TRANSPORTATION
RESEARCH
CIRCULAR

Number 469, March 1997
ISSN 0097-8515

ENVIRONMENTAL RESEARCH NEEDS IN TRANSPORTATION

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BACKGROUND PAPER

The Clean Air Act Amendments of 1990 (CAAA) include provisions to control carbon monoxide, ground-level ozone (urban smog), particulate emissions, and other air toxics from motor vehicle engines. It seeks to reduce vehicle emissions through a combination of cleaner vehicles, cleaner fuels, and transportation programs and projects that will improve traffic conditions, alter driving behavior, or make alternatives such as transit or other modes an increasingly important part of the transportation network. In December 1996, new air quality standards were proposed for ozone and particulate matter, representing significantly more difficult targets to meet.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) reinforces the need for the nation's nonattainment areas to achieve the National Ambient Air Quality Standards (NAAQS). ISTEA emphasizes an improved planning process that includes consideration of multimodal investments, land use decisions, financial constraints and air quality improvement. Through its planning framework and specific funding programs, ISTEA gives State and local officials the tools to adapt their plans to assist nonattainment areas in achieving the NAAQS. The Congestion Mitigation and Air Quality Improvement Program (CMAQ) and the Surface Transportation Program (STP) specifically enable the funding of transportation projects that reduce emissions including the transportation control measures (TCMs) listed in the CAAA. Together, CAAA and ISTEA provide complementary approaches to decrease transportation-related emissions. In practice, while the CAAA sets air quality requirements and milestones, mandates further improvements to vehicles and fuels, and requires greater integration of transportation and air quality planning, ISTEA provides the funding flexibility to target the use of transportation funds to promising strategies to reduce transportation-related emissions.

Research efforts should investigate the transportation implications of the proposed new ozone and particulate standards. Research should assess the significance of the proposed standards on current approaches to reach attainment, address the anticipated effectiveness of regional control strategies, identify the impacts of the new standards on the transportation planning process, and assess the conformity requirements in light of new standards and new, larger nonattainment areas. Impacts of new standards on ISTEA legislation should be investigated as well as current and possible future linkages between the CAAA and ISTEA. The rules proposing the new standards will be made final in 1997 with their implementation to follow. Given this very short time frame, this is considered a high priority area which should be addressed as soon as possible.

An important topic in developing transportation and air quality plans and programs is to identify the most effective transportation strategies to improve mobility and reduce emissions given Federal and other available funding. For instance, some TCMs, such as high occupancy vehicle (HOV) lanes, transit, or intermodal facilities, require large capital investments, while others such as pricing and regulatory mechanisms may be of relatively low capital intensity. It is important that each state or area decide among alternative investment strategies based on the relative costs and benefits given the multiple objectives served by transportation investments. Further, the long term impacts of certain capital investments is un-

clear, specifically whether such investments effectively induce new travel demand. To provide assistance to states and metropolitan areas, research on the relative cost effectiveness of alternative transportation investments and TCMs in reducing vehicular emissions is needed. In addition, research is needed into the question of the long term impacts of certain investments on inducing demand and/or satisfying latent demand.

To achieve national air quality goals, the CAAA require the most polluted areas to limit growth in vehicle travel by reducing Single Occupancy Vehicle (SOV) travel and VMT. Control of total vehicle miles traveled (VMT) requires broad support from jurisdictions beyond the transportation and air quality communities including the business community and general public. According to a national survey, the reasons for increased VMT during the past 20 years included a dramatic increase in the number of workers, an increase in the number of jobs located in the suburbs where fewer travel alternatives are offered and distances are greater than suburb-to-city travel, increases in vehicle ownership, a decrease in vehicle occupancy for work trips, and lower fuel costs in real terms compared to the costs in 1950. Growth in VMT has been further reinforced by the land use patterns of dispersed residences and jobs. Research is needed to explore viable and effective strategies to ensure that rising VMT will not eventually overtake mobile source emissions improvements. Whether and when emissions will rise with VMT, to what level, and what can be done at present and in the future, are important issues to be studied.

Particulates are a significant contributor to human health problems, including asthma, chronic respiratory irritation, toxic exposure, and possible carcinogenesis. Combustion of transportation fuels is implicated as a major source of these fine particles, with tire, engine and brake wear being contributors. In recognition of these effects, EPA is proposing stricter standards for particulates, notably a standard for extremely fine particle matter ($PM_{2.5}$). Research is needed to determine the contribution of mobile sources to the particulate problem, the relative contributions of tire, brake and engine wear, de-icing sands and salts, and other mobile sources; and information about what control strategies are reasonably available. Additionally, the cost effectiveness of various strategies should be researched and documented.

Heavy duty vehicles (8,500 lbs. and over) are significant contributors of NOx, SOx, and PM_{10} emissions, and also contribute to CO and HC emissions. Emission rates for heavy-duty vehicles are related to the vehicle's operating characteristics including time of day of travel, temperature, engine classifications and loads. Research is needed to specifically focus on emissions from heavy-duty vehicles and to understand and document the emission rates of heavy-duty vehicles as a function of engine load and on road activity, to explore reasonable control strategies to reduce emissions from heavy-duty vehicles, and to develop methods to analyze heavy-duty emissions as a separate component in future travel demand modeling.

A small fraction of light-duty vehicles is responsible for a large fraction of fleet emissions. These vehicles typically exhibit high emission rates during all operating conditions. Research is needed to identify these vehicles ("high emitters") in urban areas and quantify their emissions so that improved emission reduction strategies targeting this significant subset of the vehicle fleet can be developed and implemented.

The need for information required by CAAA and ISTEA guidance and regulations published on VMT forecasting, transportation and air quality planning, state implementation plan development, motor vehicle inspection and maintenance, the CMAQ program, TCMs, and conformity have placed a significant burden on state and regional officials. Depending on their classifications, some nonattainment areas have to meet mobile source requirements relating to inspection and maintenance programs, vapor recovery systems, clean fuel fleet programs, VMT limitations, reformulated gasoline, or oxygenated fuels. The development of a systematical network for assessing regulations, policies, and compliance issues is needed. In addition, the impacts of these regulations, the models to be used, and changes in compliance requirements should be evaluated efficiently and systematically.

The CAAA includes fuel along with vehicle technology as a potential source and target of emission reductions. The CAAA mandates that improved gasoline formulations be sold in some cities to reduce emissions of carbon monoxide or ozone-forming hydrocarbons. Other programs set low vehicle emission standards to stimulate the introduction of even cleaner cars and fuels. Research to identify the most promising ways to increase the market for and use of alternatively fueled fleets is needed, with an emphasis on the early transition of publicly and commercially operated fleets--including needed fueling infrastructure.

Experts and the public have become concerned about previously unrecognized environmental threats such as greenhouse effect (global warming), acid rain, and air toxics. The relationships between these threats and air emissions from transportation sources become new areas for needed research. For example, climate observation shows that the human-induced climate change has been caused by changing composition of the atmosphere and increasing air pollutants. As selected for emphasis, car-

bon dioxide (CO_2) and methane (CH_4) are increasing in the atmosphere and play a role in governing the global climate by absorbing and re-emitting infrared radiation that would otherwise escape directly into space, thereby trapping heat. These heat-trapping gases keep the earth's surface warmer than it would otherwise be. In addition, because ozone also acts as a greenhouse gas, an increase in ozone concentration in the free troposphere will have climatic consequences. The projected climate changes are further enhanced by other air pollution problems created by people, such as acid precipitation, which involves a complex pattern of emission sources of SO_2 leading to complicated chemical and physical reactions in the atmosphere.

Many new topics need to be explored such as: the impact of alternative fuels on greenhouse gases; model development for estimating CO_2 from motor vehicles based on fuel consumption; feasibility of setting international greenhouse gas standards and impacts on the economy; feasibility of future long term emission reductions in mobile engine exhausts; evaporative emission controls during refueling, storage, and dispensing; the role of emission credit programs in regional emission reduction; and the study of the linkages between land use and air quality.

RESEARCH NEEDS STATEMENTS

Title: Particulate Matter Source Apportionment and Control Strategy Synthesis

Problem Statement: Characterization of the size, distribution, and effects of airborne particulate matter has identified fine particles of 2.5 microns and less in diameter ($PM_{2.5}$) as a significant contributor to human health problems, including asthma, chronic respiratory irritation, toxic exposure, and possible carcinogenesis. In recognition of these effects, EPA is proposing standards for this extremely fine particulate matter in ambient air that will supplement standards for 10-micron and smaller particles (PM_{10}) already in place. Combustion of transportation fuel is implicated as a major source of these fine particles, with tire, engine and brake wear, road de-icing substances, and re-entrainment of road dust also identified as transportation-related contributors. Imposition of more stringent emission standards and controls on these sources will result in substantial costs for engine and vehicle manufacturers, petroleum producers, and owners and operators of commercial trucks. However, the allocation of responsibility across sources and the need for specific source controls have not been reliably established. For example, there is apparent inconsistency between the share of fine particles presumably represented by $PM_{2.5}$ and their share of total ambient particulate mass, which may incorrectly implicate some sources beyond their actual culpability. Moreover, the contribution of mobile sources cannot accurately be established without comprehensive speciation, which has not yet been performed in most areas with high ambient levels of fine particulate. (EPA is expected soon to issue monitoring and assaying protocols that will enable this to occur.) Finally, there may be yet unidentified synergism between ozone control strategies already in place or soon to be implemented and effective means of PM_{10} and $PM_{2.5}$ reduction.

Proposed Research: (1) Review available data on recorded concentrations of fine particles and their locations, and special studies conducted on the topic; (2) obtain fine particle measurements near and at longer downwind distances (up to 500 meters) from a cross section of roadway types in urban areas situated in differing climatological regimes (e.g., arid to semi-arid, forested, agricultural prairie, humid to subtropical), focusing on the variation by vehicular speed, traffic volume, and composition; (3) perform speciation and source apportionment studies for concentrations measured near each roadway, and subtract background concentrations measured upwind of the source; (4) quantify relationships among the contributions by re-entrained dust; diesel combustion; gasoline combustion; tire, brake, and engine wear; and de-icing sand/salts; and explore how these might differ by traffic volume and level of service as well as seasonality, wind and atmospheric stability conditions; (5) attempt to identify differences among fuels and engine displacements using bench testing, as necessary; (6) develop a synthesis of reasonable available control technologies, including those already in *ozone* control strategies and SIPs. Possible follow-on research would include identification of cost-effective controls that target the most important contributors. *EPA's interest in supporting this project should be explored.*

Cost: $450,000
Duration: 24 months

Title: Heavy Duty Vehicle Emissions and Activity Levels

Problem Statement: None of the current research projects focus specifically on the emissions inventory for

heavy-duty vehicles. Research in the area focuses primarily on light duty vehicles because they are the largest emission component of the mobile source problem. However, Heavy Duty Vehicles (HDVs), those vehicles above 8,500 pounds gross vehicle weight rating, are significant contributors of NOx, SOx, and PM_{10} (exhaust) emissions, and also contribute to CO and HCs. Emission rates for HDVs are related to the vehicles' operating characteristics (such as time of day), engine classifications and loads.

Proposed Research: Undertake a research effort for heavy-duty vehicles that encompasses (1) a characterization of the emission rates as a function of engines (size, maintenance, rebuilds, etc.), and engine load parameters or load surrogates (including payload, idling, and speed acceleration profiles), (2) area-specific studies of on-road activity that can be reliably linked to emission rates for short and long-distance motor carriers and for inter-city buses, (3) an analysis of the effectiveness of HDV emissions testing procedures and modeling techniques (using data from CARB, EPA, or other parties), (4) the implications of new engine technologies developed for the 1998 HDV emission standards and the proposed 2004 emission standards, and (5) a demonstration of how the framework could be used to evaluate operational changes to achieve emissions reductions. The research will not encompass proprietary information on HDV fleets' routes, destinations, or origins. Because the pollutant emissions and type of driving modes of these vehicles are different from passenger cars, this type of data would allow the analysis of HDV emissions as a separate component in future travel demand modeling.

Cost: $1,000,000
Duration: 36 months

Title: Land Use/Neo-Traditional Development and Air Quality

Problem Statement: Traditional policies and market forces direct growth and development in American cities to low density and land-use-segregated development. This development pattern results in greater transportation infrastructure requirements and costs, limited access to alternative modes for much of the population, and degraded air quality. Recent studies have indicated that higher density, mixed use, transit and pedestrian oriented development may reduce vehicle-trip making. The results of these studies, generally of older traditional urban neighborhoods, vary significantly, but after controlling for income and household size do generally indicate a reduction in vehicle use. Neo-traditional developments are being proposed and to a limited extent built as a higher density, mixed use alternative to traditional suburban development. Little is known about the potential market penetration of such developments or about the impact of such developments on air pollutant emissions.

Proposed Research: (1) Conduct case studies to identify the impact of neo-traditional development patterns in suburban and in-fill settings on personal transportation decisions (including auto ownership and trip making by motorized and non-motorized modes). (2) Identify development pattern factors that impact vehicular travel and can be measured and included in travel models. This includes identification of factors that influence use of non-motorized modes. (3) Identify and estimate the market potential for high density/mixed use development in various metropolitan settings (including in-fill versus suburban locations, and high growth versus stable metropolitan areas). (4) Identify obstacles to implementation of in-fill and neo-traditional developments from both the public sector (for example zoning and regulatory requirements such as street width and access control) and private sector (for example financial institutional lending practices and parking standards set by private investors). (5) Estimate the time frame for implementation. (6) Estimate the local and regional level impacts on vehicle use, speed/acceleration profiles and resultant modal emissions, and transportation infrastructure impacts of implementing such development patterns in a number of prototypical metropolitan areas. These areas should be chosen to represent various regional growth patterns such as areas experiencing fast versus slow growth, and areas with declining central cities versus stable or growing central cities.

Cost: $750,000
Duration: 60 months

Title: Transportation Implications of Proposed Changes to the National Ambient Air Quality Standards (NAAQS)

Problem Statement: In November 1996 the Environmental Protection Agency will propose changes to the NAAQS for ozone and particulate matter (PM). The new ozone standard is expected to be significantly more stringent, and a new standard for very small particles ($PM_{2.5}$) will likely be proposed in addition to retaining the current standard for PM_{10}. The proposed rules are expected to become final in June of 1997. For ozone and PM, the number of counties in nonattainment is expected to triple, indicating increases in the number and the size of current nonattainment areas. These new standards could require fundamental changes in the approach used to plan for and improve air quality. New control strategies or a shift toward more regional control strategies may be necessary, and new considerations regarding ozone transport and

VMT may arise. The new NAAQS could also precipitate changes to transportation planning on a par with those effected under the 1990 Clean Air Act Amendments (CAAA) and create new administrative burdens for federal, state, and local agencies. Further, the linkages forged between the ISTEA and the CAAA to blend transportation and air quality concerns, including the conformity provisions, the CMAQ program, the emphasis on TCMs, development of State Implementation Plans, and the application of highway sanctions, may be disrupted. The full nature, magnitude and scope of these changes is unknown, and research is needed to prepare the transportation community to address them.

Proposed Research: 1) Determine the significance of the proposed standards on current approaches to reach attainment. Specifically address the anticipated effectiveness of regional control strategies, such as inspection and maintenance programs and clean fuel programs, versus local control programs, such as traditional TCMs. 2) Identify the impacts of the new standards on the transportation planning process and the mismatch between the size of metropolitan areas where planning requirements (fiscal constraint, etc.) are currently applied and new, larger nonattainment areas. Identify data requirements and model developments needed to apply the transportation planning process to larger areas. 3) Assess the current conformity requirements in light of the new standards and new, larger nonattainment areas. Suggest changes to the current approach taken under the conformity regulation. 4) Determine the effect of the new standards on current and possible linkages between the CAAA and the ISTEA. Suggest legislative, regulatory and administrative changes to insure that effective transportation programs and planning processes to improve air quality are aligned with the latest approaches to effect clean air resulting from the new standards. EPA's interest in supporting this project should be explored. This project should start as soon as possible after the final rules establishing the new NAAQS are promulgated.

Cost: $250,000
Duration: 18 months

Title: Subfleet Technology and High Emitter Characterization

Problem Statement: A small fraction of light-duty vehicles on the roadway is responsible for a large fraction of fleet emissions. These "high emitters" (i.e. malfunctioning and tampered vehicles) typically exhibit high emissions rates under all operating conditions. High emitters are usually defined relative to the emissions of other vehicles within a technology group (model year and emission control technology groups that behave similarly with respect to emissions production). Thus, when a new vehicle and an old vehicle both exhibit a large gram/mile emissions rate, the new vehicle might be considered a high emitter while the older vehicle might be considered a normal emitter. The literature provides a wide range of estimated emission inventory contributions from high emitters (e.g. 10% of the vehicles are responsible for 50% of the emissions, or 20% of the vehicles are responsible for 50% of the emissions). The differences in contribution estimates stem from differences in "high emitter" definitions and methods used to estimate the activity and emissions rates for these vehicle groups. Clear high emitter definitions are needed. New methods to identify these vehicles in urban areas (both spatially and temporally) and to quantify their emissions will lead to improved emissions modeling and will provide a basis for improving emission reduction policies that target subsets of the vehicle fleet.

Proposed Research: Undertake a literature review on light-duty vehicles high emitter definitions for CO, CO_2, HC, and NOx, and evaluate the previous studies to ensure that technology group definitions represent groups of vehicles that behave similarly in terms of emissions production. Based upon the literature review, and analysis of existing data, identify the cutpoints that should be used by pollutant (in grams/mile or grams/second) to define high emitting vehicles for various technology groups. Develop means (either through remote sensing networks, IM240 or other IM program test results, and/or actual on-road in-use testing) to identify the emitter characteristics of vehicles on urban roadways such that the fraction of high emitting vehicles for each technology group can be identified and the activity can be tied to appropriate emissions rates in the MOBILE model. Develop basic methods to apply on-road technology group fractions and emitter distributions within the context of 4-step travel demand modeling and HPMS modeling frameworks so that local subfleet information can be used in the MOBILE6 emissions modeling process. Implement these basic methods in three urban areas that exhibit diverse geographic, socioeconomic, aggregate fleet, and inspection and maintenance program characteristics. Based upon analytical results for these areas, analyze the spatial and temporal distributions of high emitting vehicle operation as a function of vehicle registration and socioeconomic parameters. In addition to analyzing high emitter activity by technology group, also analyze the overall impacts of the highest emitting vehicles in the fleet. Identify technology or socioeconomic factors that appear to influence the fraction of high emitters in operation throughout the network. Based upon the cross-city results, analyze the potential effectiveness of control strategies designed to reduce the on-road fraction of high emit-

ting vehicles within and across technology groups. Analyses may include: 1) I/M repair policy changes and other I/M improvements, 2) implementation of focused vehicle scrappage programs, 3) manufacturer recall for specific failures, and 4) emissions-based annual vehicle registration fee programs. All analyses should include an overview discussion on equity impacts based upon high emitter ownership and socioeconomic correlations.

Cost: $300,000
Duration: 18 months

Title: Pollution Emissions from Specialty Fleet Vehicles

Problem Statement: Conventional motor vehicle emissions inventories and control strategy analyses include estimates of air pollutant emissions that are based on average emission rates and estimated VMT for broad classes of motor vehicles (for example, light-duty gasoline vehicles, which roughly corresponds to passenger automobiles). Vehicle emission factor models such as MOBILE may understate emission rates for special-purpose subgroups that are used particularly intensively or that operate under conditions that tend to produce elevated emission rates. These subgroups include public fleets, taxis, rental fleets, panel trucks used by the professional trade, utility vehicles, shuttles, and many others. In addition, the procedures commonly used to estimate VMT, including regional travel demand models, fuel sales, and vehicle counts on major urban arterials, may understate or even omit entirely the contributions of these vehicle subgroups.

Proposed Research: (1) Clarify the extent to which emissions (CO, HC, and NOx) from special-purpose vehicles are already recognized in developing typical motor vehicle emissions inventories and control measure analyses. (2) Develop emission rates, using MOBILE or by gathering real data from inspection programs, for a number of special-purpose vehicles at the metropolitan level (rather than relying on fleet-wide of these parameters). (3) Estimate activity (speeds, idling, VMT, etc.) possibly using data gathered from instrumented vehicles. (4) Use the data to estimate total emissions from these fleets and compare the result to the contribution of light-duty vehicle emissions in the metropolitan area. (5) In addition, the research should identify appropriate control strategies, such as conversion to alternative fuels, scrappage, or age limits for operation for application to specific vehicle classes, to achieve more accurate inventories of total motor vehicle emissions and development of more effective policies to reduce these emissions.

Cost: $500,000
Duration: 30 months

Title: Seasonal and Episodic Transportation Measures to Avoid Exceedances

Problem Statement: A number of regions have developed seasonal and/or episodic transportation measures to reduce transportation-related emissions during periods of potential high ambient ozone and carbon monoxide levels. These approaches generally include broadly based public information and outreach campaigns to minimize motor vehicle travel during days projected to have high pollutant levels. These programs have attracted significant employer involvement and support. While some evaluation has been done of their effectiveness, their actual results in reducing emissions are uncertain. Some areas use these measures as contingency measures to avoid ozone exceedances, others wish to claim credit for the emissions reduced in their State Implementation Plans (SIPs). To date the EPA has discouraged episodic or seasonal strategies, however, recently they have shown an interest in investigating the efficacy of such measures. Recently, the EPA commissioned a study of current episodic measures including a preliminary assessment of their effectiveness.

Proposed Research: This research would develop a menu of program components and resources appropriate for various air quality areas including scenarios for both episodic and seasonal measures arraying the pros and cons of each potential approach. The research would include the following components: 1) Define a range of transportation behaviors (such as mode shifts, trip substitutions as well as driving to minimize extreme modal emissions of heavy accelerations and high speeds). 2) Define and estimate potential targets by specific transportation market niches through various market research techniques such as focus groups. 3) Estimate the potential and the magnitude of marketing resources that would be necessary to achieve the potential targets, drawing on the experience of such systematic public awareness programs as energy conservation, waste recycling and non-smoking. 4) Estimate the emissions reductions, energy and carbon dioxide impacts of the varying marketing approaches. 5) Identify and develop tools to predict likely travel behavior and emission reduction benefits, and evaluation mechanisms to measure and quantify the results such as personal travel surveys, traffic monitoring, transit boarding counts, and fuel sales. 6) Demonstrate how these tools can be applied in one area. 7) Estimate the cost-effectiveness of the various measures. 8) Identify cooperative mechanisms for the public and private sector to sustain the public awareness program and measures over time. 9) De-

velop criteria to be met if such measures are to be included for emission reduction credits in SIPs including: permanence (long term commitment and resources to sustain the public awareness effort); quantification; and enforceability (including that there is an established mechanism to continue to monitor the program and results into the future).

Cost: $250,000
Duration: 24 months

Title: Modification of HPMS for Air Quality Analysis

Problem Statement: The Highway Performance Monitoring System (HPMS) was developed as a tool to track national vehicle miles traveled (VMT) and roadway conditions. Although this system was not developed for air quality analysis purposes, EPA requires that it be used for evaluating nonattainment area VMT in State Implementation Plans. A variety of air quality control measures will automatically be invoked if HPMS VMT exceed SIP projections by 3% or more. Proposed changes to the National Ambient Air Quality Standards (NAAQS) for ozone and particulate matter may greatly increase the number of nonattainment areas forced to use HPMS data. Many potential nonattainment areas under the new NAAQS lack adequate travel demand models and will be required to use HPMS data in SIP development. Some HPMS facility classifications are different than those used in travel demand modeling. Due to problems with data compatibility, HPMS data cannot readily be used to evaluate and improve travel demand model VMT estimates. In many areas, HPMS may not be the most accurate method of reporting VMT. More extensive counts or Intelligent Transportation Systems, Congestion Management Systems data may be available and may be more accurate than HPMS.

Proposed Research: For urban areas of varying size, evaluate the current accuracy of HPMS by comparing estimates to actual ground counts and examining the sampling network for potential bias. Based on this work, determine the overall uncertainty of HPMS-derived regional pollutant emissions estimates. Make recommendations on how to supplement or modify HPMS to achieve the desired accuracy. Develop guidelines for making HPMS facility types consistent with travel demand model facility types and for applying HPMS or a similar system in areas that may soon face new conformity requirements under the proposed changes to the National Ambient Air Quality Standards.

Cost: $200,000
Duration: 24 months

Title: Latent and Induced Demand from Effective Capacity Changes

Problem Statement: Driver trip-making response to added capacity has been the subject of several studies. This work generally indicates the potential for added capacity to increase demand, so that resultant flow improvements may be only temporary. The reverse phenomenon is of interest as well: reductions in capacity through traffic calming, road closure, etc. may result in diminished demand. More study is needed to determine the demand implications of a wide variety of measures that effectively increase capacity, including add-a-lane HOV, pricing, new transit services, ITS and other traffic flow improvements. Flow improvements can also serve as an incentive for new development and changes in land use at the local level. Hence, emissions from new area and indirect sources may also be facilitated by roadway capacity increases.

Proposed Research: Review literature on latent and induced demand. Identify projects or areas in which change in demand has been documented in response to increases or decreases in effective capacity. Examine and synthesize data from these examples. Effects of changes in occupancy restrictions for HOV lanes should be studied, as should volume changes in response to transportation control measures, including traffic flow improvements and traffic calming. The relationship between the growth of area and indirect source emissions along expanded highway and transit corridors should also be investigated. Identify MPOs that have included or propose to include in their four-step models feedback to trip generation, trip distribution and time of day of travel to reflect latent demand phenomena. Produce guidelines for adjusting models estimating highway vehicle emissions to reflect the consequences of changes in effective capacity.

Cost: $300,000
Duration: 24 months

Title: Ambient Microscale Monitoring for Project Compliance with the National Ambient Air Quality Standards

Problem Statement: Of the National Ambient Air Quality Standards established by the Environmental Protection Agency, carbon monoxide (CO) and particulate matter (fine dust less than 10 microns in diameter) are generally considered to have a near facility/ hot spot or micro scale level impacts, i.e. their concentration can change significantly within a short distance of the transportation facility. Transportation conformity require-

ments establish complex analysis requirements for transportation projects located in areas designated non-attainment or maintenance for these pollutants. In these areas a project cannot proceed if the analysis shows the action may cause or contribute to a new violation of the standards and/or increase the number or severity of existing violations. In attainment areas such analysis may raise concern that advancing the project could bring the area into non-attainment status.

The existing methodology is not well suited to deal with the form or stringency of the standards. Traffic models are constructed to describe average, not extreme, operating conditions. Emission models produce regional average emission rates which may not be appropriate at the sub-regional or project level. Dispersion models do not perform well under the conditions most likely to create hotspot conditions (calm or near calm wind speeds). Background concentrations are often unknown. To overcome these uncertainties and limitations, conservative modeling assumptions are used for CO analysis. Microscale analysis models for fine particulate have not yet been released by EPA but will doubtless suffer the same shortcomings. Unfortunately, while monitored data is trending down, analysis results are indicating increasing concentrations. Project sponsors would likely accept a short term need for monitoring as an alternative to the current methods used.

Proposed Research: Develop detailed methods and technical guidance for ambient monitoring at microscale levels for determining site and background concentrations. Determine if it is possible to directly measure pollutant levels in short-term direct monitoring programs (day, week, month, 3 month) to give reasonable estimates of the potential to exceed standards at the project location. An effort should also be made to combine this approach with existing screening methods. This research would allow for rapid and reliable determination of hot spot potential for CO and particulates.

Cost: $500,000
Duration: 36 months