percentage of NOx, VOC, and carbon monoxide emissions comes from each of the following sources? *(Enter percentage for each.)* (65-73)

NOx Emissions (Average)

40 % Point sources

38 % On-road mobile sources

23 % All other sources (e.g., off-road mobile sources, area sources)

100 % TOTAL NOx emissions 4(4-12)

VOC Emissions (Average)

19 % Point sources

31 % On-road mobile sources

51 % All other sources (e.g., off-road mobile sources, area sources)

100 % TOTAL VOC emissions (13-21)

Carbon Monoxide Emissions (Average)

11 % Point sources

62 % On-road mobile sources

28 % All other sources (e.g., off-road mobile sources, area sources)

100 % TOTAL Carbon monoxide emissions

32. Please rank the following sources of emissions from first to third in terms of how difficult they are to control in your state. Use 1 for the source of emissions that is the **most difficult** to control, 2 for the second most difficult, and 3 for the third most difficult. *(Enter number for each.)* (22-24)

Ranked 3rd A. Point sources

Ranked 2nd B. On-road mobile sources

Ranked 1st C. All other sources (e.g., off-road mobile sources, area sources)

33. To what extent, if at all, does ozone transport from other states contribute to air quality problems in your state? *(Check one.)* (25)

9 Little or no extent

8 Some extent

8 Moderate extent

7 Great extent

11 Very great extent

4 Do not know

13

34. Are any areas in your state currently in nonattainment or maintenance status, or is your entire state in attainment status for each of the following NAAQS criteria pollutants? *(Check all that apply.)* (26-49)

Pollutant	Nonattainment (1)	Maintenance (2)	Attainment (3)	Uncertain (4)
1. Ozone (1-hour standard)	21	20	22	2
2. Carbon monoxide	7	18	32	0
3. Particulate matter (PM-10)	15	7	31	0
4. Nitrogen dioxide	0	1	40	2
5. Lead	2	5	38	2
6. Sulfur dioxide	9	4	38	1

35. If you have any case studies or examples of how your state is considering land use strategies in your air quality planning, please provide them in the space below or attach additional pages. (50)

Thank you for your cooperation.

14

Results From Survey of Metropolitan Planning Organizations on Transportation Planning

This appendix includes the questions and responses from our survey of metropolitan planning organizations. Responses are expressed in percentage of those responding to the survey.

United States General Accounting Office

GAO

Survey of Metropolitan Planning Organizations on Transportation Planning

INTRODUCTION

The U.S. General Accounting Office is an agency that gathers and analyzes information for the Congress. We are currently reviewing what effects certain patterns of land development have on air quality and whether local communities consider these effects when conducting their air quality and transportation planning. As part of our review, we are asking all metropolitan planning organizations (MPOs) to complete the attached questionnaire.

Your participation in our study is essential for us to provide the Congress with a complete, national summary of MPO activities. One of the survey topics concerns modeling. If you are not the person who does the modeling, please coordinate your responses to the modeling questions with that person, if possible. We plan to summarize your responses with those of other MPOs in a report to the Congress.

Please complete and return your questionnaire within 10 days of receiving it, if at all possible. It will take about 45 minutes to complete. We have provided a postage-paid, return-mail envelope for your convenience. If the envelope is missing or misplaced, please return your completed survey to

Elizabeth Erdmann
U.S. General Accounting Office
441 G Street, N.W. Room 2T23
Washington, D.C. 20548

If your response will be delayed or you have any questions, please call Elizabeth Erdmann, toll-free, at 1-877-711-8101 (email: erdmanne@gao.gov).

Thank you for your cooperation.

1. Please identify the person who completed the questionnaire for your MPO and should be contacted in the event that we need to clarify responses.

Name _____

Title _____

MPO Name _____

Address _____

City, state, zip _____

Telephone _____

Email _____

1

TRANSPORTATION PLANNING

2. Which, if any, of the following transportation strategies are in use or are being implemented in the area over which your MPO has transportation planning authority? *(Check one for each.)* 1(5-23)

	In use (1)	Being imple-mented (2)	Not in use or being imple-mented (3)	Do not know (4)
1. Mass transit improvement (buses, train, light rail)	85	11	3	0
2. Commuter choice or transit subsidy	36	6	48	6
3. High occupancy vehicle (HOV) lanes	8	3	86	0
4. Carpool or shared ride services	54	10	30	4
5. Telecommuting	31	5	36	26
6. Ozone action program or other episodic emissions control	25	7	61	4
7. Roadway tolls	17	2	79	0
8. Accelerated vehicle retirement programs	3	2	81	12
9. Pedestrian and bicycle programs	69	23	5	1
10. Congestion pricing	1	1	93	2
11. Intelligent transportation systems (e.g., electronic toll collection; synchronized traffic signals)	54	30	13	1
12. Traffic flow improvement (e.g., converting 2-way streets to 1-way to improve corridor travel times; on-ramp metering)	42	18	38	0
13. Inspection/maintenance (I/M) programs	36	6	50	6
14. Reformulated fuel usage	23	4	59	11
15. Vehicle emissions technology (e.g., retrofits for buses)	20	10	49	18
16. Low or zero-emissions equipment	16	8	54	19
17. Alternative fuel vehicles	40	12	36	9
18. Public education or outreach programs	58	17	18	5
19. Other *(Please specify.)*	4	0	2	1

2

3. For the transportation strategies that are not in use or are not being implemented in your MPO's area, as indicated in Question 2, which, if any, of the following limitations at least moderately deters their implementation in your MPO's area? *(Check all that apply for each strategy you marked "Not in use" in Question 2.)* (24-42)

	Lack of start-up, or seed, money (1)	Lack of ongoing funding (2)	State restrictions on use of state trans-portation funds (3)	Federal restrictions on use of federal trans-portation funds (4)	Lack of public interest or political support (5)	Other (please specify) (6)
1. Mass transit improvement	11	56	11	0	33	22
2. Commuter choice; subsidy	17	19	5	1	80	9
3. HOV lanes	8	6	2	0	65	35
4. Carpool or shared rides	8	6	0	0	84	5
5. Telecommuting	9	3	1	0	74	15
6. Ozone action programs	9	7	1	2	53	34
7. Roadway tolls	6	4	9	2	72	24
8. Accelerated vehicle retirement	15	15	2	3	72	13
9. Pedestrian and bicycle	33	33	0	0	53	0
10. Congestion pricing	4	3	2	2	82	19
11. Intelligent transportation systems	37	34	5	3	37	21
12. Traffic flow improvement projects	15	12	1	0	65	20
13. I/M programs	7	7	3	1	72	29
14. Reformulated fuel usage	7	9	1	1	74	25
15. Vehicle emissions technology	13	14	1	0	66	22
16. Low emissions equipment	18	13	1	0	69	20
17. Alternative fuel vehicles	16	12	0	0	75	19
18. Public education or outreach	20	20	2	2	69	7
19. Other *(Please specify.)*						

3

4. How much influence, if any, does each of the following factors have on your MPO's regional transportation plan? *(Check one for each.)* (43-50)

	Little or no influence (1)	Some influence (2)	Moderate influence (3)	Great influence (4)	Very great influence (5)	Uncertain (6)
1. Existing transportation system	0	3	5	32	58	0
2. Already approved but not yet implemented transportation projects	1	3	20	42	32	0
3. Fiscal constraint on the plan	1	2	11	33	51	0
4. Impact on economic development	3	13	38	32	12	0
5. Political concerns	2	13	30	33	21	1
6. Public preferences for particular transportation modes	4	11	28	38	18	1
7. Concerns about the environment (e.g., protecting wetlands and open space; adding to air or water pollution)	4	18	35	29	13	1
8. Other *(Please specify.)*	0	1	2	1	3	1

5. Although your MPO is not required to consider environmental factors other than air quality in the planning stage, how much consideration, if any, does your MPO give to each of the following environmental factors when developing your regional transportation plan? *(Check one for each.)* (51-56)

	Little or no consideration (1)	Some consideration (2)	Moderate consideration (3)	Great consideration (4)	Very great consideration (5)	Uncertain (6)
1. Impact on air quality	11	14	26	24	23	0
2. Impact on water quality	19	28	32	15	4	1
3. Impact on open space	15	22	37	21	4	1
4. Impact on environmentally sensitive lands, such as wetlands	6	16	35	31	11	0
5. Impact on land use that may occur as a result of the transportation plan	4	15	34	34	11	0
6. Other environmental impacts *(Please specify.)*	2	3	5	3	2	2

4

6. To what extent, if any, would each of the following encourage your MPO to consider or give more consideration to environmental factors other than air quality in the **planning** stage? *(Check one for each.)* (57-62)

	Little or no encouragement (1)	Some encouragement (2)	Moderate encouragement (3)	Great encouragement (4)	Very great encouragement (5)	Uncertain (6)
1. Access to information regarding environmental effects that could result from our transportation plan	7	24	39	21	6	2
2. Access to models that integrate environmental effects and transportation	8	21	32	26	9	2
3. Increased technical assistance with analyses and modeling	7	22	31	26	11	2
4. Financial assistance for analyses and modeling	4	11	23	35	25	1
5. Public education programs	9	24	34	18	7	5
6. Other *(Please specify.)*	0	0	0	1	2	1

DEMONSTRATING CONFORMITY

7. Is any portion of the geographic area your MPO covers currently in nonattainment or maintenance status, or is your entire area in attainment status for each of the following National Ambient Air Quality Standards (NAAQS) criteria pollutants? *(Check all that apply.)* 2(5-28)

Pollutant	Nonattainment (1)	Maintenance (2)	Attainment (3)	Uncertain (4)
1. Ozone (1-hour standard)	23	16	59	2
2. Carbon monoxide	10	11	70	3
3. Particulate matter (PM-10)	8	2	75	9
4. Nitrogen dioxide	3	2	78	11
5. Lead	0	0	78	13
6. Sulfur dioxide	1	0	79	12

5

8. Is your MPO currently required to ensure that your regional transportation plan conforms with a mobile source emissions budget (i.e., demonstrate conformity)? *(Check one.)* (29)

45 Yes →Please continue.
54 No →Skip to Question 16.
1 Do not know →Skip to Question 16.

9. How much, if at all, do concerns about demonstrating conformity affect the mix of projects in your regional transportation plan? *(Check one.)* (30)

18 Little or not at all
25 Somewhat affect
26 Moderately affect
14 Greatly affect
16 Very greatly affect

10. When your MPO is trying to demonstrate conformity for your regional transportation plan, how often do you use each of the following strategies to bring your plan into conformity? *(Check one for each.)* (31-34)

	Never (1)	On occasion (2)	Often (3)	Very often (4)	Almost always (5)
1. Change the mix of projects in the plan.	35	41	8	9	3
2. Request adjustments in the mobile source emissions budget.	63	28	2	2	0
3. Adjust assumptions in the model.	41	42	7	3	1
4. Other *(Please specify.)*	2	5	2	2	2

11. How easy or difficult has it been for your MPO to demonstrate conformity for your regional transportation plan? *(Check one.)* (35)

11 Very easy
13 Somewhat easy
20 Neither easy nor difficult
25 Somewhat difficult
4 Very difficult

6

12. Listed below are statements that, if true, could interfere with your MPO's ability to demonstrate conformity. Please indicate whether or not the statement is true in your area. Then, if true, rate how much, if at all, each interferes with your MPO's ability to demonstrate conformity. *(Check if true or not true; then if true, check one rating for each statement.)* (36-53)

				Interferes with Conformity					
	True in our area (1)	Not true in our area (2)	Do not know (3)	Little or not at all (4)	Somewhat (5)	Moderately (6)	Greatly (7)	Very greatly (8)	Do not know (9)
1. Changing the mix of transportation projects does not significantly reduce emissions.	49	31	16	45	23	9	14	3	0
2. We expect mobile source emissions to increase at some point after the air quality attainment date, but our mobile source emissions budget is not allowed to increase beyond that date.	36	29	32	10	25	21	25	10	2
3. The requirement to quantify emissions reductions discourages consideration of innovative programs whose air quality benefits cannot be quantified.	33	52	11	23	25	21	9	7	2
4. Mobile emissions model assumptions used to develop the State Implementation Plan (SIP) (e.g., vehicle registrations or population) differ from those used in the most recent conformity determination.	22	55	21	14	10	24	24	14	7
5. Knowledge or concern among the general public about the air quality effects of their transportation choices is limited.	75	19	3	48	13	19	5	2	4
6. Our communication with state and/or regional air quality planners is poor.	8	89	2	20	10	30	20	0	10
7. Certain land uses can negatively affect regional air quality, but land use decision makers are not systematically involved in the conformity process.	68	25	4	24	21	19	12	8	7
8. Controlling emissions requires a regional focus, but land use decision makers primarily consider local needs.	83	10	3	24	20	21	14	6	5
9. Other *(Please specify.)*	5	0	0	0	0	33	33	17	17

7

13. In your opinion, how much would each of the following changes to the conformity process help your MPO demonstrate conformity? *(Check one for each.)* (54-60)

	Hardly or not at all help (1)	Somewhat help (2)	Moderately help (3)	Greatly help (4)	Very greatly help (5)	No opinion (6)
1. Relax the requirement to quantify emissions reductions for innovative programs whose emissions are difficult to quantify.	25	31	22	8	3	9
2. Provide technical assistance and training to help transportation planners understand the mobile emissions model.	18	28	26	22	5	1
3. If the mobile emissions model assumptions used to develop the SIP (e.g., vehicle registrations, population data) are not the same as those used in the most recent conformity determination, require that state air quality planners assess whether the mobile source emissions budget should be revised.	12	10	20	24	9	21
4. Provide public education about the relationship between air quality and transportation choices.	24	23	25	19	6	2
5. Provide an incentive for improved communication between air quality and transportation planners.	26	24	24	16	5	4
6. Increase the involvement of land use decision makers in the conformity process.	17	21	25	18	13	5
7. Other *(Please specify.)*	0	1	0	2	2	1

8

14. Currently, MPOs are required to demonstrate conformity for the duration of the long-term transportation plan. If there was an opportunity to change this requirement, which of the following would you prefer? *(Check one.)* (61)

23 Match the time frame for which conformity must be demonstrated to the time frame an area is given to attain or maintain air quality standards.

14 Make the time frame for which conformity must be demonstrated equal to the time frame an area is given to attain air quality standards plus a period of _____ years. *(Enter number of years preferred.)* (62-63)

11 Reduce the time frame for which conformity must be demonstrated to _____ years. *(Enter number of years preferred.)* (64-65)

26 Keep the current requirement.

4 Other *(Please specify.)* (66)

17 No preference

15. In your experience, how effective or ineffective has the conformity process been in helping your area achieve air quality standards? *(Check one.)* (67)

6 Very effective

25 Generally effective

19 Equally effective and ineffective

28 Generally ineffective

12 Very ineffective

8 No basis to judge

LAND USE

16. Which, if any, of the following alternative land use strategies has your MPO assessed or are you assessing when determining what mix of projects should be included in your regional transportation plan? *(Check all that apply.)* (68-80)

48 Transit-oriented development (i.e., encourage transit travel by increasing housing, retail, and employment density along or around a regional transit system)

57 Infill development, including brownfields (i.e., new development in already developed areas, some of which are underutilized or abandoned industrial lands that require cleanup)

54 Mixed-use development (i.e., colocate complementary land uses, such as housing, retail, office, services, and public facilities within walking distance of each other)

69 Downtown redevelopment (i.e., make central business districts areas of concentrated activity)

26 Jobs/housing balance (i.e., encourage new businesses to locate in areas with housing and vice versa)

77 Pedestrian/bicycle projects (i.e., provide more direct routes between locations, thus encouraging pedestrian and bicycle travel)

28 Strategic parking (i.e., encourage nonautomobile travel by limiting the parking supply, creating park-and-ride lots, etc.)

31 Open space preservation (i.e., use conservation easements and/or tax incentives; purchase development rights)

56 Concentrated corridor development (i.e., focus development along major existing transportation corridors)

6 Other *(Please specify.)*

11 None of the above

9

17. Which, if any, of the following reasons explains why your MPO has not or is not assessing alternative land use strategies when determining what mix of projects should be included in your regional transportation plan? *(Check all that apply.)*

3(5-17)

General Reasons

24 We are not required to assess land use strategies.

12 Land use in our area is established for years into the future and few alternative land uses are possible.

58 Land use is a local decision and we have limited ability to influence it.

9 We do not have collaborative working relationships with land use decision makers.

11 We only assess the strategies under consideration by land use planners and they are not considering these alternative land use strategies.

32 We have limited or no funding for transportation projects related to alternative land use strategies.

11 Vehicle emissions are not a primary contributor to our air quality attainment problems.

Technical Limitations

22 We are unable to quantify the impacts of alternative land uses on vehicle miles traveled, congestion, or travel time.

32 We do not have staff with the technical expertise needed to analyze the impacts of alternative land uses on vehicle miles traveled, congestion, or travel time.

33 We do not have the modeling capability needed to assess the impacts of alternative land uses.

11 Other *(Please specify.)*

18. As part of your MPO's assessment of alternative land use strategies, do you model (or do others model for you) the emissions generated from the mix of transportation projects? *(Check one.)*

(18)

25 Yes →Please continue.

60 No →Skip to Question 22.

13 We do not assess alternative land use strategies. →Skip to Question 22.

19. To what extent, if at all, did the emissions model results from your assessments of alternative land use strategies influence the mix of transportation projects chosen for your regional transportation plan? *(Check one.)*

(19)

53 Little or not at all →Please continue.

29 Somewhat influenced →Skip to Question 21

9 Moderately influenced →Skip to Question 21

7 Greatly influenced →Skip to Question 21

0 Very greatly influenced→Skip to Question 21

10

20. Which, if any, of the following reasons explains why your emissions modeling results from your assessments of alternative land use strategies had little or no influence on the mix of projects in your plan? *(Check all that apply.)*

(20-28)

15 We are in attainment for all NAAQS criteria pollutants and do not need to be concerned about controlling emissions at this time.

48 Changing the mix of projects did not result in significant decreases in emissions.

30 Improvements in vehicle emissions technology compensated for differences in emissions from alternative projects.

23 Improvements in fuel technology compensated for differences in emissions from alternative projects.

33 Political considerations prohibited changing the mix of projects.

58 Existing transportation system and already approved projects leave little opportunity to change the mix of projects.

13 There was a lack of public support for the transportation alternatives associated with better air quality.

3 The cost of the alternative mix of projects was too high for us to pursue them.

8 Other *(Please specify.)*

21. To your knowledge, to what extent, if at all, have the results of your emissions modeling from your assessments of alternative land use strategies affected local land use plans or zoning? *(Check one.)*

(29)

64 Little or not at all

23 Somewhat affected

4 Moderately affected

1 Greatly affected

3 Very greatly affected

3 Do not know

22. In January 2001, the Environmental Protection Agency (EPA) issued guidance entitled "Improving Air Quality Through Land Use Activities" that explains how the emissions benefits of alternative land use strategies can be used to obtain SIP credit. How familiar is your MPO, if at all, with this guidance? *(Check one.)*

(30)

55 Hardly or not at all familiar

28 Somewhat familiar

13 Moderately familiar

2 Greatly familiar

1 Extremely familiar

11

23. In your opinion, how likely is it that your MPO will use each of the following land use strategies to obtain emissions credit to help demonstrate conformity in your transportation plan as a result of EPA's January 2001 guidance? *(Check one for each.)* (31-39)

	Will definitely use for credit as a result of EPA's guidance (1)	Will definitely use for credit, but not as a result of EPA's guidance (2)	Will probably use for credit as a result of EPA's guidance (3)	Will probably use for credit, but not as a result of EPA's guidance (4)	Unsure if we will use for credit (5)	Will probably not use for credit (6)	Will definitely not use for credit (7)
1. Transit-oriented development (increase housing, retail, and employment density along or around a regional transit system)	3	2	8	6	35	16	13
2. Infill development, including brownfields (new development in already developed areas, including underutilized or abandoned industrial lands that require cleanup)	4	3	6	10	34	15	13
3. Mixed-use development (colocate housing, retail, employment, etc. within walking distance of each other)	2	2	8	6	38	16	12
4. Downtown redevelopment (make central business districts areas of concentrated activity)	4	5	7	11	32	14	11
5. Jobs/housing balance (encourage new businesses to locate near housing and vice versa)	2	1	4	5	37	17	14
6. Pedestrian/bicycle projects	5	10	6	14	27	12	10
7. Strategic parking	2	3	3	6	30	20	17
8. Concentrated corridor development (focus development along major existing transportation corridors)	3	4	6	7	34	15	13
9. Other *(Please specify.)*	1	0	0	0	3	2	5

12

24. To what extent, if any, would each of the following federal actions help your MPO to assess alternative land use strategies when developing your regional transportation plan? *(Check one for each.)* (40-47)

	Help little or not at all (1)	Somewhat help (2)	Moderately help (3)	Greatly help (4)	Very greatly help (5)	Uncertain (6)
1. Provide flexible sources of funding for research on the relationships among land use, transportation, and air quality.	10	17	23	26	14	6
2. Document and publicize case studies and best management practices that show how changes in land use, such as infill or mixed-use development, have affected vehicle emissions.	7	28	29	22	7	3
3. Develop programs to educate local governments and the general public on the relationships among land use, transportation, and air quality.	5	20	29	24	13	4
4. Provide incentives (e.g., financial, regulatory flexibility, technical assistance) to encourage land use and transportation planners to collaborate on projects that convey air quality benefits.	6	16	24	27	19	4
5. Ensure that federal funding (e.g., transportation, housing, community development) and activities (e.g., location of federal facilities, such as post offices) are consistent with state and local growth management initiatives.	6	13	25	29	18	5
6. Assume a higher share of the costs for transportation projects that minimize environmental effects when it is difficult for local governments to cover their share.	5	7	18	29	29	8
7. Develop guidance on how to design and implement land use strategies that reduce vehicle miles traveled and/or congestion.	3	20	30	30	11	3
8. Other *(Please specify.)*	0	1	0	1	3	1

13

TRAVEL DEMAND MODELING

25. To what extent does your MPO's travel demand model allow you to do each of the following? *(Check one for each.)* (46-55)

	Not at all (1)	Little extent (2)	Some extent (3)	Moderate extent (4)	Great extent (5)	Very great extent (6)
1. Model micro-scale changes to the transportation plan (e.g., pedestrian/ bicyclist improvements).	51	22	8	8	3	0
2. Integrate land use and transportation planning.	6	14	25	22	19	5
3. Account for induced demand generated from transportation projects.	19	17	17	18	14	4
4. Accommodate for changes in trip patterns created by mixed-use developments.	12	20	22	22	12	3
5. Make accommodations for the effect of mixed-use development on the time of day in which trips are taken.	41	21	17	8	4	1
6. Give equal consideration to modes other than cars (e.g., transit, pedestrian, and bicyle).	28	24	16	11	9	5
7. Account for reduced travel demand as a result of the land use strategies, such as mixed-use or transit-oriented development.	25	24	22	14	7	1
8. Other *(Please specify.)*	1	3	1	0	0	0

26. Overall, how satisfied or dissatisfied is your MPO with your travel demand model's capabilities? *(Check one.)* (56)

6 Greatly satisfied
48 Generally satisfied
25 About as satisfied as not
11 Generally dissatisfied
3 Greatly dissatisfied

27. Who runs your MPO's travel demand model? *(Check all that apply.)* (57-60)

65 MPO staff
36 State department of transportation
22 Private consultants or contractors
3 Other *(Please specify.)*

14

BACKGROUND

28. What formal relationship, if any, does your MPO have with a regional planning commission, council, or other coordinated regional planning organization? *(Check one.)* (61)

49 We are a regional planning organization.

17 We are part of a regional planning organization, but we have independent authority.

23 We are not linked to a regional planning organization.

10 Other *(Please specify.)*

29. Does your MPO or regional planning organization, if you are linked to one, participate in air quality, water quality, or land use planning, in addition to transportation planning? *(Check all that apply.)* (62-65)

50 Air quality

40 Water quality

64 Land use

12 None of the above

30. About how large, in square miles, is the geographic area that your MPO covers for transportation planning purposes? *(Enter square miles.)* (66-69)

_____

31. What is your best estimate of the population in the geographic area that your MPO covers for transportation planning purposes? *(Enter number of people.)* (70-76)

_____

32. Please list below the counties or parts of counties over which your MPO has transportation planning authority. If the counties are in different states, please also identify the states. (77-78)

_____

33. If you have any case studies or examples of how your area is considering land use strategies in your transportation or air quality planning, please provide them in the space below or attach additional pages. (79)

Thank you for your cooperation.

15

Question From GAO Survey of Local Growth Issues

Which of the following best describes the change you expect in your community's population over the next 10 years? (Responses are expressed in percentage of those responding.)

(0) Decrease greatly
(2) Decrease somewhat
(9) Stay about the same
(46) Increase somewhat
(42) Increase greatly
(1) Uncertain
(0) Other

Expert Panel Questionnaire

This appendix presents the questions contained in the two questionnaires completed by members of the expert panel selected for this study. There were two phases of this survey. The questionnaires for both phase I and phase II were administered over the Internet. Phase I consisted entirely of open-ended questions. Phase II consisted of several series of items derived from the responses generated by experts during phase I. We asked the expert panel to evaluate these items on several dimensions in the phase II questionnaire. The dimensions were importance, feasibility, effectiveness, and prevalence (note that not all series of items were evaluated on all dimensions). The four series of evaluated items for this report were:

1. Identifying Land Management Practices and Development Strategies

2. Identifying Impediments to Consideration and Implementation

3. Identifying Incentives for Consideration and Implementation

4. Defining the Role of Federal Government

We also calculated the average rating, across all members of the expert panel, for each item on the relevant dimensions for a particular series. These averages are reported in the tables below in the columns to the left of the items presented in phase II.

1. Identifying Land Management Practices and Development Strategies:

Phase I: In your experience, what are examples of the types of land management practices and development strategies considered by water quality managers and land use planers and implemented by decisions makers to mitigate adverse impacts on water quality?

Phase II: In the first round of this survey the panel identified numerous land management practices and land development strategies that mitigate adverse impacts on water quality. We have summarized those responses into 10 items that represent both practices and strategies (as many of you pointed out, distinctions between land management practices and land development strategies are inexact).

In this section we ask that you evaluate land management practices and development strategies along three dimensions:

1. how effective are the land use practices and strategies in preventing or mitigating water quality impacts,

2. how extensively have these land use practices and strategies been employed to date, and

3. how feasible it is to promote more widespread use of these practices and strategies.

The dimensions are arrayed after each item is listed. Click in the appropriate circle to indicate your response.

Two of the dimensions, in particular, need defining. By "highly effective" we mean that the practice or strategy has a positive effect, and little or no negative effect, that the practice is justifiable on its own merit, and is valuable. Conversely, at the other extreme, "highly ineffective" means that the practice or strategy has major negative effects, is not justifiable, and is harmful.

By "definitely feasible" we mean that the practice or strategy is easily implemented, is within available resources, and is acceptable to the general public. "Definitely infeasible" means that it is not easily implemented, uses too many resources, and is completely unacceptable to the general public.

Land management practices and development strategies generated by experts during Phase I. The following items were presented to experts during Phase II and assessed on effectiveness, prevalence, and feasibility.		**Average Expert Group Scores on Rated Dimensions.[a]** Items were rated on a five-point scale. Lower scores reflect higher levels of effectiveness, prevalence, and feasibility. See notes below.		
		Effectiveness[b]	**Prevalence[c]**	**Feasibility[d]**
1.	Research, demonstrations, and innovative programs: Examples include research with artificial wetland filtering systems, smart growth demonstration projects, tradable development permits, and use of large quantities of interdisciplinary data to assess water quality and ecological impacts.	1.93	3.00	1.86
2.	Land protection: Examples include conservation easements and preservation or conservation of land, farmland, open space, and wetlands.	1.66	2.41	1.76

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Land management practices and development strategies generated by experts during Phase I. The following items were presented to experts during Phase II and assessed on effectiveness, prevalence, and feasibility.		**Average Expert Group Scores on Rated Dimensions.**[a] Items were rated on a five-point scale. Lower scores reflect higher levels of effectiveness, prevalence, and feasibility. See notes below.		
		Effectiveness[b]	**Prevalence**[c]	**Feasibility**[d]
3.	Smart Growth principles and strategies: Examples include innovative designs for cluster zoning, conservation and large-scale subdivisions, and runoff control measures that can be used for multiple purposes (e.g. parks with buffers). Examples also include a focus on transportation development that encourages mass transit and economic incentives to buy transit-friendly homes; and, mixed-use, infill, low-impact, new-town, traditional neighborhood, transit-oriented, and zero-impact development strategies.	2.00	3.45	2.00
4.	Zoning/ordinances related to existing and new development: Examples include zoning for greater density, ordinances prescribing irrigation practices for lawns and gardens, lot size, on-site treatment of wastewater (i.e., septic systems), open space, parking, re-forestation, setback requirements, narrower street widths, water quality ordinances, and wetland ordinances (preserve/replace).	2.14	3.10	1.93
5.	Federally imposed regulations: Examples include environmental assessments/impact statements, federal permitting processes (Clean Water Act) 401, 404, and Endangered Species Act), monitoring/enforcement programs.	2.62	2.07	2.38
6.	Structural Best Management Practices (BMP): Examples include erosion/sediment control, minimal treatment of wastewater (settling/skimming), natural ground cover/wetland detention, retention ponds, separation of sanitary and storm sewers, swales, underground pipes/curbs/gutters, and vegetative/riparian buffers.	2.29	2.32	1.93
7.	Development restrictions: Examples include construction standards, growth boundaries, growth restrictions, limits on impermeable surfaces as a total percent of developed area, and siting restrictions.	2.00	3.48	2.38
8.	Non-structural Best Management Practices: Examples include preventative maintenance (street cleaning and regular maintenance of structural BMPs), pollution prevention practices, such as the minimization of de-icing on roadways, public education/outreach, regular maintenance of sewer infrastructure, and seasonal land development moratoriums.	2.37	2.79	1.90
9.	Site-level design techniques: Examples include alternative driveway/parking lot configuration, the use of alternative paving products, increased common space, one-sided sidewalks, reduced footprints and impervious areas, reduced street width, and the concerted use of storm water as a resource rather than treating it as a waste product.	1.96	3.75	2.07

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Land management practices and development strategies generated by experts during Phase I. The following items were presented to experts during Phase II and assessed on effectiveness, prevalence, and feasibility.		Average Expert Group Scores on Rated Dimensions.[a] Items were rated on a five-point scale. Lower scores reflect higher levels of effectiveness, prevalence, and feasibility. See notes below.		
		Effectiveness[b]	Prevalence[c]	Feasibility[d]
10.	Management strategies: Examples include adaptive management, storm water programs that focus on stream morphology, Total Suspended Solids (TSS) control requirements, and good planning for and management of floodplains, riparian buffers, storm water, and watersheds.	1.76	3.58	2.13

[a]The scale ranges from 1 to 5; "Don't know/No Opinion" responses excluded in calculations of the average. Lower scores reflect higher levels of effectiveness, prevalence, and feasibility.

[b]The actual wording of the assessment question for each item on this dimension was as follows: "How effective is this practice or strategy? 1. Highly Effective, 2. Effective, 3. Neither Effective Nor Ineffective, 4. Ineffective, 5. Highly Ineffective, or 6. Don't Know/No Opinion."

[c]The actual wording of the assessment question for each item on this dimension was as follows: "How prevalent is this practice or strategy? 1. Very Prevalent, 2. Prevalent, 3. Neither Prevalent Nor Rare, 4. Rare, 5. Very Rare, or 6. Don't Know/No Opinion."

[d]The actual wording of the assessment question for each item on this dimension was as follows: "How feasible is this practice or strategy? 1. Definitely Feasible, 2. Probably Feasible, 3. May or May Not be Feasible, 4. Probably Infeasible, 5. Definitely Infeasible, or 6. Don't Know/No Opinion."

2. Identifying Impediments to Consideration and Implementation:

Phase I: The questions in this section ask about factors that might limit consideration and implementation of any of the land management practices and development strategies to mitigate negative water quality effects that you identified in section 1.

What *technological factors* such as the lack of water-quality data or analytical tools, limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

What factors established in *federal*, *state*, *or local laws* (non-regulatory) limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

What factors established in *federal*, *state*, *or local regulations* limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

What *institutional factors*, such as the customary separation of land development and water quality management responsibilities into different divisions or agencies, limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

What *resource factors*, such as funding and staffing, limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

What *economic or market factors*, such as pressures to provide more job opportunities or affordable housing, limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

What *other factors*, such as public attitudes, political leadership, or special interest influence, limit consideration and implementation of land use practices and development strategies to mitigate negative water quality effects?

Phase II: In the first round of this survey, experts identified numerous factors that might limit consideration and implementation of land management practices and development strategies to mitigate negative water quality effects. In this section, we have listed the impediments to consideration and implementation produced in the first round. We ask that you evaluate these items along the following dimensions:

1. how important is it that actions are taken to remove the impediment, and

2. how feasible, or difficult would it be to remove the impediment.

These dimensions are arrayed after each item is listed. Click in the appropriate circle to indicate your response.

By "very important" we mean that removing the impediment is a first order priority, has a direct bearing on major issues, and must be resolved. On the other hand, "very unimportant" means that there is no priority, no relevance, no impact on major issues, and should be dropped as an item to consider.

By "definitely feasible" we mean that action to remove the impediment could easily be implemented, would be within available resources, and would also be acceptable to the general public. "Definitely infeasible" means that it would not be easily implemented, would use too many resources, and would be completely unacceptable to the general public.

Impediments to consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
11.	Confusion about both current and future requirements to control nonpoint source pollution causes localities to be less likely to use innovative land use practices for fear that they will conflict with regulatory requirements.	2.93	2.93
12.	The focus on short-term planning and the lack of clear organizational accountability deter efforts to assess and mitigate environmental impacts of land use, especially impacts on water quality.	1.79	3.89
13.	Water quality managers and land use planners lack advanced water quality models (and guidelines promoting their uniform use) that assess the impacts of land use practices and help inform choices of appropriate water quality improvement strategies. For example, there is a lack models that (1) assess and predict both site specific and cumulative effects of development on watersheds, (2) integrate these effects over space and time, (3) accurately address variables such as loading, concentration, source contributors, and transport of pollutants, and (4) adequately consider impacts on biotic factors and habitat.	2.11	3.70
14.	Localities, sometimes because of limited resources, lack (1) effective user-friendly models, (2) consolidated water quality and land use data, and (3) monitoring equipment and methods that aid accurate diagnoses of water quality problems.	1.83	3.54
15.	Federal and state laws and regulations are narrowly focused rather than comprehensive. This imposes a “one-size-fits-all” approach that is difficult to implement, and inhibits innovation and inclusive approaches to linking land use and water quality.	2.17	3.59
16.	Water quality managers and land use planners lack basic information that would allow them to assess the cumulative impacts of urbanization on water quality. Such information includes urban characteristics, ecological factors, habitats, flow control impacts, watershed hydrology, stream geomorphology and channel stability impacts, and land use patterns using GIS.	1.55	3.34
17.	The federal government lacks any role or authority to support local land use decisionmaking that would promote consideration of the impact that land use has on water quality.	2.61	3.82

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Impediments to consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
18.	Economic markets drive current patterns of development. For example, land is available and cheaper in greenfields and rural areas, and infrastructure costs to develop there are subsidized. Developers can make more money building in rural locations, farmers can make money on their property, and home buyers prefer these locations because they get more value for their dollar, compared to development in infill, urban, and brownfield areas.	2.07	4.41
19.	Certain federal, state, and local policies do not encourage innovative development practices that may better protect water quality. For example, some existing tax policies, and policies that subsidize water and transportation infrastructure costs, encourage prevailing practices such as the development of more highways, rather than mass transit.	1.86	3.89
20.	Certain legal, regulatory, and other factors promote the conventional view that runoff is a waste product that needs to be drained away as quickly as possible. These factors do not promote management techniques that treat storm water as a resource to be managed and that are more protective of a watershed's overall health.	2.17	3.14
21.	There is opposition to certain innovative land use practices among some members of the public, local governments, and the development community. This opposition stems from the perception that such practices are costly and limit economic growth, their quality of life, and convenience, such as automobile usage.	1.90	3.66
22.	Communication, coordination, and better integration of land use planning that prevents or mitigates water quality impacts is inhibited due to (1) institutional stovepiping, (2) conflicting missions, and (3) the increasing number and fragmentation of organizations at the federal, state, and local levels based on subject matter and geographic jurisdictions.	1.75	4.14
23.	Regional planning agencies lack sufficient authority to help address the cumulative, cross-jurisdictional impacts of land use on water quality.	2.00	3.76
24.	Government institutions at all levels are resistant to change and inherently have institutional biases, barriers, and conventions. This limits the promotion of innovations to better link land use and environmental quality.	2.11	4.04
25.	Economic pressures dissuade localities from considering the water quality impacts of land use decisions. Some of these economic pressures include the need (1) to develop land to accommodate population growth, (2) to provide jobs, (3) to provide affordable housing, and (4) to develop other measures designed to keep small towns viable.	1.83	4.31
26.	Water quality managers and land use planners lack sound, scientific data that would allow them to effectively characterize the water quality impacts of prevailing land uses to the public and local decisionmakers. Therefore, local decisionmakers may be reluctant to more aggressively promote land uses that better prevent or mitigate water quality impacts.	1.79	2.93

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Impediments to consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
27.	In some states, enabling legislation mandates that only state legislatures can grant localities authority to plan, zone, and raise revenue for land use that mitigates environmental impacts. This sets up generic, rigid requirements, such as building codes that require waivers for innovative practices.	2.20	3.50
28.	Interests of the development community are over-represented during land use decision-making processes, which limits consideration of potential water quality impacts of development.	2.00	4.03
29.	In part due to a lack of funds, there is limited enforcement of existing land use regulations, such as sediment control and storm-water management programs, as well as new initiatives such as technology transfer and habitat preservation programs.	1.78	3.56
30.	Localities lack funds to implement local and regional planning initiatives, such as watershed councils, regional land use policies, model ordinances, and watershed protection plans.	2.10	3.41
31.	The provisions in transportation law (ISTEA and TEA-21) that were intended to promote more consideration of environmental impacts for large transportation projects are not effectively enforced.	2.06	3.61
32.	Parochial views held by localities can discourage land use controls and greater consideration of overall environmental and water quality impacts of land use decisions.	2.04	3.89
33.	Some state enabling legislation is dated and does not provide for such things as, comprehensive planning, land use strategies, local land use authority, consideration of land use impacts that cross local jurisdictional boundaries (e.g. coordination among jurisdictions), or consideration of environmental (e.g. water quality) impacts of development.	1.97	3.71
34.	Beliefs that residential development will increase the tax base create pressures for localities to approve projects without due consideration of water quality impacts.	2.10	3.72
35.	Governments at all levels lack people in key positions who are versed in innovative planning, assessment, management, land use, and water quality practices. Governments also find it difficult to recruit and retain qualified staff or to provide technical cross-training.	1.93	3.26
36.	Concerns about regulatory “takings”, together with strong beliefs about private property and water rights, discourage localities from considering land use practices and controls which limit environmental impacts.	1.93	4.14
37.	Large federally financed projects (e.g. water infrastructure and transportation projects) are not necessarily selected nor designed to prevent or mitigate environmental impacts. Additionally, environmental impact statements for large federal projects (required by the National Environmental Policy Act) are completed too late in the decision-making process—after a project is already on the drawing board—to be effectively considered.	2.32	3.27

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Impediments to consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		Average Expert Group Scores on Rated Dimensions[a] Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	Difficulty[c]
38.	Local laws and ordinances (e.g. relating to street widths, parking requirements, and lot size requirements) are outdated, restrict innovation, and inhibit comprehensive assessments of environmental and land use impacts.	1.86	3.46
39.	Water quality managers and land use planners lack (1) standardized water quality monitoring procedures and (2) comprehensive, long-term, ambient water quality and biological monitoring data (spatial and temporal). This deficiency limits the ability to evaluate how effectively various BMPs, or land uses, limit or remove pollutants.	2.17	3.36

[a]The scale ranges from 1 to 5; "Don't know/No Opinion" responses excluded in calculations of the average. Lower scores reflect higher levels of importance and lower levels of difficulty.

[b]The actual wording of the assessment question for each item on this dimension was as follows: "How important is it to remove this impediment? 1. Very Important, 2. Important, 3. Neither Important Nor unimportant, 4. Unimportant, 5. Very Unimportant, or 6. Don't Know/No Opinion."

[c]The actual wording of the assessment question for each item on this dimension was as follows: "How difficult is it to remove this impediment? 1. Definitely Not Difficult, 2. Probably Not Difficult, 3. May or May Not be Difficult, 4. Probably Difficult, 5. Definitely Difficult, or 6. Don't Know/No Opinion."

3. Identifying Incentives for Consideration and Implementation:

Phase I: The next set of questions asks about incentives that might be offered to water quality managers and land use planners and decision makers to encourage consideration and use of land management practices and development strategies that mitigate adverse impacts on water quality.

What types of *technological support*, such as new models or tools, could serve as incentives to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

What types of *legal action* (non-regulatory), such as changes in current law, could create incentives to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

What types of *regulatory action* could create incentives to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

What types of *institutional factors* could serve as incentives to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

What types of *resources* could serve as incentives to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

What types of *economic or market based* incentives could be provided to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

What *other measures* could be taken to create incentives to encourage consideration of land management practices and development strategies to mitigate adverse impacts on water quality?

Phase II: In the first round of this survey, experts identified numerous factors that might serve as incentives to encourage consideration and implementation of land management practices and development strategies to mitigate negative water quality effects. In this section, we have listed the incentives produced in the first round. We ask that you evaluate these items along the following dimensions.

1. how important is it to take actions to create these incentives, and

2. how feasible, or difficult, would it be to create the incentive.

These dimensions are arrayed after each item is listed. Click in the appropriate circle to indicate your response.

Here, by "very important" we mean that creating the incentive should be a first order priority, and that it could have a direct and positive bearing on major issues. On the other hand, "very unimportant" means that there is no priority, no relevance, no impact on major issues, and creating the incentive should be dropped as an item to consider.

By "definitely feasible" we mean that the incentive could be easily implemented, would be within available resources, and would be

acceptable to the general public. "Definitely infeasible" means that it could not easily be implemented, would use too many resources, and is completely unacceptable to the general public.

Incentives to encourage consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
40.	Ensure greater consultation and coordination among planning, land use, and water quality agencies, and across regions (cross-jurisdictional), in order to achieve comprehensive water quality improvement and land use planning. This could be accomplished by funding watershed associations or councils to increase stakeholder involvement, by creating regional institutions such as watershed authorities, or by sharing fiscal resources so that jurisdictions don't compete for tax revenue.	2.00	3.48
41.	Provide remote-sensing tools to reduce the cost of on-the-ground assessments and assist in better understanding of watershed-scale issues and solutions.	2.27	2.76
42.	Ensure that water quality laws and regulations integrate both water flow (quantity) and quality considerations.	1.81	3.11
43.	Provide local land use decisionmakers and the public visualization tools to illustrate the impacts of various land use options.	1.96	2.67
44.	Alter the National Pollutant Discharge Elimination System (NPDES) so that it focuses on identifying and managing the key chemical, biological, or physical pollutants in storm water as well as the rate, volume, and temperature of storm water discharged into receiving water bodies. Current emphasis is on the use of BMPs, but data are lacking on the effectiveness of many of these BMPs in protecting water quality.	2.44	3.78
45.	Provide outreach and education that will inform decisionmakers about the water quality and other environmental impacts of their land use decisions. Methods could include (1) providing workshops, publications, and guidance, (2) public recognition programs for localities that encourage environmentally-friendly development, and (3) school curricula describing the effects of urban nonpoint source pollution in terms relevant and understandable to children.	2.00	2.22
46.	Develop and implement better standards and criteria for ambient water quality. These would include biological water quality criteria and standards that set minimum pollutant levels to be achieved through point and nonpoint source controls, as well as simpler water-quality assessment criteria that could serve as early indicators of impacts resulting from changes in land use.	1.69	3.58
47.	Develop and strengthen standards and criteria for land management—with more stringent standards for land management practices that are less protective of water quality—and provide guidance in their use.	1.92	3.64

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Incentives to encourage consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
48.	Impose fees, charges, and requirements on developers that cover the cost of both new infrastructure and services to achieve water-quality protection. For example, (1) levy impact fees based on projected development impacts (e.g. impervious cover generated), (2) build infrastructure and environmental mitigation costs into charges for construction permits, or (3) require new greenfields development to cover the full cost of extending new water and sewer lines, roads, and other services.	1.70	4.04
49.	Emphasize an ecosystem (biocentric) watershed planning and management approach that integrates land use, water resource management/allocation, and water quality. Such an approach would encourage development of a comprehensive water resource strategy that combines water, sewer, and storm-water technologies and management.	1.70	3.92
50.	Promote the additional amenities popular with the public that accrue from land use practices that protect water quality (e.g. conservation of wildlife habitat and open space and attendant recreational opportunities, and protection of drinking water sources and working lands, such as productive farmland).	1.76	2.35
51.	Revise State Revolving Fund requirements so localities can address a broader set of water quality issues. For example, provide funding on a cost/share basis to states and localities that actively monitor watersheds, have targeted those watersheds that need continuous improvement, and implement BMPs and other land use management practices that reduce or eliminate urban nonpoint source pollution.	2.13	2.83
52.	Provide technical assistance to localities that includes (1) helping localities determine which BMPs offer the most water quality protection from land use and (2) assisting localities designing retrofits to existing storm-water systems that pose problems.	1.96	2.58
53.	Improve water quality monitoring procedures and data (including physical, chemical, and biological data) so that current, site-specific information is available to decisionmakers. Make available also updated national monitoring information, such as that provided by the former National Urban Runoff Program.	1.73	2.85
54.	Provide models that can simulate cumulative impacts throughout a watershed, and that also integrate transportation, land use, infrastructure, and water quality, to permit evaluation of the effects of alternative land uses on water quality. This would also include training individuals to use these models.	2.07	3.62
55.	Help localities obtain access to qualified staff to strengthen their capabilities to conduct land use planning that considers water quality impacts. Access could be created by hiring employees or consultants.	1.88	3.48
56.	Require that states and localities conduct anti-degradation analyses of their watersheds as a condition for receiving federal funding.	2.42	3.96

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Incentives to encourage consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
57.	Provide better biological and sediment assessment tools and procedures, such as Rapid Bio-assessment Protocols, that consider visual and user-friendly measures to assess stream quality and provide early warnings of degradation.	1.96	2.67
58.	Update local planning, zoning, and development law and procedures to favor land use management that protects water quality. This includes ordinances and standards for parking, street widths, and other aspects of land use and development that reflect scientific understanding of the impact of impervious cover on water quality and are based on environmental and natural resource considerations.	1.41	3.56
59.	Provide watershed runoff simulation models that are relatively inexpensive and easy-to-use (includes training people to use the models). These models should allow for customization to local circumstances and conditions and segregation of jurisdictional boundaries so that a locality can address its urban runoff issues and assess the downstream impacts of its actions.	2.26	3.00
60.	Establish unambiguous federal authority to mandate load reductions when states fail to do so and to issue penalties when reductions are not met.	2.46	4.11
61.	Use tax policies as incentives to implement land use practices that are protective of water quality. For example, (1) increase an entity's property tax rate if the amount of nonpoint source pollution it contributes exceeds a community's standard, (2) employ split rate taxation or provide developers tax relief to encourage urban rather than greenfield development, (3) establish stormwater utilities and base charges on projected water quality impacts, and (4) provide property tax relief for property owners willing to permanently conserve land.	1.81	3.73
62.	Give federal agencies the land use authority they need to more fully implement the goals of the Clean Water Act, the Safe Drinking Water Act, and the Endangered Species Act on federal lands that these agencies manage.	2.65	4.00
63.	Update state planning enabling legislation to allow communities to use comprehensive land use planning and growth management techniques that help protect water quality. Examples include, adoption of state-wide land use management plans and the use of developer impact fees, urban growth boundaries, and transfer of development rights.	1.89	3.89
64.	Use federal and state funding as leverage to promote development that is environmentally benign. For example, provide more funding for public services and facilities in designated growth/development zones, tie infrastructure funding to the adoption of urban nonpoint source reduction measures, and subsidize only those land uses that are protective of water quality, such as open space preservation or the restoration of riparian buffers.	1.78	3.27
65.	Sponsor research, studies, and demonstration projects of environmentally protective development practices, such as innovative site designs and model development standards, and involve universities and land grant institutions in these activities.	1.85	2.22

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Incentives to encourage consideration of land management practices and development strategies. The following items were generated by experts during Phase I and presented to experts during Phase II to assess on importance and difficulty.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. On importance, lower scores reflect higher levels of importance. On difficulty, higher scores reflect higher levels of difficulty. See notes below.	
		Importance[b]	**Difficulty[c]**
66.	Provide population-based or zoning-based build-out models that predict future growth impacts.	2.31	2.67
67.	Impose and enforce regulatory requirements and funding conditions to mitigate water quality impacts of land development. This could include requiring developers to assess the impacts of proposed projects and overseeing developers' compliance with zoning, subdivision, erosion, and sediment controls and protection of wetlands. This could also include requiring land use practices, such as riparian barriers, limits on site clearing, and narrower streets, that mitigate such impacts, and the use of planning and growth management tools, such as urban growth boundaries, purchase and transfer of development rights, and open space zoning.	1.67	4.15
68.	Structure federal agencies, in particular EPA, to be more interdisciplinary in order to discourage "stovepiping" and to encourage the use of multi-purpose, multi-disciplinary teams that can more effectively integrate land use and water quality considerations.	2.23	3.27
69.	Authorize localities within a watershed to use a market approach to control pollution, allowing them to exchange pollution credits between point and nonpoint sources.	2.81	3.42
70.	Encourage regulatory innovation, flexibility, and relief where appropriate. For example, streamline permitting for land use projects selected by consensus of all stakeholders, including regulators and developers. Give performance-based pollution credits for certain land use actions, such as open space and wetlands preservation and for minimizing sediment runoff from development.	2.11	3.24
71.	Provide land use planners and decisionmakers training, information, and case studies to help them better understand the water quality impacts of their decisions and be more aware of innovative land use practices that mitigate such impacts.	2.07	2.22
72.	Provide hardware, software, and ancillary support for fully developed GIS systems that help planners assess land use impacts.	2.37	2.92
73.	Provide resources to upgrade and replace, as appropriate, the water, sewer, and storm-water infrastructure of the nation's cities and older suburbs as a means to both prevent water quality degradation and encourage redevelopment in these areas, as opposed to development in greenfields.	1.56	3.85
74.	Reform state and local laws to better control nonpoint source pollution. This could be achieved by allowing state and local taxing authorities, such as storm-water utility districts, and mandating BMPs for construction, development, road maintenance, and residential uses that are proven to mitigate water quality impacts, and tying the receipt of state funding to their implementation. This could also include gearing regulations more to comprehensive watershed protection that takes into account all influences on a stream, reservoir, or groundwater resources.	1.59	3.85

[a]The scale ranges from 1 to 5; "Don't know/No Opinion" responses excluded in calculations. of the average. Lower scores reflect higher levels of importance and lower levels of difficulty.

[b]The actual wording of the assessment question for each item on this dimension was as follows: "How important is it to create this incentive? 1. Very Important, 2. Important, 3. Neither Important Nor Unimportant, 4. Unimportant, 5. Very Unimportant, or 6. Don't Know/No Opinion."

[c]The actual wording of the assessment question for each item on this dimension was as follows: "How difficult would it be to create this incentive? 1. Definitely Not Difficult, 2. Probably Not Difficult, 3. May or May Not be Difficult, 4. Probably Difficult, 5. Definitely Difficult, or 6. Don't Know/No Opinion."

4. Defining the Role of Federal Government

Phase I: In what ways, if any, could the federal government (1) address any of the limiting factors and (2) provide any of the incentives that you described above? Please include any specific observations or thoughts you may have on ways that federal funding sources pose impediments or could be better used to provide incentives.

Phase II: In the first round of this survey the panel identified numerous potential federal actions designed to address any of the impeding factors, or provide any incentives to land use planners and decision makers, to encourage consideration and use of land management practices and strategies that mitigate adverse impacts on water quality.

We have compiled those responses in this section and ask that you evaluate each suggested federal action along the following three dimensions:

1. how important is it to implement the federal action,

2. how feasible would it be to implement the federal action, and

3. how effective would the federal action be, in terms of costs and benefits, both economic and social.

These dimensions are arrayed after each item is listed. Click in the appropriate circle to indicate your response.

Here, by "very important" we mean that the action should be a first order priority, and that it could have a direct and positive bearing on major issues. On the other hand, "very unimportant" means that there is no priority, no relevance, no impact on major issues, and that the action should be dropped as an item to consider.

"Highly effective" means that the action will have a positive effect and little or no negative effect, that it is justifiable on its own merit, and is valuable.

Conversely, "highly ineffective" means that the action would have major negative effects, would not be justifiable, and in fact is harmful.

By "definitely feasible" we mean that the action would easily be implemented, would be within available resources, and would be acceptable to the general public. "Definitely infeasible" means that it would not be easily implemented, would use too many resources, and would be completely unacceptable to the general public.

Federal actions designed to address impeding factors generated by experts during Phase I and presented to experts during Phase II.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. Lower scores reflect higher levels of importance, effectiveness, and feasibility. See notes below.		
		Importance[b]	**Effectiveness[c]**	**Feasibility[d]**
75.	Provide new financial tools and financial incentives to encourage greater state and local investment in water quality improvement planning and implementation of successful runoff management. This could include allowing the use of state revolving funds for cost/share programs that give preference to those localities that monitor watersheds, target certain ones for continuous improvement, and implement land management practices that protect water quality.	1.58	2.08	2.08
76.	Provide regulatory flexibility to encourage consideration of environmental impacts of land use. This could include allowing alternative approaches to the TMDL rule or storm-water management regulations that produce equivalent or superior water quality improvements. It might also include consolidating and streamlining permitting processes, at least for those communities that demonstrate significant water quality improvements.	2.31	2.38	2.23
77.	Fund and support basic research and development on the science of ecology and hydrology. This would also include the development of better biological assessment tools, criteria, and standards that can serve as indicators of degraded water quality. Furthermore, more funding should be provided directly to research organizations, such as universities.	1.92	2.00	1.88
78.	Encourage the Environmental Protection Agency to develop an interdisciplinary approach, both within the agency and with other relevant federal agencies, to encourage better links between land use and environmental considerations, and provide a climate conducive to the development of innovative solutions.	2.00	2.24	2.24

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Federal actions designed to address impeding factors generated by experts during Phase I and presented to experts during Phase II.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. Lower scores reflect higher levels of importance, effectiveness, and feasibility. See notes below.		
		Importance[b]	**Effectiveness[c]**	**Feasibility[d]**
79.	Fund and support studies, research, and pilots to show the benefits of various land use management practices and development strategies and ways to measure their long-term impacts or effectiveness. This would include low-impact development strategies, those BMPs that appear to provide the most water quality protection, and cost-effective retrofits to existing storm-water management systems.	1.69	2.12	1.64
80.	Provide incentives for water quality managers and land use planners and decisionmakers to (1) coordinate their water quality improvement and land use plans, (2) consider cross-jurisdictional issues and impacts, and (3) involve all key stakeholders in the decision-making process. This could involve support for the creation of regional bodies that have direct responsibility for ensuring that land use does not degrade water quality.	1.92	2.12	2.42
81.	Promote comprehensive watershed planning, including approaches that seek to develop water resource strategies that combine water, sewer, and storm-water technologies into total water resource planning and management. Assist these planning efforts by more clearly defining water quality goals and objectives and outlining requirements for improving water quality.	1.54	2.04	2.04
82.	Use federal funding and taxing authorities to provide incentives for historic preservation, energy conservation, and land conservation. These would include conservation easements, protection or restoration of riparian barriers, and other conservation land uses.	1.96	2.04	1.92
83.	Better integrate federal policies and grant programs intended to help achieve water quality protection or that influence land use.	2.15	2.50	2.19
84.	Eliminate the factors in federal infrastructure funding programs—including transportation and water infrastructure—that encourage current patterns of growth. These patterns include development in greenfields instead of urban infill and redevelopment, highways instead of mass transit, and a focus on short-term economic gain instead of long-term sustainable development.	1.96	2.08	3.12
85.	Require that environmental impact analyses on federally funded projects also include analysis that considers the cumulative water quality and other environmental impacts of the proposed development.	2.08	2.64	2.04
86.	Provide states and localities funds to hire, train, and maintain the qualified staff they need to promote better land use planning that considers water quality impacts.	1.81	2.04	2.69

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Federal actions designed to address impeding factors generated by experts during Phase I and presented to experts during Phase II.		**Average Expert Group Scores on Rated Dimensions[a]** Items were rated on a five-point scale. Lower scores reflect higher levels of importance, effectiveness, and feasibility. See notes below.		
		Importance[b]	**Effectiveness[c]**	**Feasibility[d]**
87.	Fund and support efforts to collect and analyze the necessary data (physical, chemical, and biological) to determine ambient water quality and the water quality impacts of alternative land uses. Provide tools to help obtain this data, including long-term water quality surveys and monitoring, GIS, and remote sensing.	1.69	1.92	2.04
88.	Condition the provision of federal funds on states or localities taking specific actions to control nonpoint sources, improve water quality, and achieve performance goals. For example, make grants of federal funds contingent on localities basing land use and water quality plans on good economic, environmental, and anti-degradation analyses.	2.19	2.23	2.88
89.	Serve as a mediator and partner with states and localities rather than as an overseer, and help them to devise their own solutions to concerns about the environmental impacts of land use. These concerns are local, and federal one-size-fits-all policies do not encourage tailored innovative strategies.	2.46	2.58	2.38
90.	Ensure that the implementation of the TMDL rule does not come at the expense of developing comprehensive watershed protection programs.	1.83	2.09	2.22
91.	Effectively implement the TMDL rule and support a national assessment of nonpoint source pollution, identification of successful source controls, and the creation of the necessary supporting databases.	2.17	2.21	2.33
92.	Promote comprehensive land use planning that considers environmental impacts and involves all key stakeholders. This should also include efforts to update state enabling legislation so that it provides for such planning.	1.88	2.12	2.56
93.	Fund and lead efforts to improve modeling capabilities for states and localities. This would include models that localities can easily adapt to reflect their unique water quality conditions and that measure the impacts of land use, including transportation patterns and changes in hydrology.	1.88	2.20	2.21
94.	Provide for measures of watershed protection that gauge the amount of water quality improvement actually achieved as opposed to measures of activities, such as permits issued, administrative actions undertaken, technologies used, or fines imposed.	1.64	1.92	2.20

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Federal actions designed to address impeding factors generated by experts during Phase I and presented to experts during Phase II.		Average Expert Group Scores on Rated Dimensions[a] Items were rated on a five-point scale. Lower scores reflect higher levels of importance, effectiveness, and feasibility. See notes below.		
		Importance[b]	Effectiveness[c]	Feasibility[d]
95.	Serve as an information clearinghouse and educator to (1) state and local governments, (2) planners, (3) the general public, and (4) relevant trade associations that are involved in land use and water quality issues. Provide information and guidance on case studies of ways communities have successfully linked water quality protection and land use, new environmental technologies, innovative development techniques, growth management strategies, model ordinances, conservation efforts, and water quality assessments and monitoring techniques.	2.12	2.35	1.65
96.	Promote the use of market-based approaches that encourage nonpoint source control and land uses that minimize water quality impacts. For example, allow localities to trade pollution credits between point and nonpoint sources within a particular watershed or basin.	2.68	2.58	2.78
97.	Increase funding for infrastructure and provide it in a way that ensures upgrades and repairs for existing infrastructure.	1.73	2.08	2.48
98.	Provide some federal tax benefit for renters to make it easier and more attractive to rent townhouses and apartments in high-density, mixed-use developments as an alternative to ownership of single family detached houses.	3.52	3.73	3.09
99.	Reform regulatory approaches for water quality. For example, revise storm-water management regulations so that localities (1) are less inclined to view and manage storm water as a waste product that must be immediately removed, (2) are more inclined to consider alternatives, such as greater reliance on on-site management and treatment, (3) will place less reliance on implementing conventional BMPs, and (4) shift attention toward source reduction, pollution prevention, and mitigation of other harmful factors such as the quantity and temperature of storm water discharged to receiving water bodies.	1.84	2.17	2.48
100.	Make low-cost loans available to localities to implement comprehensive land use plans that consider environmental impacts or that target public investments to designated growth areas.	2.62	2.76	2.67

[a]The ale ranges from 1 to 5; "Don't know/No Opinion" responses excluded in calculations. Lower scores reflect higher levels of importance, effectiveness, and feasibility. See notes regarding actual wording of questions below.

[b]The actual question wording is as follows: "How important is it to take this action? 1. Very Important, 2. Important, 3. Neither Important Nor Unimportant, 4. Unimportant, 5. Very Unimportant, or 6. Don't Know/No Opinion."

[c]The actual question wording is as follows: "How effective would this action be? 1. Highly Effective, 2. Effective, 3. Neither Effective Nor Ineffective, 4. Ineffective, 5. Highly Ineffective, or 6. Don't Know/No Opinion."

[d]The actual question wording is as follows: "How feasible is it to implement this action? 1. Definitely Feasible, 2. Probably Feasible, 3. May or May Not be Feasible, 4. Probably Infeasible, 5. Definitely Infeasible, or 6. Don't Know/No Opinion"

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Acknowledgments

In addition to the individual named above, Carolyn Boyce, Elizabeth Erdmann, Scott Gannon, Brandon Haller, Mitch Karpman, Karen Keegan, Ralph Lowry, Gopaul Noojibail, Frank Rivera, and Carol Herrnstadt Shulman made key contributions to this report.

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