THE COSTS OF TRANSPORTATION IN SOUTHEASTERN WISCONSIN

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CONTENTS

List of Figures

Figure

List of Tables

Table

EXECUTIVE SUMMARY

Transportation planning in the Southeastern Wisconsin region is at a crucial juncture. Today's choices will impact the quality of transportation services, their costs, and the quality of the region and its environment for a generation to come. This report reviews the cost implications of the 1992 land use plan and 1994 long range transportation plan issued by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). These plans lay out infrastructure investments and operational priorities through 2010.

The recent plans take steps in the right direction through improved transit services; however, the transit funding framework is weak. The plans and funding formulas reveal a continued preference for roads, along with loose land use controls that let development happen based on short-term opportunities with little regard to regional accessibility. Past experience shows that road building offers but temporary congestion relief at best, guaranteeing greater traffic in the future while choking off choices for other options more appropriate for an urbanized area. At the same time, outlying areas in the region's counties suffer from encroachments on rural lands. Such sprawl development offers a temporary respite for some people while compounding traffic growth and burdens on county and municipal services. More effective policies are needed to better coordinate land use with transportation. Better funding for transit is crucial to residents for whom private vehicles are too costly or inaccessible, as well as to reduce congestion for those who are otherwise stuck on increasingly crowded roads.

SEWRPC's planning process was quite thorough and did explore alternative paths. One such option gave greater emphasis to transit and complemented it with transportation pricing reforms that provide incentives for more efficient mode choice and more efficient land use while creating a richer set of travel choices in the seven county area. The planning commission's plans for potential transit expansions identify what is needed to create and effective and comprehensive transit system. However, state and local authorities have not come forward with the funding needed to implement these plans.

Citizens for a Better Environment (CBE) has outlined new planning options that would build on transit corridors already identified by SEWRPC. CBE is working with the Commission to analyze a transit-oriented, "Livable Communities" plan which would lengthen the time horizon sufficiently to explore a better coordination of land use with transportation investments. This study is developing a new, long-range approach to the region's transportation and land use, entitled "Vision 2040: An Alternative Way to Grow." This approach would concentrate new development around transit stations and along major travel corridors within the region. The analysis reported here provides an economic context for the CBE study by examining the financial and social cost implications of current plans.

Examining economic issues is a key aspect of evaluating planning alternatives. Foremost are the cost implications for taxpayers. Through local, state, and federal governments, taxes pay to build and maintain the transportation infrastructure. The economics of regional transportation

also includes many private costs, the largest of which is now that of cars themselves. A number of other monetary burdens are associated with cars and light trucks, such as accident costs and parking. Besides such dollar transactions, external costs, such as air pollution and congestion, enter the picture. A thorough analysis of planning alternatives should attempt to tally all such relevant cost items, whether they are direct public and private expenditures, hidden costs, or difficult-to-quantify but still quite real external costs. The benefits side of the economic equation for transportation is very difficult to characterize. But for comparing plans of a regional scope, designed to equivalently accommodate the accessibility needs of a population, analyzing the cost side of the equation can help guide the public and decision makers toward less costly options.

A first step in providing an economic analysis of regional transportation planning alternatives is to characterize the current cost picture. That exercise is the subject of this study, which sets the stage for subsequent analysis to compare the costs of alternative long-range plans for Southeastern Wisconsin region. Social cost analysis of transportation is an emerging field; a number of studies have addressed the issue at the national scale but few studies have had a regional focus. It builds, however, on more traditional financial analyses of transportation projects, such as those reported in the plans.

To carry out this study, we developed a social cost analysis model oriented toward region-scale analysis. It provides a partial analysis in that it is restricted to passenger transportation; a full analysis (and worthy extension of the model) would also cover freight transportation. The present analysis also excludes transportation-linked land use costs—those that are the subject of fiscal impact analyses of development at the municipal and county levels. While not part of the transportation infrastructure per se, other community services costs, such as schools or water and sewer services, can vary depending on the density of development and its proximity or coordination with other development.

This report's key findings are listed on the adjoining page. Following this summary, the report has four major sections. First, the introduction gives an overview of the region, its transportation system and plans, and a review of relevant literature. Section 2 analyzes public spending trends on transportation in the region, based on an examination of past plans and budgets, in order to develop a overall balance sheet breaking down recent spending by level of government and mode. This part of the analysis pays particular attention to imbalances in the financial picture, particularly local road costs not covered by transportation user fees and the net outflow of transportation revenues from the region. Section 3 extends the analyses to cover all major costs associated with passenger travel, presenting a social cost snapshot. Section 4 then examines the recent plans, particularly SEWRPC's long-range plan through 2010, and then projects the cost implications, both public expenditures and the social costs, for passenger travel as expected under the current planning paradigm. The rest of this summary highlights key points from this first phase analysis of transportation costs in Southeastern Wisconsin.

The Costs of Transportation in Southeastern Wisconsin—Key Findings

Public expenditures on the regional transportation system amounted to $536 million in 1992, an average of $780 per household. Locally raised funds covered 46 percent of the spending; state and federal funds covered 39 percent and 15 percent, respectively.

Most local government transportation funding (86 percent) comes from non-transportation sources, including property taxes and shared revenues derived from state income and sales taxes. Local roads comprise the single largest portion (36 percent) of public spending on transportation in the region. Counting local roads, recent public expenditures show a 75 percent/25 percent roads/transit split.

Planned public spending on transportation in the region through 2010 has a 76 percent/24 percent roads/transit split, essentially unchanged from the current pattern. The 1994 plan entails a $222 million average annual shortfall in transportation financing; given recent state and federal proposals, transit bears a much greater risk of funding shortages than roads.

Transportation-based fees (mainly gasoline taxes) collected in the region amount to 75 percent of transportation spending, but net outflows of these fees from the region result in their covering only 61 percent of spending. Transportation revenues collected by federal and state governments exceeded their expenditures in the region by an average of 29 percent from 1987-92.

Although public expenditures on infrastructure play a major role in shaping the regional system, these public costs amount to only 11 percent of the total monetary cost of the regional system.

The total social cost of transportation in the region is estimated at $7.3 billion ($10,500 per household) in 1992, counting both public and private costs as well as hidden and external costs. Although some of these costs are uncertain, they are significant, and so it would be misleading to omit them from a transportation cost analysis.

The largest transportation cost item is the private cost to individuals of owning and operating automobiles (cars and light trucks), which averaged nearly $3600 per household in 1992. Autos account for 98 percent and transit for 2 percent of the full cost of passenger transportation in the region.

The second largest cost is that of accidents, which averaged nearly $3400 per household; insurance premiums cover only 21 percent of total accident costs when including those associated with loss of life and serious injuries. External costs associated with congestion, air pollution, and petroleum consumption amount to 17 percent of total costs.

The region's population is expected to grow 6 percent from 1991 to 2010, but regional road travel (vehicle miles traveled—VMT) is expected to grow nearly six times as fast (35 percent by 2010) under current plans. Direct, hidden, and external costs of transportation grow nearly in step with automobile use, increasing the total social cost by 27 percent over the 1992 level by 2010 and cost per capita by 20 percent.

State and local officials should revisit transportation and land use plans for the region, accounting for the funding imbalances and social costs identified here, and pursue revised plans that promote transit-oriented development and pricing reforms that could together yield a future system less dependent on automobiles and their high social costs.

Transportation Spending Trends

Figure ES-1 shows public revenues and expenditures on transportation in the Southeastern Wisconsin region in 1992, broken down by level of government (federal, state, local). Overall spending amounted to $536 million in 1992 (all figures are given in 1992$). Revenues obtained from transportation sources in the region amounted to $403 million in 1992. Thus, transportation-derived revenues were equivalent to 75 percent of overall transportation expenditures. Consumers pay the difference, largely through part of general sales taxes. Moreover, as the figure suggests, not all revenues collected in the region are spent in the region.

Of total spending, local governments provided the largest portion, 46 percent; state funds provided 39 percent, and federal funds provided 15 percent. The picture developed for 1992 is in line with statistics for 1985-92. Generally, all levels of government increased spending, even in inflation-adjusted terms, on both roads and transit. An exception is federal transit support, which declined at an average inflation-adjusted rate of 6.4 percent per year from 1987-92. In contrast, federal highway support increases averaged 3.8 percent per year from 1985-92. State aids for both roads and transit increased at average rates of 4.1 percent per year and 4.4 percent per year, respectively. Local government road spending showed a slight inflation-adjusted upward trend of 0.8 percent per year, averaging $276 million from 1986-93; an average of 27 percent of this spending was offset by state aids. Thus, general revenues devoted to roads by local governments averaged about $200 million per year.

Total local transportation spending in 1992, excluding transit fares, is equal to $195 million for roads plus $16 million for transit, a total of $211 million. This spending draws on local general revenues, including property taxes and state shared revenues derived from non-transportation sources, which therefore cover 39 percent of the region's transportation spending. Local general revenues, not directly linked to transportation when collected, tie with state transportation aids as the largest sources of support for transportation in the region. Adding the $34 million in transit user fees brings the total of locally derived revenues spent on transportation to $245 million, for the 46 percent total local share noted above.

Financial Outflows from the Region

The region's situation in 1992 illustrates a recent pattern in which federal and state road user fees collected in the region exceed federal and state transportation expenditures in the region. In 1992, federal user fees (mainly the gas tax) amounted to $122 million, of which $82 million (67 percent) was returned for federal transportation programs in the region. The State of Wisconsin collected $247 million in transportation user fees, compared to state spending of $209 million (85 percent) in the region. Over the 1987-92, both federal and state transportation user fee collections exceeded federal and state transportation spending in the region by an average of 29 percent, for a cumulative net outflow of $420 million over the six-year period. This phenomenon is common for urbanized areas in the United States, since most driving and therefore most fuel tax collections occur in metropolitan areas, while extensive portions of state and federal highway systems run through less developed areas. Since regional

interconnectedness is now largely accomplished while urbanized regions struggle with congestion, inadequate transit service, and often strained local budgets, it may be time to revisit the extent to which urban areas subsidize roads throughout the countryside.

Current Social Costs of Transportation

In the broader context of total social costs, public spending on the region's transportation infrastructure and related services is but a small portion of the overall cost of the system. Figure ES-2 summarizes our analysis of the total cost of passenger transportation in the Southeastern Wisconsin region for 1992. The estimated total annual cost is $7.3 billion regionwide; averaged over the region's 690,000 households, this total works out to $10,500 per household. Not all costs are monetary, and of the monetary costs, not all are directly paid. In interpreting these results, it is important to note the uncertainties inherent in any such analysis. Items like public spending are quite exact, since they are drawn from budget tables. More uncertainty is involved in monetary costs based on averages, such those of regionwide car ownership. Admittedly much greater uncertainty is involved in estimating external costs, such as those associated with accidents, congestion, and air pollution. But none of these costs are zero. Even though some of the "point" estimates entail substantial uncertainty, they are significantly greater than zero. Therefore, an analysis that omits them would be more misleading than an analysis that includes them, duly qualified by a reminder of the uncertainties.

Monetary costs—those of roads, the transit system, private vehicles, their fuel use, and portions of other cost categories—account for 65 percent of the total social cost. Of these monetary costs, 73 percent are directly paid, meaning paid by users (drivers, bus riders, etc.) in a way linked closely enough to inform decisions about transportation. Thus, only 47 percent of total costs are directly paid, and the largest portion of unpaid social costs are those associated with automobile use. This finding is consistent with other recent transportation cost studies. Coupled with the fact that local roads are largely financed by general revenues, these results indicate how extensively automobile use is subsidized, both directly (through use of property taxes and other general revenues) and indirectly (through hidden and external costs).

The $536 million in public costs associated with transportation infrastructure amount to only 11 percent of the monetary cost associated with transportation in the Southeastern Wisconsin region, and only 7 percent of the $7.3 billion total social cost. The largest item—34 percent of the total—is what private individuals pay to own, maintain, and operate their automobiles (both cars and personal light trucks). Nearly as large—32 percent of the total—are the comprehensive costs of automobile accidents in the region. Although drivers pay for insurance, premiums cover only part of the costs associated with accidents. The larger part of the toll is the non-monetary cost associated with lost quality of life, including fatalities and serious injuries. Parking costs are also only partly paid directly; some are included among road expenditures, but many are hidden or only indirectly paid. We estimate the annual average cost of parking at $966 per household, or about 9 percent of the total cost picture. Congestion, air pollution, and a number of other costs are externalities, that is, costs caused by an action but not borne by the individual responsible for it. The external costs associated with air pollution and

petroleum supply amount to 11 percent of the total cost. Congestion accounts for 6 percent. Broken down by mode, cars and light trucks account for 98 percent and transit buses account for 2 percent of the total social cost.

A conclusion of this analysis is that the regional transportation system fails to pay its own way in terms of cost. The largest portion of the effective subsidy, both direct and indirect, accrues to automobile users. The difference between total monetary costs and direct payments is $1.2 billion, or $1,800 per household in 1992. Given the one million private vehicles consuming nearly 600 million gallons of gasoline in the region, this difference works out to $1200 per car per year or $2.00 per gallon. The indirectly paid costs (which include costs of local roads, non-insurance-covered monetary accident costs, and indirectly paid parking costs) thus underwrite a higher level of driving that might be chosen if costs were directly borne—a level of driving that is economically inefficient as well as humanly and environmentally damaging.

Where the Region is Headed

Based on an intermediate growth scenario used as the basis for SEWRPC's regional plan, the population of the seven county area is expected to increase 6 percent between 1990 and 2010. Expected growth is 12 percent in regional employment and 15 percent in number of households. Given socioeconomic and geographic trends reflecting an ongoing shrinkage in average household size and steady jobs growth, along with land use based on low- to medium-density development poorly coordinated with transit, the current plans will result in continued automobile dependence. Even without accounting for the additional traffic likely to be induced because of road expansions, under current plans a 35 percent VMT increase is forecast for 2010 compared to the 1991 level. This VMT growth is more than double the growth in number of households and nearly six times the rate of population growth. Therefore, auto-related costs will increase. Given that past projections have understated VMT growth and that induced auto travel will follow from road building, future VMT and associated costs may be higher than projected and congestion relief is likely to be less than promised by the plan.

SEWRPC's 1994 plan contains a set of road, transit, and transportation system management measures to be pursued between now and 2010, entailing $4.9 billion in capital spending and average annual spending is projected of $522 million. Allocations under the plan yield a 75 percent/25 percent roads/transit split for the capital spending and a 66 percent/34 percent roads/transit split on an average annual basis. This plan only covers "regional" roads; we estimate an average annual cost of $220 million for local roads managed by cities, towns, and counties. Counting local roads, estimated annual average spending would have a 76 percent/24 percent roads transit split, essentially the same as in 1992. Other than farebox revenues, we estimate that an annual average of $261 million of local revenues, net of expected state and federal aids, will be needed for transportation by 2010 (84 percent of which is the $220 million for local roads). Altogether, public expenditures by all levels of government for both roads and transit in the region would need to average $780 million per year by 2010, a 46 percent increase over the 1992 level.

To cover these expenditures, SEWRPC estimated annual average available funds of $300 million based on current revenue collection levels and allocations. This value is $222 million short of the projected average cost of the regional plan (excluding local roads). Proposed changes in state programs are slated to provide some additional revenues, particularly for roads. Wisconsin's "Translinks 21" plan proposed raising the gasoline tax and other user fees to provide more funding for transportation programs throughout the state, including additional road funding of $108 million for the Southeastern region. However, recent legislatures have not been inclined to raise the gasoline tax. Even if the funds were available, the state plan would allocate $95 million (88 percent) of these additional funds to state highways—more than needed to cover that portion of the shortfall. But county roads and especially transit would be left with a large revenue gaps.

The plans identify proposed increases in state transit funding that could yield an annual average of $39 million more for transit and also assumes a $40 million increase in federal funds. Compared to the projected transit funding shortfall of $96 million, this combined $79 million still leaves $17 million to be made up by local sources in the region. Thus, the funding shortfalls anticipated by SEWRPC are not modally balanced. The risk of inadequate transit funding is considerably greater than the risk to roads.

Social Cost Trends

Turning to the social cost picture, the region's total transportation cost is expected to rise to $9.2 billion in 2010, a 27 percent increase over the $7.3 billion estimate for 1992. Figure ES-3 illustrates projected trends in major components of transportation cost, based on SEWRPC's land use and transportation modeling results and our corresponding cost analysis. Driven by rising automobile use and a continuing rise in the real (inflation-adjusted) cost of auto ownership, private costs of owning and operating cars and light trucks lead the increase. Transit system spending would double, but remain a small share (about 1 percent) of the total cost picture (too small to be shown separately from the other public costs in the figure). Other items contributing to the overall rise in transportation costs are mainly those associated with auto use, including road and parking costs, accident costs, and the petroleum-related external costs of greenhouse gas emissions and oil supply. Declines are projected for criteria air pollution and congestion (although, as noted above, such declines may not be as great if induced demand were taken into account). The cost items having an increasing share of the total are public costs of the road and transit system plus that largest item, the privately borne costs of owning and operating cars and light trucks.

In developing its recent regional plan, SEWRPC considered an alternative providing improved transit services and higher fuel taxes needed to provide adequate funding. The Commission's analysis found a better benefit/cost ratio and lower environmental damage than for the plan subsequently adopted. Raising users fees such as the gasoline tax was considered politically very unlikely. However, ways to achieve such better transportation pricing by reducing other taxes were not explicitly considered. Such tax shifting, e.g., by lowering property taxes or reducing state income taxes, could be accomplished at zero net cost burden to the

region's residents. However, the resulting increase in transportation efficiency would yield lower costs overall. Moreover, such user fees could address the funding shortfall identified above, particularly for transit. In this case, it is critical that such transportation pricing and funding reforms be designed so that new revenues are allocated where they are most needed, rather than perpetuating the current pattern of net outflow from the region and a disproportionate share of state spending in the region being devoted to state highways. Such an approach, coupled with less road expansion and more concerted measures for coordinating land use and transportation investments, promises lower overall costs for the region than the auto-dependent plans still being followed by the region.

ES.1: Transportation Finance in Southeastern Wisconsin in 1992.

Figure ES.2: Social Costs of Transportation in the Southeastern Wisconsin Region (Estimated Average Costs per Household in 1992).

Figure ES.3: Social Costs of Transportation in Southeastern Wisconsin (Assessment for 1992 and Projection for 2010).

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1. Introduction

The private automobile is used for the great majority of trips in the greater Southeastern Wisconsin region (92 percent), as it is in virtually all other areas of the United States (91 percent). Automobile dependence is explained by a number of factors. First, given current land use and infrastructure, the automobile is the most convenient and flexible mode of transport for most trips. A related factor is that land use patterns and infrastructure that presume and facilitate automobile use hamper non-auto modes of transport (Pushkarev and Zupan 1977; Newman and Kenworthy 1989; Hanson 1992). The marginal cost per auto trip is generally less, in terms of both dollars and time, than that for competing modes. Finally, private, low-occupancy automobile use is subsidized, particularly if one accounts for full social costs (Miller and Moffet 1993; Apogee 1994). Overall, costs include the public expenditures that support the road system, private costs of vehicle ownership and use, indirect costs (such as the imbedded or subsidized costs of parking), and external costs (such as air pollution, energy use impacts, noise). Examining the full costs of transportation for the Southeastern Wisconsin region is the purpose of this study.

The region is seven counties, including and surrounding Milwaukee, near the western shore of Lake Michigan (Figure 1.1). Transportation and land use planning is coordinated by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), which is the designated metropolitan planning organization (MPO) for the region. SEWRPC's commissioners are drawn from jurisdictions throughout the region. The region comprises a small part of the state's total area but holds major portions of its population and built environment. The region is 2,689 square miles in size, 5 percent of the state's total area, and has a population of 1.82 million people, 37 percent of the state's residents. The region contains about 41 percent of the state wealth as measured in property value and about 39 percent of statewide employment. Overall in Wisconsin there are 111,025 miles of public road, of which 11,075 miles (10 percent) are in the Southeastern region (SEWRPC 1994c). In terms of *lane* rather than *road* miles, Wisconsin has 223,731 miles, of which 193,375 are classified as rural and 34,357 as urban (FHWA 1993); a count of lane miles in the Southeastern region is not readily available.

Like many metropolitan areas, the SE Wisconsin region struggles with congestion and air quality problems. Six of the seven counties have been designated as "severe" nonattainment areas with respect to the National Ambient Air Quality Standard (NAAQS) for ozone.[1] Motor vehicle emissions of hydrocarbons and nitrogen oxides are a key cause of ozone formation. Thus, the federal Clean Air Act requires that the region's transportation plans conform to the State Implementation Plan (SIP) for bringing the region into attainment of the NAAQS. As explained later in this report, major highways and arterial roads in the region are maintained by the state and federal road dollars flow through the state government. Thus, the Wisconsin

[1] See SEWRPC (1994f); the remaining county, Walworth, has been in marginal nonattainment status but is recently proposed to be classified as in attainment for ozone.

Department of Transportation (WDOT) plays a major role in implementing much of the region's transportation system plan. Like many state DOTs around the country, WDOT heavily slants its spending toward road projects, even in urbanized areas where transit needs are arguably greater.

The region's recent land-use and transportation plans, worked out in consultation with WDOT, remain largely based on an automobile-oriented, business-as-usual approach to providing mobility to the region. At the statewide level, the road-oriented planning is even more pronounced. These plans call for major road capacity expansions, no attention to efficient land use, and limited strengthening of transit or other modes of access in the region. Environmental advocates in the region, as well as many local government officials, have questioned the appropriateness and cost-effectiveness of ongoing investments that would largely serve car and truck use in the region. Citizens for a Better Environment (CBE), a non-profit organization in Wisconsin, is developing an alternative land-use and transportation scenario based on transit-oriented development and a redirection of transportation system investments away from roads and toward greater support of other modes. A working hypothesis of this effort is that combining clustered (rather than sprawl) development with good transit services will yield a regional transportation system that is less costly for all parties involved.

In developing the long-term (2010) plan subsequently adopted, SEWRPC compared it to a "no-build" scenario and to an alternative plan involving a substantial increase in the perceived cost of driving (equivalent to 6¢ per mile) as well as greater provision of transit (though little decrease in road building, compared to the adopted plan). First among the reasons listed for adopting the largely business-as-usual plan over the pricing and more transit-oriented alternative was the regional Advisory Committee's view of "the relatively low probability of achieving the significant increases in automobile pricing" needed for the alternative plan (SEWRPC 1994b, 485). It is difficult to argue with such an assessment given the current terms of discourse surrounding government fiscal policies and the underlying lack of public awareness of transportation costs and how they are paid. As we see below, however, a number of recent studies plus the analysis developed here indicate that there are likely to be better ways to approach the region's transportation planning and financing. Even though the road-pricing based alternative plan was rejected, SEWRPC found that its estimated benefit/cost ratio (1.68) exceeded that of the adopted plan (1.55); this ratio is that of dollars of incremental benefit per dollar of incremental cost (SEWRPC 1994b, 469). A broader examination of transportation costs, as presented here, tends to strengthen the case for shifting a greater portion of costs (now often hidden) to driving, while allowing reductions in other payments and greater investments in transit and other efficient transportation options.

Literature Review

Transportation cost analysis has already received attention in Wisconsin, by both state government and academic researchers. As part of a statewide multimodal planning exercise, "Translinks 21," the Wisconsin Department of Transportation has issued a series of studies, including two that are particularly relevant here. The *Financing Local Roads* study (WDOT 1994a) reviews the different roles of state and local government in maintaining the road system

to provide background for addressing the adequacy of current road assistance programs in the state. The *Highway Cost & Pricing Study* (WDOT 1994b) examined statewide highway costs and their relation to highway pricing for the purpose of assessing the likely impact of alternative road pricing options. An academic study, Hanson (1992), addresses the issue of automobile costs, subsidies, and policy issues from a nationwide view and uses Wisconsin data for a case study, providing a cost analysis particularly relevant to the region examined here.

More generally, several areas of ongoing nationwide research help inform our study. One is the growing body of work which attempts to calculate the total social cost of our transportation systems, accounting for both direct and indirect costs, including externalities. Also, a number of studies have begun to extend the traditional project-oriented cost-benefit analysis to examine corridor-level impacts and provide applications of full cost analysis to compare investments in different modes. Finally, the literature on land use and the costs associated with various development patterns is suggestive of the types of approaches needed to fully examine the regional economics of high density versus low density development.

Transportation Social Cost Studies

This research has attempted to quantify a wide array of costs that our transportation system imposes on society. A variety of approaches have been taken. Some studies focus on the costs of auto ownership and operation, including comparisons to other modes and sometimes incorporating indirect and external costs. Others examine cost allocation, detailing public expenditures for the transportation system and sources of those related revenues. A number of studies have attempted to take a comprehensive approach, addressing all transportation related cost categories. Some give aggregate answers, such as the estimate that national receipts from transportation-related sources totaled $73.6 billion in 1989 while expenditures totaled $245.4 billion (MacKenzie et al. 1992). Others present their findings per unit of travel, for example, providing estimates of various cost items as dollars per vehicle mile or passenger mile of travel. Fairly comprehensive literature reviews are given by Apogee (1994) and Litman (1995).

The majority of this literature indicates that road users do not directly pay for all of the direct costs of the road system and that if social costs (such as environmental externalities) are considered, then the apparent net subsidy to road users is quite large. In terms of direct costs, dissenting views include API (1995), which concluded that road users' payments exceed road-related expenditures, implying that road users in fact subsidize others. The differing conclusions appear to follow from different accounting and fee allocation conventions (Morris and DeCicco 1997). Here, we focus on the issue at the regional level. The supposition that road users receive a net subsidy even on a direct cost basis is supported by the Hanson (1992) analysis, which found that one-half of the funds expended statewide by local governments on Wisconsin roads came from non-user fees.

Development Cost Studies

This area of research has examined the municipal finance implications of land-use development at various densities and of choices between mixed-use, infill development and separated-use, sprawl development. The costs examined include major infrastructure and services that municipalities provide to their residents, such as roads, schools, water, and sewer. Studies generally conclude that the more spread out a community is the more expensive it is to provide services to that community and that a community needs a mix of land uses to remain financially viable. Thus, cost of local government services, and therefore local tax bills, can be reduced, if planners encourage dense and mixed-use development and avoid subsidizing sprawl development.

The Costs of Sprawl, published by the Real Estate Research Corporation in 1974 but now out of print, was a comprehensive study of the monetary costs of residential development according to density (cited in Frank 1989). Largely based on development simulation analysis calibrated to cost surveys, the study examined a range of residential growth patterns, depending on density and form of development. It found that public costs—for schools, recreational and other public facilities, streets, water and sewage services—were 36 percent higher for low-density sprawl development than for higher-density planned development. The Frank (1989) review, which examined a number of related development cost studies and their critiques, and concluded that public costs do substantially vary with the density of development as well as according to its relation to existing development (e.g., leapfrog sprawl vs. contiguous growth vs. infill) and other factors.

The American Farmland Trust (AFT 1984) examined municipal finances according to land-use type: residential, commercial or industrial, and farmland. The goal was to determine the net cost to local governments by land use type. While this particular study examined three cities in Minnesota, AFT has conducted similar research at the county level for locations in several states. Although effects vary with geographic location, their results show how municipal expenditures to serve residential development are generally higher than tax revenues received from residential development. The reverse is generally true for commercial, industrial, and agricultural uses, which are typically net generators of income for their municipalities. The implication is that a balance of land uses is desirable and that residential sprawl can lead to fiscal imbalance.

AFT (1986) used data from various areas within Loudoun County, Virginia to determine costs of municipal services for four different densities of residential development. The study found that four categories of costs varied with density: school operating costs, school transportation costs, road maintenance, and water and sewer operating costs. Estimating the revenue generated according to residential density, the study found that, for the least dense development examined (0.2 dwellings per acre), revenue covered 54 percent of costs, while for a higher density (4.4 dwellings per acre), revenue covered 80 percent of municipal costs.

Incorporating development costs into a regional transportation cost analysis is difficult and an area of ongoing research. Land use and transportation are interdependent, and a given degree of cost association does not necessarily imply that costs can be changed by a certain degree through different transportation plans. Also, many effects are very location specific, so a superficial analysis or extrapolations from detailed studies done elsewhere may not be meaningful. Therefore, we do not incorporate development costs into the social cost accounting presented here for the SE Wisconsin region.

Overview of Report

This study details recent transportation spending patterns and estimates the associated social costs associated with providing transportation services in the region. We first examine past and present transportation revenue and expenditure patterns to assess their impact on local budgets. The result is a snapshot of regional transportation finance as well as a review of recent regional transportation spending trends. We then turn to a broader examination of the total social costs of transportation. Private costs borne by individuals, directly and indirectly, are examined, along with other public costs linked to transportation. We also estimate external costs, such as those associated with air pollution and congestion. Finally, SEWRPC's most recent transportation plans are reviewed with specific attention to the revenue and expenditure aspects of the plans and an analysis of how the social costs of the regional system are likely to evolve through the current planning horizon of 2010.

In the course of carrying out this analysis, we developed a spreadsheet-based transportation cost accounting model. This model embodies a general methodology for regional scale analysis and we exercise it for current conditions (1992) and for future conditions under current plans (2010, the target year of SEWRPC's most recent long-range plan). The model will be documented in an ACEEE working paper which supplements this report. The results of this study and the model developed for it provide a framework which can later be applied to perform the cost comparison between conventional and alternative plans for the region. The model can also be applied for similar analysis in other regions.

Figure 1.1: The Seven Counties of the Southeastern Wisconsin Region.

2. TRANSPORTATION FINANCE IN THE REGION

Overall, four levels of government—federal, state, county, and municipal—are involved in managing the regional transportation system. Each level has different responsibilities, used here to mean financial responsibility. Federal dollars are mostly channeled through the state and then on to local entities and this "purse strings" role gives the state a major influence in infrastructure planning. Those parts of the system under direct state jurisdiction, including interstate highways, comprise only 22 percent of the road miles in Wisconsin, but these major highways and arterials have an important role in shaping the overall system. The remaining 88 percent of road miles are under local jurisdiction, with the largest portion of that (70 percent of the total) being managed by municipalities rather than counties (WDOT 1994a, 2ff). Nevertheless, federal and state highways and other roads that are part of the formally planned regional system are estimated to carry 91 percent of the traffic (SEWRPC 1994f, 41).

For roads that are a state responsibility, the state largely contracts road work to county and local governments. The use of local governments to perform state work has historically been viewed as mutually beneficial because the state does not shoulder the burden of maintaining staff while the employment benefits accrue to the locality where the work is done. Transit services (mainly buses; no rail) are organized at the county or city level and receive a share of their support from state and federal government. Seven local transit systems serve the region; the largest by far is the Milwaukee system, which accounts for 84 percent of transit operating expenses in the SE region (WDOT 1992, 26).

Overview of the Planning Process

As the designated Metropolitan Planning Organization (MPO) for the region, Southeastern Wisconsin Regional Planning Commission (SEWRPC) prepares transportation plans and improvement programs to meet federal requirements. The MPO itself has limited spending authority. Its plans are intended to be consensus documents developed cooperatively by all jurisdictions in the region (SEWRPC 1994c). Federal law requires plans meet state approval and be consistent with the state transportation and air quality plans if federal dollars are to be used. State approval is handled by the Wisconsin Department of Transportation (WDOT). Thus, the primary planning process is carried out at the local level. State and federal players enter the planning process as funders and approvers of the plans.

SEWRPC was established in 1960 by the State of Wisconsin under the Wisconsin Regional Planning Enabling Act and is funded by member counties as well as state and federal governments. The Commission is composed of representatives from the counties, cities, villages, and towns that are in the region. Not all government entities have representation at the same time. The Commission has twenty-one members, three from each of the seven member counties. One commissioner from each county is appointed by the county's board and is usually one of the county board supervisors. The remaining two commissioners from each county are appointed by the governor. Thus, representation is not based on population. Planning commissions are largely advisory in nature; final budget decisions are made by the local governments.

SEWRPC serves the counties of, Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha. Within these counties there are a variety of municipal governments, including 28 cities (incorporated, minimum population is 1,000 for rural, 5,000 for urban), 55 villages (incorporated, minimum population of 150 for rural, 2,500 for urban), and 64 townships (unincorporated). In addition to the municipal governments, a number of special service districts operate in the region. The geographic borders of the districts are not necessarily consistent with the borders of the political units of government, such as counties and cities. These special districts are numerous and would complicate an analysis of service costs. The region's special districts and the number of each are: school (53), water (50 public utility, 256 private community systems), and sewer treatment facilities (46).

Transportation planning is a cyclical process; in Southeastern Wisconsin, major updates have occurred roughly each decade, although there is no formal deadline for revising the comprehensive plans. After SEWRPC was formed in 1960, the first comprehensive study was released in 1963. That report was a combined land use and transportation plan with a horizon year of 1990. A new combined plan was issued in 1975 with a horizon year of 2000. For the 2010 time horizon, only a new land use plan was released in 1992; the transportation component was released two years later. In between these comprehensive plans, SEWRPC produces many smaller reports and plans for subregions and sub-topics, such as water quality plans. Three key documents address transportation planning in the region:

The *Land Use Plan* serves as general (nonbinding) guidance for development in the region. The land use planning process starts with population and employment forecasts, their geographic distribution, desired land use patterns, and the necessary infrastructure needed to support that land use. The most recent SEWRPC Land Use Plan at the time of our analysis was issued in January 1992 (SEWRPC 1992a).

The *Long-Range Transportation Plan* (LRP) is a detailed document developed with a regional model, using inputs based on the land use plan. The LRP provides forecasts of future travel demand and identifies major road and transit operations, maintenance, and improvements needed to accommodate projected travel in the region. However, the LRP does not consider local roads. The final section of the plan details the costs of the system and the expected sources of funds. The most recent LRP for the Southeastern Wisconsin region addresses transportation needs through 2010 (SEWRPC 1994a; SEWRPC 1994b) and is one of our primary sources of information on recent and projected transportation spending in the region.

The *Transportation Improvement Program* (TIP) provides specific, near-term implementation plans for all arterial highway and transit improvement projects under regional planning jurisdiction. SEWRPC (1994c) is the TIP used for our analysis and covers transportation spending from 1995-97. A TIP need not address all local roads, but must include any projects that receive federal funds. A TIP must include federally assisted transit and arterial highway projects, identifying each project, its estimated costs, and how much of the cost each level of government will pay. A TIP must conform to the State Implementation Plan (SIP) for air quality; its projects must also be consistent with the LRP; and it must be approved by both

the MPO (SEWRPC) and the state (WDOT). Major projects covered in the 1994 TIP include resurfacing of state Route 32, bridge replacement and interchange modernization at I-94 and Marquette, feeder bus service from Greenbay to the Milwaukee Amtrak station, and an IVHS study for the Milwaukee-Chicago corridor.

An important gap in the formal regional planning structure is its exclusion of many local roads, which, if they do not receive federal assistance, need not be included in the major regional plans. As noted above, over 80 percent of road miles are under local jurisdiction and, as we show below, local governments cover 45 percent of overall road spending in the region. While county and municipal governments participate in the planning of the regional (those under SEWRPC jurisdiction) roads as well as their own local roads, there is no formal mechanism to insure coordination of local road plans in a way that make sense for the region as a whole.

Regional Transportation Finance

Figure 2.1 illustrates the relationships among the different levels of government—federal, state, and local (including county and municipal)—involved in financing the regional system. A portion of transportation expenditures are made with funds granted to one level of government by another. We count such intergovernmental transfers as expenditures by the level of government providing the grant. Fuel taxes and other user fees flow mainly to state and federal coffers, from which they are disbursed for transportation projects largely administered by the state transportation department. Hanson (1992) found that half of overall road spending is funded by state and federal user fees in Wisconsin based on a review of finances for 1978-85; his results show a slightly increasing state and federal share in the later years (1983-85). WDOT (1994b) reported that 56 percent of statewide road spending was from federal and state sources in 1992. The balance is paid for with local government general revenues, derived from property taxes and from other unrestricted revenues (such as state shared revenues which are in turn based on state income and sales taxes). The results below confirm this major reliance on general revenues at the regional level.

Table 2.1 summarizes transportation revenues and expenditures for the Southeastern Wisconsin region in 1992; parts (a)-(c) of the table indicate how we accounted for and netted out intergovernmental transfers. Overall transportation spending amounted to $536 million dollars, including the regional components under SEWRPC jurisdiction as well as local roads that are not part of the formal regional planning framework. Transportation-based revenue collections—road user fees plus transit fares—were $403 million in 1992. Thus, spending exceeded transportation-derived revenues by $133 million, so that revenues equaled 75 percent of direct public expenditures related to transportation. State and federal expenditures cover 54 percent of overall regional expenditures for both roads and transit. The combined state and federal share is 55 percent for roads in the region, a share similar to that noted above for roads on a statewide basis.

The bases for our estimate of the financial picture are detailed in the table's notes. Table 2.1b shows how we estimated a breakdown of local road spending according to local, state, and

federal sources. Total local government road-related expenditures were complied from the Wisconsin Department of Revenue's detailed tables covering each jurisdiction in the state (WDOR 1992). The portion of local government finances provided as transfers from federal or state government were then subtracted to yield a net of $195 million. This road spending by county, city, township, and village governments turns out to be the largest part of the region's transportation spending. Locally generated funds (of which the largest portion is the $34 million in farebox revenues) cover 48 percent of the $105 million spent on transit. General revenues contributing to transportation in the region amounted to $211 million ($245.6 million total local spending less $34.4 million in transit fares) in 1992. Overall, locally generated funds cover 46 percent of the region's direct public expenditures on transportation infrastructure and operations.

Also notable in the table are the net outflows of road-related revenues from the region to state and federal coffers. An estimated $122 million in federal user fees (mainly the gas tax) was collected in the region, of which 67 percent ($82 million) was returned for federally funded transportation programs in the region in 1992. The state returned 85 percent ($209 million spent vs. $247 million collected). As to be noted shortly, this net outflow of regional transportation-derived user fees to federal and state uses outside the region is not unique to 1992, but represents the pattern that has been followed under current conventional transportation finance arrangements.

Table 2.1 provides a snapshot of SE Wisconsin regional transportation financing for one year, 1992. To examine how well this one-year picture corresponds to historical financing patterns, we examined available revenue and expenditure data for the 1987 to 1992 period (see Appendix A). Older data are available for state and federal transportation finances, but compilations of local spending are only available since 1987. Over this period, local governments' budgets have been generally stable in terms of their allocations to transportation. Revenues—including fuel taxes and other transportation user fees as well as transit fares—collected by all levels of government totaled $2.1 billion over the six-year period, 64 percent of which was collected at the state level. Expenditures—including all funds spent on roads and transit by all levels of government—totaled $2.8 billion over 1987-92. Thus, transportation related revenues collected in the region were equivalent to 74 percent of transportation expenditures, essentially matching the ratio estimated for 1992. This ratio was reasonably consistent over the period, ranging from 68 percent in 1990 to 76 percent in 1991 (this one-year jump was due to an increase in the federal gas tax). Shares by level of government were also fairly consistent throughout the period. On average, federal funds accounted for 15 percent of expenditures, state 37 percent, and local governments 48 percent.

The multiyear analysis also confirms the outflow of transportation user derived funds from the region. From 1987-92, the federal government took in $551 million in user fees from the region but only spent $427 million (77 percent of revenues) in the region, leaving a cumulative net outflow of $124 million. Likewise, the state transportation fund received more funds from the region, $1.334 billion, than it spent in the region, $1.037 billion (78 percent of revenues), for a net outflow of $297 million spent elsewhere in the state. This phenomenon is common for urbanized areas in the United States, since most driving and therefore most fuel tax

collections occur in metropolitan areas, while extensive portions of state and federal highway systems run through less developed areas. The following sections provide a more detailed examination of transportation finance in the Southeastern Wisconsin region by level of government.

Federal Funds

The federal government collects transportation user fees primarily through taxes on gasoline and diesel fuel. Statistics on federal revenues are complied at the state level, so we apportioned the Wisconsin estimate according to the estimated share of state motor vehicle fund revenues paid by residents of the counties in the region (30.5 percent, from Table H-1 of SEWRPC 1994c). Thus, we assume that the distribution of federal revenues collected is the same as that for state revenues. The resulting estimate of $122 million for 1992 includes all federal transportation taxes and fees, including portions not allocated to the highway trust fund (such as the 2½¢ per gallon of motor fuel taxes that was used for deficit reduction in 1992).

Federal expenditures for state and regional transportation systems are drawn from the portion of the user fees that is deposited into the federal highway trust fund, which has two sub-accounts, the highway account and the transit account. Approximately every five years, Congress develops a transportation act (once termed the "highway bill") which authorizes federal transportation spending for a 5–6 year period. The current authorizing legislation is the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, which authorizes federal spending for fiscal years 1992-1997. During the annual budget process, specific transportation appropriations are itemized with the basic direction taken from the authorizing bill. Federal transfers to states need not match the amount of federal user fees collected in the state; rather, the funds are apportioned according to formulas set up for various transportation programs covered by the authorizing legislation (ISTEA 1991; USDOT 1992).

The TIP (SEWRPC 1994c) lists major federal program expenditures in the region totaling to $68 million in 1992, as shown in Table 2.1a. This sum is 28 percent of statewide federal expenditures for the same set of programs, significantly less than the region's 37 percent share of the state population. The TIP also provides historical spending information. Figure 2.2 charts the recent history of federal and state road expenditures in the region. Although there is year-to-year variation, a result of project scheduling, the federal spending reveals a modest rising trend, even in constant dollars (Figure 2.2a). Federal highway expenditures in the region averaged $57 million (1992$) from 1985–92 and the inflation-adjusted upward trend averages out to 3.8 percent per year over the period.

For transit, federal funds are distributed through the Federal Transit Administration (FTA), which provides both capital and operating assistance, though capital grants are the largest share (75 percent in 1992). Most federal funds require a local match, 20 percent for capital and 50 percent for operating assistance (FTA 1994). Within Wisconsin, federal transit spending was $30 million in 1992, of which $13.6 million (45 percent) went to the Southeastern region. Federal transit spending at both the state and regional levels divides almost evenly between

operating and capital expenditures. Federal transit operating expenditures in the region averaged $7.9 million (1992$) between 1987 and 1992. As shown in Figure 2.3, however, this federal aid had an inflation-adjusted downward trend that averaged 6.4 percent per year over the six-year period (WDOT 1989, Tables 14-16; WDOT 1992, Tables 12-14).

The divergence of federal funding between roads and transit seen in the region is further illustrated by looking at the picture statewide. Figure 2.4 shows annual federal funding trends in Wisconsin from 1984 to 1996. Road spending took a big jump beginning in 1992, reflecting the larger authorization available under ISTEA. In 1996, nominal federal road dollars in the state were 88 percent higher than in 1984. Over the same period, federal transit funding is essentially flat and, since the chart shows nominal dollars, the result is that federal support for transit in Wisconsin has been on a steadily declining trend in inflation-adjusted terms across the state, just as seen in the Southeastern Region.

State Funds

Good overviews of statewide transportation finance in Wisconsin are given in WDOT (1994a, b), which provide breakdowns of transportation revenues and expenditures and identify the major programs through which the state supports local roadways. As noted earlier, the central account for transportation finance is the state's Transportation Fund. The fund has a two-year budget cycle and receives the bulk of its revenue ($1.2 billion in 1991-92) from state user fees (71 percent), such as the gasoline tax and vehicle registration fees (WLRB 1993, 803). Since 1985, the state fuel tax has been indexed to the inflation rate and gasoline consumption in order to produce a stable funding source. The state Transportation Fund also receives federal transportation dollars as well as some local revenues (FHWA 1994). The state fully covers the costs for all regional roads under state jurisdiction, including interstate highways, U.S. highways, and some designated connecting highways. In 1992, the state disbursed $92 million for these major regional roadways, $70 million for construction and $22 million for maintenance (SEWRPC 1994c, H-32). Combined with the local road aids discussed below, state road spending in the SE region totaled $168 million in 1992 (Table 2.1b). As illustrated in Figure 2.2b, total state road spending in the region increased at an average, inflation-adjusted rate of 4.1 percent per year from 1985-92.

The state assists some local roads, primarily through revenue-sharing programs with legislatively determined allocations to counties, cities, villages, and towns throughout the state. These funds are provided in the form of reimbursements to local governments for a percentage (which averaged 25 percent statewide in 1989—Hanson 1992) of their road spending. The state indirectly supports local government transportation costs through revenue sharing for general operations, redistributing monies raised by the state income tax, sales tax, and other broad-based taxes. There is no requirement that these funds be used for any specific purpose. Thus, like local property taxes discussed below, state general shared revenues can be considered to support the transportation system in the same proportion as they are received by the local government (WDOT 1994).

The total local road aids were obtained as the sum for all seven counties from budget tables obtained from WDOT, yielding a 1992 estimate of $77 million, as detailed in the notes for Table 2.1. The principal source is the state's General Transportation Aid program, which accounted for 90 percent of all state road aids for the region. For comparison, an estimate based on the county and municipal budget tables of WDOR (1994) was obtained by summing four road-related items among the intergovernmental revenues lines for all local jurisdictions in the region. This latter estimate, $88.925 million, is higher, but portions of it are based on statewide percentages rather than region-specific information.[2] It may be that the region receives less than the statewide average for local road assistance programs.

After adjusting the state road aid allocation formula several times in the 1980s, the Wisconsin legislature settled on a formula that, among other provisions, takes into account the level of funding a local government has been allocated in the prior six years, effectively creating a rolling average. The formula also has a provision that limits the percentage change in the rise or fall of a local government's road aid allocation in any given year. These provisions create a predictable state road aid expenditure program, reflected in the relatively stable pattern shown in Figure 2.2b. In 1992, state road aids covered 28 percent of overall local government road-related expenditures in the SE region (Table 2.1a).

For transit, the state of Wisconsin statutorily pays 42 percent of operating costs for every transit system in the state. The state provides no assistance for capital costs. A large portion (70 percent) of the state's transit operating assistance went into the Southeastern region, $40 million in 1992 (Table 2.1). Thus, state funds provided 58 percent of the $70 million in regional transit spending not covered by farebox revenues in 1992. For the seven major transit systems in the region, state operating aid grew from $31.6 million (1992$) in 1987 to $40.4 million in 1992 (Figure 2.3). This growth averaged 4.4 percent per year, in contrast to federal aid which fell over that period (WDOT 1989, Tables 14-16; WDOT 1992, Tables 12-14).

Local Funds

Local governments pay for transportation system costs using federal and state transfers as well as locally generated revenue. Because local governments generally do not levy transportation user fees, they rely on general sources, such as property and sales taxes. Road and transit programs compete with other local interests for such revenues. Because Wisconsin local governments receive more of their general revenues from the state than do local governments in most other states, local governments rely on local taxes for less of their general revenues than local governments in other states (WDOT 1994a, 9). Wisconsin local governments rely

[2] The estimate was based on: 100 percent of "State Highway Aids," 1.3 percent of "All Other State Aid," 23.6 percent of "Other Local Government Aid," plus 13.9 percent of "Intergovernment Charges for Service;" percentages are statewide averages for road-related portions of these lines (pers. comm., Harvey Simon, WDOR, 19 Jan. 1996).

substantially on the property tax for locally generated revenue. Based on our summations of revenue lines for the region in WDOR (1994), total state aid was 40 percent of local government revenue in 1992, a greater portion than property taxes, which accounted for 33 percent. The remaining 27 percent is from other taxes, fees for services, federal aid, and interest income. Overall, locally generated revenues meet 58 percent of local government budgets. In the SE region, 59 percent of locally generated revenues come from property taxes.

Several non-property or local-option taxes are authorized for local government use in Wisconsin. Only one, a local vehicle registration fee known as the wheel tax, is transportation derived, but it is not used by any jurisdictions in the SE region. Counties can also institute a sales tax of 0.5 percent, which is currently used by 46 of 72 counties in the state, including 4 of the 7 counties in the region. The county sales tax is the most extensively used local-option tax; in 1992 the sales tax generated a total of $49.8 million in the region. For those counties in the region that use it, the tax provides 5 percent of their total revenue, and the sales tax accounts for 1.8 percent of total local government revenue regionwide (WDOR 1994; Kiemel 1996).

The other local option taxes, such as lodging room taxes and cable TV taxes, are smaller sources of revenue. Statewide, the makeup of local government general funds has been fairly stable with regard to property tax and state aid which together make up about three-quarters of local government revenue. Between 1986 and 1993, the property tax has accounted for an average of 34 percent and state aid 40 percent, nearly identical to the figures noted above, thus indicating that 1992 was a fairly typical year, based on the accounts from WDOR (1994 and other annual editions).

Roads under county jurisdiction are financed by a combination of federal, state, and local funds. Municipalities have primary responsibility over local streets and property access roads. While these roads do not carry as much traffic as collectors and arterials, they account for most of the total road mileage. Roads classified as town roads, city streets, or village streets comprise 69 percent of road mileage statewide and roughly 75 percent in the region (WLRB 1993, 825-26). Of course, these shares are based on road ("centerline") miles rather than lane miles, and local roads are generally less elaborate and built to less exacting standards than the major highways and arterials that receive most state and federal support. Based on the 1992 breakdown shown in Table 2.1a, funding for local roads in the SE region comes primarily from local general revenues (70.6 percent) supplemented by state shared revenues (27.8 percent) and federal aids (1.6 percent).

Table 2.2 lists road spending by local governments in the region along with the amount of road aids they received for 1986 through 1993, based on records from WDOR (1994 and previous years). Local government road spending averaged $276 million (1992$) and had a modest inflation-adjusted upward trend (0.8 percent per year) over the period (Figure 2.5). The portion obtained from state aids has been stable as a fraction of local road spending, averaging 27 percent from 1987 to 1993. The 1992 values closely match the average spending and state share over the 7-year period, suggesting that 1992 was a typical year in this regard. Considering all local government expenditures, local road spending comprised 12 percent of the $2.4 billion

(1992$) in average annual combined spending by local governments in the SE Wisconsin region from 1987 to 1993 (based on WDOR 1994 and other annual editions). Table 2.3 shows the estimated proportion of county road expenditures funded by each level of government in recent years. The county portion is paid for out of non road-user revenue received by the county, including non-designated state aid and locally derived funds from sources such as the property tax. It appears as though there is a slight trend towards using county revenues and away from state revenues.

Roads consume a significant portion of municipal budgets and as the road network expands, so do its long-run maintenance costs. In the SE Wisconsin region, transportation expenditures constituted 3.5 percent of county expenditures, 14.9 percent of city expenditures, 14.8 percent of village expenditures, and 23.0 percent of township expenditures in 1992, based on our summations of data from WDOR (1994). The average for all levels of local government in the region was 9.9 percent. Figure 2.6 shows recent trends in the components of local government road spending. Maintenance is the largest portion of road expenditures, averaging 53 percent over the 1986-93 period, and its share may be trending upward.

Sixty-five percent of local government transit expenditures in Wisconsin occurred in the SE region, with nearly 90 percent of the expenditures going to operating assistance, which is higher than the state average (WDOT 1992). Local governments in the SE region paid for 15 percent of their transit systems' operating costs and 20 percent of their capital costs in 1992 (WDOT 1992, Tables 14 and 22). Regionwide, local government operating assistance for transit showed a rising trend averaging 8.7 percent per year from 1987 to 1992 (Figure 2.5). While there was a substantial drop in funding to the Milwaukee system between 1987 and 1988, from $12.2 million (1992$) to $7.1 million (1992$), local support to the Milwaukee system was back up to $9.7 million in 1992 (WDOT 1989, Tables 14-16; WDOT 1992, Tables 12-14).

Referring back to Table 2.1, we estimate the total local government general fund contributions to transportation in the region as $211 million in 1992. This total is comprised of $195 million in net locally based spending on roads and $16 million in locally based operating and capital funds for transit. Thus, locally generated government revenues covered 39 percent of the region's total transportation expenditures of $536 million in 1992. Counting $34 million in transit fares, 46 percent of expenditures are covered by locally derived revenues in the region.

Special service districts provide school, water, and sewer services through locally defined districts, which generally have dedicated funding sources. The districts are financed either through fee-for-service billings, in the case of water and sewer, or are paid for through allocations from the property tax, in the case of schools. As noted in the introduction, the costs of providing these services can depend on land use development patterns, linking these costs to transportation choices. However, in this report we do not attempt to incorporate these indirect costs into our financial accounting for the region's transportation system.

Summary

Overall public spending on transportation in the Southeastern Wisconsin region amounted to $536 million in 1992. Of this total, local revenues provided the largest portion, 46 percent; state funds provided 39 percent, and federal funds provided 15 percent. Revenues obtained from transportation sources in the region amounted to $403 million in 1992. Thus, transportation-derived revenues covered 75 percent of regional public expenditures on transportation. Road user fee collections are equal to 85 percent of road expenditures in the SE region; however, not all of the user fees go to roads, so that only 55 percent of the region's road expenditures are covered by road user fee sources. Transit user fees (farebox revenues) covered 33 percent of the region's public transit expenditures in 1992.

Federal and state road user fees collected in the region exceed federal and state transportation aids provided to the region. Federal aid was 67 percent of the estimated $122 million in federal transportation user fee collections in 1992. The state aid of $209 million was 85 percent of the estimated $247 million in state collections. Of the $403 million total transportation-related revenues (road and transit user fees), 81 percent can be said to have been applied to support the region's transportation system in 1992. The remainder mostly served roads outside the region plus some non-transportation uses, such as federal deficit reduction.

The detailed picture of the region's transportation finances which we developed for 1992 is consistent with recent historical spending since 1987, for which adequate data were available. Over that period, revenues collected in the region from transportation sources equaled 74 percent of transportation expenditures in the region, and this ratio has been generally consistent from year to year. Shares by level of government were also fairly consistent throughout the period, with federal funds accounting for 15 percent, state 37 percent, and local governments 48 percent of expenditures on average. The multiyear analysis also confirms the outflow of transportation user derived funds from the region. Federal transportation spending in the region averaged 78 percent of federal user fee collections, for a cumulative net outflow of $124 million from 1987-92. State transportation spending also averaged 78 percent of state transportation user fee (mostly gasoline tax) collections, for a net outflow of $297 million, allocated largely to transportation uses in other parts of the state.

Of course, most driving and therefore most fuel tax collections occur in metropolitan areas, while extensive portions of state and federal highway systems run through less developed areas and are used by citizens of all areas, including metropolitan regions. However, now that interstate system is largely built and regional interconnectedness has been accomplished, it is time to revisit the extent to which urban regions contribute to roads throughout the countryside while themselves struggling with congestion and inadequate transit service. State and local governments are having to compensate for declining federal contributions to transit systems and local government financial burdens are increasing generally. The financial picture revealed here suggests that one opportunity for beneficially changing the transportation financing balance would be to use Federal funding flexibilities to direct greater spending to the metropolitan

portions of the state's transportation system and, in particular, from roads to transit and other services that provide alternatives to low-occupancy vehicle travel in congested areas.

Table 2.1: Overview of Southeastern Wisconsin Transportation Finances in 1992.

Level of Government	(Millions of 1992$)						
	Revenues			Expenditures			
	Road	Transit	Total	Road	Transit	Total	Share
Federal	122.286[a]	0	122.286	68.182[b]	13.605[c]	81.787	15%
State	246.629[d]	0	246.629	168.465[e]	40.379[f]	208/844	39%
Local	0	34.429[g]	34.429	195.032[h]	50.522[i]	245.554	46%
TOTAL	368.915	34.429	**403.344**	431.679	104.506	**536.185**	100%
Transportation based revenues equaled 75% of regional transportation expenditures.							

Table 2.1a: Estimation of Local Government Expenditures of their own General Funds for Roads in the SE Wisconsin Region (million 1992$).

Total road-related expenditures by local governments	276.163[j]
Federal road aids to local governments in region	(4.501)[k]
State road aids to local governments in region	(76.630)[l]
Net road-related expenditures by local governments	195.032

Table 2.1b: Estimation of Total State Road Aid (millions 1992$).

State highway construction and maintenance expenditures	91.835[m]
State road aids to local governments in region	76.630[n]
Total state road expenditures in SE Wisconsin region	168.465

Table 2.1c: Estimation of Local Transit Expenditures.

Operating funds provided by local governments	14.419[o]
Capital funds provided by local governments	1.674[p]
Farebox revenues	34.429[q]
Total local expenditures in SE Wisconsin region	50.522

Notes for Table 2.1

(a) Estimated as the region's share (30.51 percent) from SEWRPC (1994c, H-2), of federal highway user fees collected in Wisconsin in 1992 ($400.807 million), from FHWA (1994, IV-8)

(b) SEWRPC (1994c), H-32

(c) From WDOT (1992), the sum of federal operating funds (p. 26) plus federal capital funds (p. 43).

(d) Average of 1991 and 1993 estimates taken from SEWRPC (1992b), G-2, and SEWRPC (1994c), H-2, respectively.

(e) Table 2.1b.

(f) WDOT (1992), 26.

(g) Third line of Table 2.1c.

(h) Table 2.1a.

(i) Table 2.1c.

(j) Sum of road-related expenditure items for all local jurisdictions (county, city, town, village) in the region, from WDOR (1992).

(k) Statewide, an average of 5.6 percent of the "Federal Aids" line under intergovernmental revenues is road related (pers. comm., Harvey Simon, WDOR, Madison, 4 Jan. 1996); the sum of the "Federal Aids" line for in the region is $80.369 million (WDOR 1992); our estimate is 5.6 percent of this sum. We assume that the resulting $4.5 million is part of the $68.2 million of federal road spending identified in SEWRPC (1994c).

(l) Second line of Table 2.1b.

(m) SEWRPC (1994c), H-32.

(n) Sum of General Highway Aids, Connecting Highway Aids, Highway Flood Damage and Lift Bridge Aids, and Expressway Aids in 1992 (from budget tables provided by M. Mansfield, Office of Policy and Budget, Wisconsin Dept. of Transportation, pers. comm., Feb. 8, 1996), plus one-half of Local Road Improvement Program (LRIP) funding for the 1991-93 biennium (from table provided by M.P. Forlenza, Bureau of Program Management, Wisconsin Dept. of Transportation, pers. comm., Feb. 8, 1996), for the seven SE Wisconsin counties.

(o) WDOT (1992), 26.

(p) WDOT (1992), 43.

(q) Sum of SE Wisconsin region transit systems' operating (farebox) revenues, from WDOT (1992), 26.

Table 2.2: Local Road Expenditures and State Road Aid in the Southeastern Wisconsin Region, 1986-1993.

	(Millions of Nominal $)		
Year	Local Road Spending	State Road Aids	State Aids Cover
1986	214.522	58.136	27.1%
1987	223.088	61.746	27.7%
1988	239.636	63.765	26.6%
1989	244.770	67.622	27.6%
1990	264.473	69.749	26.4%
1991	278.100	73.356	26.4%
1992	276.163	76.680	27.8%
1993	288.177	78.498	27.2%
Average (10^6 1992$)	276	75	27

Source: Summations for jurisdictions in the SE region from WDOR (1994 and previous years)

Note: The 1992 state road aid value differs very slightly from that shown in Table 2.1a ($76.630 million), which was based on a different set of budget tables; the two accounts (WDOR and WDOT) match quite well for the 1986–92 time period.

Table 2.3: County Road Expenditure Shares by Funding Source in the Southeastern Wisconsin Region.

	Share of road expenditures by level of government		
Year	Federal	State	County
1986	26.8%	35.7%	37.6%
1987	24.6%	41.0%	34.5%
1988	25.7%	33.6%	40.7%
1989	25.3%	29.8%	44.9%
1990	28.0%	28.0%	44.0%
1991	23.6%	28.1%	48.3%
1992	30.0%	27.3%	42.7%
1993	26.3%	27.8%	46.0%

Source: Derived from WDOR (1986-1993)

Figure 2.1: Flow of Road Revenues and Expenditures in Southeastern Wisconsin.

Figure 2.2: Recent History of Federal and State Highway Expenditures in Southeastern Wisconsin.

Figure 2.3: Federal and State Transit Operating Aid in Southeastern Wisconsin, 1987–92.

Figure 2.4: Statewide Annual Federal Funding for Roads and Transit in Wisconsin, 1984–96 (nominal dollars).

Figure 2.5: Recent History of Local Government Spending on Roads and Transit in Southeastern Wisconsin.

Figure 2.6: Percent of Municipal Road Expenditures by Type, 1986–1993.

3. TOTAL COSTS OF PASSENGER TRANSPORTATION IN THE REGION

The public expenditures on a region's transportation infrastructure and services are only a portion of the overall costs of providing and operating the system. The largest direct cost is what private individuals pay to own, maintain, and operate their motor vehicles. Parking is another cost—a small part of it paid directly by drivers, some of it included in public spending, but much of it hidden or only indirectly paid. Drivers pay for automobile insurance, but as we see below, this too covers only part of the costs associated with accidents. Congestion, air pollution, and a number of other costs fall into the category of externalities, that is, costs caused by an action but not borne by the individual responsible for it. Overall, as we find below, the public costs associated with transportation infrastructure—that part of the system that is formally planned—amount to only 11 percent of the monetary cost associated with transportation in the Southeastern Wisconsin region, and only 7 percent of the total social cost of the regional system.

The scope of this total cost analysis is passenger transportation, including both passenger vehicles (cars and light trucks) and transit (buses), which share the same roadway infrastructure. Some costs of freight transportation are implicit in this analysis because trucks share the same roads as cars; however, we do not present a specific accounting for freight because of study resource limitations. In any case, system capacity issues and most major infrastructure investments are motivated by the need to accommodate passenger travel, which accounts for 88 percent of the region's vehicle trips (SEWRPC 1994b, 170). Also excluded from the analysis are non-motorized modes (walking and bicycling), because of lack of adequate data and since the costs of these modes are much smaller than those of motor vehicles. Incorporation of walking and bicycling may be important for a comparative cost analysis of alternative future plans for passenger transportation, since less-sprawling, transit-oriented development would encourage greater use of these non-motorized modes. Finally, this analysis does not attempt to address "cost of sprawl" issues, e.g., community services costs (such as schools and utilities) other than those associated with road infrastructure.

In developing a picture of the total social cost of passenger vehicle transportation, we use a framework that distinguishes between costs incurred and payments made. We adopt the perspective of the region as a whole, rather than that of an individual driver or transportation system user. To provide a framework for analyzing and understanding transportation costs in the region, we developed a detailed spreadsheet model of costs on a regional basis. The model is a general one, with the cost accounting tables separate from the data input tables, and so could can be applied to other regions by substituting region-specific data. The model is also set up to allow cost calculations for a present and future year, so that comparisons can be made allowing for changes in the system. This section of the report details the methods used to estimate each cost component and presents results for the SE Wisconsin region in 1992. The next section, which examines current trends for the regional transportation system, applies the model to develop cost estimates for 2010 using projections based on the current SEWRPC plan.

Since this analysis is meant to provide a foundation for comparing the costs of alternative plans, it is important to develop estimates using cost bases that are properly sensitive to potential

changes in the system. In economic parlance, an analysis of what are termed *marginal costs* is desired. Many published transportation cost analyses present a static picture of *average costs*, which can help build the case for alternative planning or pricing policies emphasizing different modes. Thus, costs are reduced to averages per passenger mile traveled (PMT), or per vehicle mile traveled (VMT). However, such bases are not adequate for comparing future alternative plans, which requires expressing costs in terms of the types of system changes that can occur. Some cost components may be invariant with a static infrastructure even if usage changes. For example, some road operation and maintenance costs (e.g., signs, lane marking) may be largely insensitive to traffic volume *per se*, and so might be better represented on a per lane mile rather than per PMT or per VMT basis. Therefore, in developing our estimates, we use bases appropriate for examining costs in a dynamic rather than static framework, subject to available data. However, given the available information, we cannot claim to have done a true marginal cost analysis, for which further analysis, some of it quite extensive, would be needed. We have attempted to express costs on a marginal basis when possible and, as noted in Section 4, adjust cost factors when estimating changes for the system in the future.

Costs of Automobile Use

The costs of transportation fall into several categories. A useful typology developed by Mark Delucchi was presented in OTA (1994, Table 4-1). That treatment was concerned with the economic efficiency of cost allocation and so disaggregated some items according to how they are paid. Allocational efficiency is only one issue for our purposes, so some of our cost categories span several of the OTA categories. We have a concern with who incurs costs, particularly on the public side, since transportation planning is largely about public investments and costs. Thus, we disaggregate the public infrastructure category by level of government. Table 3.1 lists the automobile costs we analyze and cross-references them to the categories given in the OTA report. A similar classification is applicable for other modes.

Many costs are equal to payments made; for example, the costs of vehicle ownership and the direct costs of motor fuel consumption are of this type. In other instances, costs are partially covered by payments; for example, public infrastructure costs are partially paid by fuel taxes and accident costs are partially covered by insurance premiums. A number of costs are only indirectly paid; for example, the "free" parking at shopping centers is incorporated into retailers' overhead costs and ultimately charged to shoppers as part of retailers' markups on the price of merchandise. Some costs are non-monetary, such as personal travel time (excluding delays caused by having to share the road with other travelers). Finally, there are external costs, which incorporate effects imposed on others and not accounted for by the parties imposing them. Externalities include congestion delay and environmental damages such as air and water pollution.

In interpreting a social cost analysis such as that developed here, it is important to note the uncertainties inherent in many of the values estimated. Some items, such as public expenditures are quite certain, since they are based on standard budget reports. Monetary costs based on averages, such those of regionwide car ownership, insurance premiums, and fuel costs,

are less certain but probably accurate within ±10 percent or so. Other monetary items, such as many parking costs, which are hidden or embedded other charges such as commercial rents and housing costs, are more uncertain. And admittedly much greater uncertainty is involved in estimating external costs, such as those associated with accidents, congestion, and air pollution. Nevertheless, although some of the estimates reported here entail substantial uncertainty, all of them are significantly greater than zero. An analysis omitting them would be more misleading than an analysis such as this, which includes them in spite of their uncertainties. Readers should keep in mind that the social costs estimates are uncertain in their specific values but that the items covered still credibly portray the relative importance of various costs associated with the regional transportation system.

Table 3.2 summarizes the costs of passenger transportation, with part (a) covering automobiles (cars and light trucks) and part (b) covering transit (buses). Table 3.3 (discussed later) shows the payments made within the context of the regional system. Estimates are presented for calendar year 1992 and all values are given in 1992$. We discuss the various cost bases for our estimates as we present them below; further details are given in the spreadsheet model developed for this analysis. Appendix B tabulates various parameters used in the model for the regional system, such as population, VMT, PMT, number of vehicles, etc., which we applied to calculate the estimates shown in Table 3.2. Descriptions of the cost items and key assumptions used to estimate them follow below.

Public Costs

Estimates for road system construction and maintenance costs were the subject of Section 2. The total for the SE Wisconsin region in 1992 is $432 million (from Table 2.1). A number of other local government service costs are often excluded from account of transportation system operational expenditures. Such items include portions of local planning, public health, education, local government utility bills, judicial systems and fire departments, public waste disposal and water treatment services. Miller and Moffet (1993, 15) developed nationwide average estimate $0.0026 per PMT for such additional publicly provided services. Using this value to estimate other public service costs would result in a small upward adjustment (about 5 percent) to the total direct public expenditures for transportation in the region. However, because Wisconsin's local government financial accounting system is quite thorough and because of the comprehensive accident cost accounting estimate used (see below), we omit this adjustment to avoid the risk of double counting. Thus, we estimate the total public costs of transportation infrastructure in the SE Wisconsin at $432 million, or an average of $626 per household for the region's 690,000 households, in 1992.

In presenting any of these public systemwide costs, however, we note that cost allocation remains unaddressed. For example, road maintenance costs are partly related to road damage, which varies greatly according to the type of vehicle. Per mile of travel, heavy vehicles (including buses) are responsible for much more wear and tear on the road system than are light vehicles. If we were to account for freight, some of the road maintenance costs included here for automobiles would be allocated to freight trucks. Other costs vary with time of travel (peak vs.

off-peak). The more detailed cost accounting framework developed by DeCorla-Souza et al. (1996) provides a way to estimate costs by vehicle type and time of travel, but requires more data than are available at this phase of our study. Thus, we do not separately allocate public infrastructure costs to automobiles and transit, which both share the same road system.

Private Costs of Vehicle Use

Privately borne costs include the vehicle expenses, time, and portions of the costs of parking and accidents. Parking and accidents are treated in the next two subsections; for time costs, we consider only congestion, which is discussed under Other Costs, below.

The private expenses associated with owning and operating motor vehicles are the largest component of transportation costs. The cost of buying and financing cars and light trucks accounts for just over half of this expense, based on an average annual cost of $1,384 per vehicle for depreciation and finance (FHWA 1992a, 17). Private fuel costs (excluding taxes) were estimated using a pre-tax price of $0.79 per gallon (EIA 1995, Table 9.7). Note that we do not count fuel taxes as a cost, since we are taking a regional (social) perspective. Finally, costs of maintenance (including repairs, oil changes, tires, etc.) were estimated at $0.052 per VMT (FHWA 1992a, 17). Thus, the components of private vehicle owning and operating costs separately depend on number of vehicles, fuel consumption, and amount of driving, for capital, fuel, and maintenance, respectively. Regionwide, these private vehicle costs amounted to $2.5 billion, or an average of $3,660 per household, per year in 1992. Using regional VMT statistics, which imply average annual usage of 11,450 miles per vehicle, the cost works out to $0.21 per VMT. This value is lower than the $0.38 per VMT used in WDOT (1994b, Table 2.3), which was apparently based on costs of a new car retained for 4 years; our estimate is an average for all cars in use, new and old.

Parking

Costs were separately estimated for off-street parking at residences, workplaces, and other locations, such as shopping centers. Note that substantial parking is provide on-street (e.g., on city blocks and suburban roads in residential areas), so its cost is included in the public costs of roads. We estimated ***residential parking*** on a per-vehicle basis, so that it would be sensitive to changes in regional vehicle ownership rates. Apogee (1994, 109) provides a formula accounting for both the land occupied by a garage and the cost of a garage structure. Applying this formula using a land value of $32,000 per acre[3] yields an estimated cost of $52 per year per car. The cost of ***workplace parking*** was estimated using a statewide estimate of $240 per year as the average market value of a parking space (WDOT 1994b, 2-7) along with region-specific estimates for the number of jobs and average occupancy of work-based automobile trips (1.06 in 1990, from SEWRPC 1994b, 549). The cost of ***other parking*** is estimated based on a value

[3] Derived from a 1994 Milwaukee land value estimate of $1.534 billion for 48,000 acres, based on pers. comm. from Julie Penman, Milwaukee Tax Assessors Office.

of $0.035 per VMT derived from the lower nationwide estimate of $64.3 billion for the value of free off-street nonresidential parking for non-work trips as reported by OTA (1994, 106). The implied cost for this other parking is $401 per year per car. The cost of on-street parking is assumed to be included among the costs for the road system.

Regionwide, estimated off-street parking costs work out to $53 million at residences, $209 million at workplaces, and $405 million elsewhere, for a annual total of $666 million in 1992. This cost averages out to $966 per household or $0.046 per PMT. By comparison, Apogee (1994; 99, 109) estimated a range of $0.038 per PMT–$0.158 per PMT for low to high density areas in Portland, Maine. The largest component is the non-work, non-home, off-street portion, which accounts for 61 percent of our estimate. The wide range in estimated parking costs by purpose (home, work, other) suggests that further analysis may be needed to reconcile the variation in these estimates, which were derived with different approaches.

Accidents

Part of the cost of auto accidents is covered by the insurance premiums plus out-of-pocket expenses paid by drivers. These directly paid costs are borne by private households as well as businesses and government agencies that use vehicles. However, the accidents result in additional costs not covered through the insurance system or direct expenses of drivers. A comprehensive cost accounting for motor vehicle accidents would include all medical care, emergency services, lost wages and productivity (both at workplaces and homes), administrative and legal burdens, property damage, and travel delay, in addition to "lost quality of life" due to injuries and mortality. All costs except lost quality of life are monetary, and paid for somewhere within the economic system. Quality of life, including the value of a life, is difficult to convert to a dollar cost. Nevertheless, estimates can be made based on how much individuals are willing to pay to increase their probability of survival under various circumstances. Miller et al. (1991) estimated a total nationwide cost of $334 billion (1988$) for highway crashes in 1988, amounting to $0.16 per VMT averaged over all vehicle types. The largest portion entails the non-monetary costs of lost quality of life, including loss of life (which Miller et al. valued at $2.4 million per life) plus uncompensated pain and suffering. To develop accident cost estimates for the region, we apply the Miller et al. cost values using regional vehicle use statistics. A more refined calculation could be done using regional accident statistics.[4] Such an effort would be worthwhile if it were suspected that the frequency and damage distributions of accidents in the region differ greatly from national averages.

Insurance covers 49 percent of U.S. roadway accident costs other than the non-monetary costs of lost quality of life (Miller et al. 1991, 103). In Wisconsin, the average annual auto insurance premium is $492 per vehicle in 1992 (Wenzel 1995, Table 2). Multiplying by the number of cars and personal light trucks in the region yields a total of $497 million. Assuming

[4] Region-specific accident data have been gathered from WDOT and U.S. DOT; we may be able to provide more detailed analysis in follow-up work.

that this insurance-based value covers 49 percent of monetary accident costs in the region, we estimate the remainder as 51/49 times this value; the resulting $518 million estimate is shown as "other monetary costs" in Table 3.2. Total monetary costs are therefore roughly $1 billion for the region in 1992.

For non-monetary costs of accidents, we divided the estimate of $228.5 billion (1988$; Miller et al. 1991, 101) by total U.S. VMT, 2.026 x 10^{12} miles (FHWA 1989, 172), to obtain a national average cost per mile estimate for 1988, which equals $0.131 per VMT in 1992$. However, U.S. traffic fatalities have been on a long-term declining trend because of improved technology (such as vehicle safety features and roadway design improvements) and other safety measures. Therefore, rather than adopting a fixed constant-dollar value for non-monetary accident costs, we extrapolate from the fatality-reduction trend to obtain an estimate for 1992 of $0.113 per VMT (1992$). The resulting estimate for the non-monetary, lost quality-of-life cost of traffic accidents works out to $1.3 billion regionwide.

Combining the non-monetary accident costs with the $1 billion in monetary costs yields a total accident cost estimate for the SE Wisconsin region of $2.3 billion. This regional aggregate cost corresponds to an average of approximately $3,400 per household, of which only 21 percent is covered by insurance premiums. Accident costs are dominated by the lost quality of life portion; accordingly, adopting values much lower than those used would make this cost appear much smaller. In any case, as noted by Miller (1993), neglecting lost quality of life in an economic analysis results in an inappropriate bias favoring mobility over safety.

Environment

The environmental costs associated with transportation are all considered externalities, that is, effects on others which are not accounted for by the parties causing the effects. An external cost need not be negative, but we do not know of positive externalities (external benefits) associated with transportation. Generally, externality cost estimates are quite uncertain. However, all of those which we list are considered significant in the sense that there is a consensus that substantial costs are incurred when aggregated over a large population. Estimates for each of the externalities we consider amount to tens of billions of dollars nationwide, as summarized in OTA (1994), for example. Thus, while a particular value may be uncertain, we have high confidence that the associated cost is significant. Therefore, a better overall picture of social costs is obtained by including an uncertain non-zero value than by leaving out a value just because it is uncertain, which would be equivalent to assuming that its value is trivial (i.e., best represented by a zero value).

For criteria ***air pollution,*** we considered impacts of carbon monoxide (CO), volatile organic compounds (VOC; largely hydrocarbons [HC] particularly those classified as reactive organic gases), nitrogen oxides (NOx), and particulate matter (PM, based on estimates for particles up to 10 microns, "PM_{10}"). SEWRPC (1994b, 475) reports total regional emissions of CO, HC, and NOx, for 1990 with projections for 2010. SEWRPC (1994f, 33ff) describes the emissions modeling done to establish conformity of the regional transportation plan with the

state air quality plan. However, emissions estimates given in these reports are not disaggregated by vehicle type (i.e., cars, light trucks, heavy trucks, etc.). Dissaggregated region-specific estimates might be obtainable from model runs (e.g., using EPA's MOBILE model), which can better represent trip-specific emissions, rather than relying on VMT-averaged emissions rates. However, such additional analysis is beyond the scope of this study and is not likely to provide greater accuracy for overall region emissions (it would be more important for estimating effects on peak ozone days). For this report, we estimated CO, HC, and NOx emissions using average vehicle emission rates values from Ross et al. (1995), which are based on a review and statistical analysis of available in-use vehicle emission measurements. For particulate matter, we used estimates derived from the MOBILE model by Apogee (1994, 151). Average gram per mile estimates for each pollutant are given in ACEEE (1996).

Wang and Santini (1995) estimate air pollution damage costs for major U.S. cities including Milwaukee. Some estimates of air pollution externalities are based on control costs rather than damage costs. Control costs are often higher than estimated damage costs; a notable exception is for fine particulates, which recent studies reveal to be more damaging to health than assumed for current emissions standards and control strategies (Shprentz 1996). By using damage costs, we avoid potential mis-estimation of costs due to: (1) market, regulatory, and implementation imperfections that lead to control costs being different than damage costs; and (2) the fact that existing pollution controls already internalize some of the costs, e.g., in the higher cost of a car due to its emissions control system or the higher cost of gasoline due to reformulation requirements. For the Milwaukee area, air pollution damage costs are below the national average and notably lower than oft-cited values for major metropolitan areas such as Los Angeles or New York City, which have larger exposed populations. Our average air pollution cost estimate for 1992 works out to $0.023 per VMT (1992$), which is lower, for instance, than the range of $0.05 per VMT - $0.09 per VMT implied by Miller and Moffet (1993) and Apogee (1994). Nevertheless, the estimated external cost of criteria air pollution amounts to $263 million, or $382 per household, for cars and light trucks in the SE Wisconsin region, making it the largest component of environmental cost.

For ***greenhouse gas emissions*** we use an external cost estimate of $0.37 per gallon of gasoline ($0.019 per VMT for 1992), as implied by a carbon emissions cost of $100 per metric ton (full fuel cycle carbon mass basis). It is practically impossible to estimate damage costs for the risks of climate disruption associated with greenhouse gas emissions. The value selected is based on the carbon tax level ($25 per short ton of CO_2) adopted by UCS et al. (1991) as appropriate for a cross-sectoral U.S. carbon emissions control scenario. It is lower than values needed to stabilize emissions using a carbon tax alone, but higher than the costs of controlling emissions by investments in technically feasible energy efficiency measures whose adoption is inhibited by market imperfections (some of which, such as auto efficiency increases, actually have negative costs because the value of fuel saved exceeds the costs of technology improvement). The $100 per ton value also falls in the middle of the wide range of estimates based on carbon sequestration through forest plantings, which Pace University (1990, 165-185) reviewed as ranging from $2 per ton for projects in Central America up to $200 per ton for forest plantations in North America. Our value is just above the $0.03 - $0.32 per gallon range used

for a greenhouse gas emissions externality cost by OTA (1994). The $100 per ton valuation implies a total cost of $221 million for car and light truck greenhouse gas emissions in the region, making it almost as large as the estimate for criteria air pollution.

For ***noise*** effects, we adopted a value based on the discussion by Miller and Moffet (1993, 33-35). Based on their review of studies examining adverse health and productivity of traffic noise, the cited a range of $0.0014 per PMT to $0.0023 per PMT for urban conditions. Picking the mid-range and converting to a VMT basis using the regional average vehicle occupancy of 1.3 yields an estimate of $0.0026 per VMT (updated to 1992$). The regionwide external cost estimate for auto-related noise works out to $30 million.

For ***water pollution,*** we also draw on Miller and Moffet (1993, 49-50), who estimate an average cost of $0.0013 per PMT. Their review considers effects of water runoff, fuel storage tank leaks, oil spills, and road salt (net of its vehicle and road maintenance costs, which are included in those categories). Converting to a VMT basis using the regional average vehicle occupancy of 1.3 yields an estimate of $0.0018 per VMT (updated to 1992$). The regionwide auto-related water pollution cost estimate is $21 million, which is about one-twelfth (8 percent) as large as our estimate for air pollution.

The total external costs of environmental damages from cars and light trucks in the region amount to $535 million, or $776 per household. This aggregate cost is equivalent to an average of $0.046 per VMT; if translated to a fuel price, it would be $0.89 per gallon of gasoline (based on the 1992 average fuel economy of 19.4 mpg). The contributions to this total automobile environmental damage cost break down as 50 percent from criteria air pollution, 40 percent from greenhouse gases, 6 percent from noise, and 4 percent from water pollution. Given the uncertain nature of environmental damage cost estimates and even of the pollution levels involved, it would be valuable to examine the sensitivity of this estimate to changes in parameters used to develop it; this step we save for a future revision of the study.

Other Costs

Two other costs commonly considered in transportation costs analyses are those of congestion and oil supply.

For ***oil supply,*** estimates of the economic and military costs associated with oil imports range from $0.24 to $0.58 per gallon (OTA 1994, 127-128, updated to 1992$). A related cost is that of public subsidies and other favorable tax treatments enjoyed by the U.S. petroleum industry. Its value is relatively small and would amount to another $0.02 per gallon to $0.06 per gal, based on values discussed in OTA (1994, 107) and Miller and Moffet (1993, 18). The largest element of uncertainty among these cost items has to do with how to allocate the military costs associated with insuring adequate U.S. domination and defense of oil producing regions, particularly in the Middle East. Military costs and oil industry subsidies are public costs indirectly associated with the transportation system rather than externalities. Economic costs associated with supply disruption risks and the opportunity cost associated with the large U.S.

share of the world oil market are externalities. For convenience, we combine all of these items and use a mid-range value of $0.45 per gallon (1992$) for the indirect and external costs associated with petroleum supply. The resulting total for the SE Wisconsin region is $271 million, a sum comparable in magnitude to the portion of environmental costs estimated for criteria air pollution.

Congestion causes both lost time to travelers as well as increases in other costs, such as those associated with fuel use and air pollution emissions. We do not, however, separately attribute to congestion its impacts on other cost categories, since we assume that these impacts are captured in the statistics on fuel consumption and emissions rates, for example. Generally, the cost associated with travel time takes two forms: normal time spent traveling in non-congested conditions, and congested travel time, which is the additional time spent due to traffic volumes that result in congested flow. Normal travel time is directly borne by travelers and is accounted for in travel behavior and mode choice decisions; we do not consider it in our analysis. Congestion, on the other hand, involves an external cost to the extent that each traveler added to traffic slows down other travelers. Travelers bear some of this cost themselves—this component is not external, since travelers presumably account for it in their decisions of when, where, and how to travel. However, the delay added to the travel times of other is presumably not considered and so is an externality.

Estimating the cost of the congestion externality is difficult and, as for other external costs, involves uncertainty. The range of external costs for congestion time imposed on others estimated by OTA (1994, 108) is $130 - $150 billion nationwide, which works out to $0.06 per VMT—$0.07 per VMT if allocated to all travel. However, for a regional cost calculation, it is more appropriate to assume that the bulk of the cost pertains to that fraction of travel which occurs under very congested conditions. Litman (1995, 3.5-7) assumes a $100 billion nationwide cost to derive estimates of $0.17 VMT for urban peak travel and $0.02 per VMT for urban off-peak travel. Note that the congestion cost for off-peak travel is not intended to represent the cost of travel time. Rather, a non-zero value indicates that even under low volume conditions, each additional vehicle on the road does impact the travel of others. Congestion cost might be more realistically modeled along a continuum, but the regional data are not so reported (e.g., total traffic distribution by level of service). Thus, we apply a simpler, two-level representation of congestion cost, approximating the portion of VMT to which the peak value figure applies at 11.5 percent, which is the percent of arterial facilities experiencing traffic congestion in the SE region estimated in SEWRPC (1994b, 545), and applying the off-peak value to the remainder of VMT. The resulting congestion cost estimate is $464 million.

Summary of Auto Costs

The bottom line in Table 3.2a is a total annual cost of $7.1 billion for automobile (car and light truck) use in the SE Wisconsin region. This estimate corresponds to $10,300 per household per year or $0.49 per PMT. A breakdown of the major components is shown in Figure 3.1. Private costs of auto ownership are the largest portion, accounting for 35 percent, followed by comprehensive accident costs, accounting for 33 percent. Seen in this light, the public infrastructure costs, an estimated $432 million regionwide, are among the smaller cost

elements, at 6 percent of the total; estimated parking costs amount to 9 percent of the total. Costs of environmental externalities, indirect oil supply costs, and congestion are collectively responsible for 17 percent of the total. These cost items are largely related to the amount of driving; allocating them to the amount of travel in the region would imply a cost of $0.11 per VMT, or $2.08 per gallon if allocated to the price of fuel.

Costs of Transit Use

Estimating the direct costs of public transit—mainly the region's bus service—is fairly straightforward since the expenses of owning, operating, and maintaining vehicles are all handled by the regional transit service agencies and regularly reported in state and federal publications. These are all public costs, which we listed in the transit expenditures column of Table 2.2 and repeat them in Table 3.2b. These public transit expenditures totaled $105 million in 1992.

Other cost aspects of transit were estimated similarly to corresponding items for automobiles, but using values specific to buses. For accidents, Miller et al. (1991) reported a comprehensive cost, i.e., including both monetary and non-monentary components, of $0.279 per VMT (inflated to 1992$) for bus accidents. Given the 27 million miles of bus travel in the region (WDOT 1992, 11) in 1992, the result is an estimated accident cost of $7.5 million. Criteria air pollution emission factors for buses were derived from Wang (1995). The result is an estimated annual cost of $1.8 million for bus air pollution in the region in 1992. Based on the full fuel cycle carbon content of diesel fuel and the $100 per tonne valuation noted above, greenhouse gas emissions cost work out to $2.5 million. Smaller costs of noise and water pollution associated with buses were derived using estimates from Miller and Moffet (1993; 35, 50). Overall, environmental damage costs associated with the region's transit system amounted to an estimated $4.5 million in 1992. On average, this works out to $0.17 per VMT (per bus mile of travel) or $0.73 per gallon of diesel fuel (based on the estimated average bus fuel economy of 4.3 mpg). Oil supply externality costs for transit amount to $2.8 million. Finally, congestion costs were estimated by assuming that one bus is equivalent to four cars in terms of its added contribution to congestion; the result is a congestion cost of $4.1 million.

Overall, the costs of the regional transit system totaled to $123 million in 1992. Using the estimated ridership statistics giving 180 million PMT carried by transit in the SE region (FTA 1992), the resulting average cost is $0.69 per PMT. Public expenditures on the system account for most (85 percent) of its cost.

How and Which Costs are Paid

Some costs of regional passenger transportation are paid for within the system, meaning that a monetary exchange is involved and the cost item is either priced or budgeted as transportation related. Other costs are monetary but not clearly linked to transportation in the sense that information on the item's relation to transportation is not directly involved in the transaction. An example of this category is "free" parking at workplaces or shopping centers; the

transportation aspects of the cost are known to developers and perhaps to retailers or employers using the space, but not to the drivers who use the parking. The cost may be ultimately passed on to them, e.g., as a higher price of a good or a lower wage, but its link to transportation is hidden. The costs of some items, such as environmental damages, are non-monetary, and are hidden as well as unpriced. As shown in Table 3.1, some costs span more than one category. Apportioning such costs to categories can be difficult and is not needed for our analysis, so we have assigned them to one category. Other analysts may prefer a different assignment, but it is more important for the accounting to be complete than classified in a particular way. For our purposes, the main distinction is between those costs paid within the system and those that are otherwise hidden or indirectly paid, or not paid at all. Table 3.3 presents the resulting view of how and which transportation costs are paid in the SE Wisconsin region.

Costs paid within the transportation system include the privately borne costs of owning and operating motor vehicles, including portions of parking costs; user fees, such as fuel taxes, registration fees, and transit fares; and local non-user-fee public revenues that are explicitly budgeted for transportation. Some studies consider the later category separately, since it can be interpreted as a subsidy for transportation. However, transportation systems are at least in part a public good, and so a case can be made for devoting some of the public's general revenues to the system. The parts that are explicitly budgeted for transportation thus represent a clear political choice made within the context of regional planning. Of course, one can question how much general revenue should be spent on transportation and how it should be allocated (e.g., roads vs. transit). In contrast, other public expenditures, such as the military costs of maintaining U.S. access to oil supplies owned by other nations, are related to transportation but are not explicitly budgeted as such. We exclude these from our category of payments made within the transportation system.

Just as it is the largest cost category, privately paid expenses of owning and operating cars and light trucks used for passenger travel comprise the largest portion of payments within the regional transportation system. These are listed as the "Direct User Payments" in Table 3.3 and total to about $3 billion, or $4,400 per household. We include some of the off-street parking in this category. Parking at residences, e.g., costs of garages and driveways, is directly paid for by homeowners, although it is bundled with the cost of a house; it is also bundled in rents, which is somewhat less direct. Some might consider such residential parking to be a hidden cost, but the distinction tends to be semantic. Most workplace parking is a hidden cost. We are unaware of survey data indicating the extent to which workplace parking costs are directly paid in the region; we adopt an estimate of 10 percent as used in WDOT (1994b, 2-7), which was based on national estimates.

Public revenues and expenditures for transportation in the region were identified in Table 2.1. User fee collections account for public payments within the regional system, as shown in Table 3.3. Federal and state road user fees dominate, amounting to 91 percent of the estimated $403 million in total transportation user fee payments. User fees also include diesel fuel taxes and other fees mainly collected from freight vehicles. Overall user fee payments average $585 per household. As discussed in Chapter 2, only 81 percent of these payments are applied to the

regional transportation system, since portions of federal and state road user fees go to other uses, mostly roads outside of the region.

Local government general revenues used for transportation system costs amount to $211 million in the region, or an average of $306 per household. As indicated earlier, these are derived mainly from property taxes. Thus, we list them separately in Table 3.3 and do not include them as *payments* made within the transportation system (even though they are part of *spending* on the system). Although these local expenditures are budgeted specifically for transportation, they are quite distinct from user fees, which are raised from transportation sources.

The final category of monetary payments includes various "hidden" payments, which are ultimately paid by consumers though not directly. This category totals to $1.4 billion for the SE region in 1992, or $2,000 per household. The largest portion (43 percent) of hidden costs are for parking, incorporating "free" workplace parking and other, non-workplace, non-residential parking. Monetary payments for accident costs not covered by insurance amount to $518 million in the region, or 37 percent of hidden payments. Various oil supply-related costs described earlier account for the remaining 20 percent of hidden payments.

Tallying the monetary payments for passenger transportation in the region, the total is $5 billion, or $7,300 per household, including direct payments within the system, local government spending derived from general revenues, and the various hidden payments. Direct payments subtotal to $3.4 billion, or 68 percent of total monetary payments for regional transportation. Note that this direct payment total includes all transportation user fees (mainly gasoline tax) revenue collected in the region, not just the portion actually returned to the region for roads and transit.

Total Cost Summary

Table 3.4 provides a condensed summary of costs from Table 3.2 and payments from Table 3.3. The estimated total social cost—direct, hidden, and external—of passenger transportation in the SE Wisconsin region was $7.2 billion in 1992, or $10,500 per household. Passenger cars and light trucks accounted for 98 percent of that total; transit buses accounted for only 2 percent (allocating all road infrastructure costs to light vehicles). Thus, the direct payments of $3.4 billion cover only 47 percent of the total costs. Adding other monetary payments (hidden costs plus spending based on property taxes) brings coverage of total costs up to 69 percent. Thus, 31 percent of the total costs of passenger transportation are non-monetary costs: externalities and lost quality of life due to accidents. (Some externalities do result in monetary costs, such as medical care related to air pollution health impacts, but such expenditures cannot be tracked and allocated to transportation in the way that, say, hidden costs of parking can be. Note that the non-insurance-covered monetary costs of accidents are part of our hidden cost category.)

Thus, a picture emerges of how poorly the regional transportation system pays its own way in terms of cost. Excluding non-monetary costs (externalities and lost quality of life), transportation costs total to $4.7 billion in the region, or $6,800 per household. Drivers do pay the substantial monetary costs of owning and operating their vehicles, which, as noted earlier, amount to $3.4 billion regionwide (counting insurance premiums and user fees). However, this payment covers only 73 percent of the total monetary costs. The unpaid balance equals $1.2 billion, or $1,800 per household. If allocated as a cost per gallon of gasoline, based on the 597 million gallons consumed in 1992, the result is $2.08 per gallon. These indirectly paid costs—which include costs of local roads, non-insurance-covered monetary accident costs, and indirectly paid parking costs—can be considered an effective subsidy of driving. Shifting some of these costs to direct payment, e.g., through higher gasoline taxes or parking fees used to offset present indirect payments, could be accomplished at zero net cost burden to the region's residents. However, the resulting higher apparent price of drivers would result in more efficient decisions, resulting in less driving and lower costs overall. The need to find ways to exploit such opportunities will become more apparent in the next section of this report, where a look at SEWRPC's current plans reveals a business-as-usual, auto-subsidizing vision for the future of transportation in the region.

Table 3.1: Costs of Automobile Use Considered and Social Cost Classification.

Costs Considered	Cost Category[a]					
	Private, excluding user fees	Public, covered by user fees	Hidden private costs	Public, not covered by user fees	Classical unpriced extern-alities	Personal non-market costs
Roads[b]						
federal		*				
state		*				
local		*		*		
Public services[c]		*		*		
Parking						
home			*			
work	*		*			
other	*	*	*	*		
Motor vehicle						
ownership	*					
operation	*					
Accidents						
insured costs	*					
other costs			*	*	*	*
Environmental						
air pollution					*	
global warming					*	
noise					*	
water pollution					*	
Congestion					*	*
Oil import			*	*	*	

(a) As classified following OTA (1994), Table 4-1, p. 101.

(b) Includes construction and maintenance coss for all federal, state, and local roads.

(c) Includes road system related government services, such as police, fire and rescue, justice system, safety and environmental regulations, and other relevant public administration costs.

Table 3.2a: Social Costs of Light Duty Vehicles in Southeastern Wisconsin, 1992.

Cost Category	Avg. Annual Cost, Millions 1992$	Category Share	Average Cost per Household ($/yr.)	Implied $/VMT	Implied $/PMT
Road system	432		626	0.037	0.030
federal	68	16%			
state	168	39%			
local	195	45%			
Parking facilities	666		966	0.058	0.046
home	53	8%			
work	209	31%			
other	405	61%			
Private motor vehicle	2,472		3,583	0.214	0.171
capital (ownership)	1,399	57%			
operating					
fuel	471	19%			
maintenance	602	24%			
Accidents	2,323		3,367	0.201	0.161
private insured costs	497	21%			
other monetary costs	518	22%			
lost quality of life	1,308	56%			
Environment	535		776	0.046	0.037
criteria air pollution	263	49%			
greenhouse gases	221	41%			
noise	30	6%			
water pollution	21	4%			
Oil supply	269		389	0.023	0.019
Congestion	437		633	0.038	0.030
peak travel	232				
off-peak	204				
TOTAL	**7,134**		**10,339**	**0.616**	**0.493**

Source: ACEEE Regional Transportation Costs Accounting model, estimates for 1992.

Note: Average costs are based on values of 690,000 households, 11.6 billion miles per year light duty vehicle VMT, and 1.25 average vehicle occupancy, implying 14.5 billion miles per year PMT.

Table 3.2b: Social Cost Analysis for Mass Transit in Southeastern Wisconsin, 1992.

Cost Category	Annual Cost, Millions 1992$	Category Share	Average Cost per Household ($/yr.)	Implied $/VMT	Implied $/PMT
Public Expenditures	105		151	3.882	0.581
federal	14	48%			
state	40	39%			
local	51	13%			
Accidents	8		11	0.279	0.042
comprehensive	8				
Environment	5		7	0.169	0.025
criteria air pollution	2	41%			
greenhouse gases	3	55%			
noise	0	3%			
water pollution	0	1%			
Oil supply	3		4	0.105	0.016
Congestion	4		6	0.151	0.023
TOTAL	**123**		**179**	**4.585**	**0.686**

Source: ACEEE Regional Transportation Costs Accounting model, estimates for 1992.

Note: Average costs are based on values of 690,000 households, 26.9 million miles per year bus VMT, and 6.69 average bus occupancy (implying 180.0 million miles per year PMT in buses).

Table 3.3: Payments and Non-Monetary Costs in SE Wisconsin Region Transportation System, 1992.

Payment Category	Payment, Millions 1992$	Category Share	Average Payment per Household ($/yr.)	Implied $/VMT	Implied $/PMT
Within the system:					
User Fees	403		585	0.035	0.028
Federal road fees	122	30%			
State road fees	247	61%			
Transit fares	34	9%			
Direct user payments	3,043		4,410	0.263	0.210
Auto own, maint, fuel	2,472	81%			
Insurance	497	16%			
Residential parking	53	2%			
Paid workplace parking	21	1%			
SUBTOTAL, within system	**3,447**		**4,995**	**0.297**	**0.235**
General Public Revenues	211		306	0.018	0.014
Hidden Payments	1,382		2,003	0.119	0.094
Parking at work "free"	188	14%			
Other parking	405	29%			
Accident costs, uninsured	518	37%			
Oil supply	271	20%			
TOTAL, Monetary payments	**5,040**		**7,304**	**0.434**	**0,344**

Source: ACEEE Regional Transportation Costs Accounting model, estimates for 1992.

Note: Average costs are based on values of 690,000 households, 11.6 billion miles per year light vehicles VMT and 1.25 average vehicle occupancy (implying 14.5 billion miles per year PMT in light vehicles)

Table 3.4: Regional Transportation Cost Analysis Summary.

Cost/Payment Category	Value, millions 1992$	Implied Annual $/Household	Implied $/VMT
Costs			
private automobile costs	2,472	3,583	0.214
road system public costs	432	626	0.037
transit system public costs	105	151	0.009
parking costs	666	966	0.058
accident costs	2,331	3,378	0.201
environmental costs	540	782	0.047
national oil supply costs	271	393	0.023
congestion costs	441	638	0.038
Total	**7,258**	**10,518**	**0.627**
Payments			
private user payments	3,043	4410	0.263
user fees	403	585	0.035
Subtotal, Direct Payments	**3,447**	**4,995**	**0.298**
general public revenues	211	306	0.018
hidden payments	1,382	2,003	0.119
Total, Monetary Payments	5,040	7,304	0.435
Ratios			
monetary costs/total costs	65%		
monetary payments/total costs	69%		
direct payments/monetary costs	73%		
direct payments/total costs	47%		

Source: ACEEE Regional Transportation Cost Accounting model, estimates for 1992.

Note: Average costs are based on values of 690,000 households, 11.6 billion miles per year light vehicle VMT, and 1.25 average vehicle occupancy (implying 14.5 billion miles per year PMT in light vehicles)

Figure 3.1: Social Costs of Light-Duty Vehicles in Southeastern Wisconsin (1992).

4. WHERE IS THE REGION HEADED?

Having presented a current snapshot of transportation costs in the Southeastern Region, we now turn the future of transportation trends and costs in the region under the current SEWRPC and state plans. As noted in Section 2, three key planning documents lay out a future of the region for a time horizon through 2010. The *Land-Use Plan* (SEWRPC 1992a) provides basic geographic and demographic projections. The *2010 Long-Range Transportation Plan* (LRP, SEWRPC 1994b) forecasts travel demand and identifies major system operation and improvement needs. Finally, a periodically issued *Transportation Improvement Program* (TIP) document itemizes regional transportation expenditures over an immediate (roughly three year) horizon. As also noted, these documents concern only regional highways and arterial roads; local road planning occurs outside of the formal regional planning process. Therefore, we extrapolate from recent data to estimate likely local road costs and provide a more complete picture of future transportation costs in the region.

Although 2010 is identified as the "long-run" horizon in the SEWRPC plans, relatively little change in land-use and infrastructure can occur over such a horizon. A much longer time period would be needed to transform a regional system into one that could be substantially less dependent on automobiles. Such a transformation is the goal of the Vision 2040 plan being developed by CBE. Nevertheless, accomplishing such long-term change will require changing transportation investment decisions sooner. This look at the next 15 years trends indicates how the costs of auto dependent transportation can be expected to rise and begins to examine opportunities for changes that can lead toward a more efficient and less costly system, such as that being examined through the Vision 2040 planning exercise.

Regional Transportation Trends

Table 4.1 and Figure 4.1 summarize shows growth in the region's socioeconomic attributes (population, households, jobs, income) and transportation characteristics (vehicles, VMT, trips), both historically and through the SEWRPC forecast year of 2010. From 1972-91, population shrank by 12,000 persons (0.7 percent), although the number of households grew by 21 percent and the number of jobs grew by 31 percent. These SE Wisconsin trends reflect the nationwide changes of smaller household sizes and the large workforce expansion due to the "baby boom" generation and an increasing number of wage-earning women. For the future, the region's projected population is most sensitive to the extent of migration, which is itself dependent on economic conditions and job opportunities in the region relative to the rest of the state and country. SEWRPC identified low- and high-growth population scenarios, largely reflecting substantial out-migration and in-migration, respectively, and ranging from a 16 percent decrease to a 28 percent increase by 2010, compared to the 1990 level (SEWRPC 1994b, 224). The intermediate growth scenario used as the basis for the regional plan involves a 6 percent population increase 1990-2010.

A key element of travel demand is "trip production," the number of person trips households need to make for their daily activities (work, school, shopping, etc.). The number of trips increases with household size, and survey data indicate that the number of trips per

household grew for all household sizes from 1963-72 and further from 1972-91 (SEWRPC 1994b, 147-49). However, the shift toward smaller households held the average weekday trip rate steady at just under 8 one-way trips per day per household. Thus, on balance, travel growth was largely driven by the increase in number of households. Operating along with these demographic factors have been land use trends favoring low density development outside of traditional urban core areas. Figure 4.2 shows changes in the region's developed residential areas by density, from 1970 to 1985 and as projected for 2010. The recent history saw most growth occurring as low density development, in the category of 0.7-2.2 housing units per net residential acre. The average density of developed parts of the region has fallen steadily in the post-war period, with persons per urbanized square mile dropping from roughly 10,000 in 1945 to 5,100 by 1970 and down to roughly 3,200 by 1990 (SEWRPC 1994, 53). Not surprisingly, decreasing density has resulted in increasing trip lengths. Within the region, average trip length increased from 4.5 miles in 1963 to 5.3 miles in 1972 and to 6.1 miles by 1991 (average for all trip purposes from SEWRPC 1994b, 156).

Given the commitment to road building and suburbanization in the post-war era, automotive travel has been the main option for most people. Coupled with the changes in household structure, the lack of convenient travel alternatives, and increasing trip lengths, the result has been strong VMT growth. In the SE region, the number of vehicle trips grew 43 percent and VMT grew 49 percent from 1972-91. In terms of annual rates, the two decades previous to the current planning base year of 1991 saw a VMT growth rate averaging 2.1 percent per year, compared to 1.0 percent per year for households and 1.4 percent per year for jobs. The relative rates are fairly consistent with national statistics over the 1970-90 period, which show average growth rates of 3.4 percent per year for VMT and 2.0 percent per year for jobs and households (Bureau of the Census 1995).

VMT Projections

Under an intermediate growth scenario, SEWRPC (1994b) projects annual growth rates for 1991-2010 of 0.32 percent per year for population, 0.72 percent per year for households (reflecting a continuing trend toward smaller household size), and 0.61 percent per year for jobs. Also, most future growth is proposed as medium density development (2.3-6.9 housing units per acre). Nevertheless, most of this growth will not occur as infill and will not be coordinated with transit provision, and so the region's households will still have little choice other than extensive automobile use under current plans. SEWRPC thus projects a 35 percent VMT increase by 2010 compared to the 1991 level, for an average growth rate of 1.6 percent per year over the period.

Given the orientation of the plans, plus the fact that most development and infrastructure affecting travel patterns over the 15-20 years is already in place, this projection appears to be a reasonable guide to the likely demand on the regional transportation system. The ratio of the projected VMT growth rate to the number-of-households growth rate is 2.2, similar to the ratio of 2.1 experienced from 1972-91. However, since travel models as used by SEWRPC do not account for the additional travel induced by road expansions, VMT growth may be greater than expected. Greater VMT growth has certainly occurred than what was forecast for the region in the past; for example, 1991 VMT exceeded the 1972 forecast by 22 percent (SEWRPC 1994b,

76). Moreover, given that the area has experienced increased congestion, road capacity expansions that relieve congestion—as planned by SEWRPC—could result in a travel rebound, since the time costs of driving would be lowered. For example, Hansen (1995) found that a 1.0 percent increase in lane miles can induce a 0.9 percent increase in VMT on a metropolitan regionwide basis, based on studies in California. As we note below, SEWRPC's plan calls for a 13 percent increase in regional lane miles by 2010. Accounting for induced demand might increase the 2010 VMT projection by nearly 12 percent, suggesting a level of 50 rather than 45 million miles per day, or a 50 percent rather than 35 percent increase over the 1991 level.

Although we base the cost estimates given below on SEWRPC's transportation modeling results, the likelihood of an induced traffic effect suggests that automobile associated costs are likely to be underestimated. Future costs linked to automobile VMT could well be as much as 12 percent higher than the values shown and congestion relief could be much less than promised by the plan.

SEWRPC's Plan for 2010

To meet projected transportation needs in the region, SEWRPC weighed various alternatives and proposed a plan identifying a set of road, transit, and transportation system management measures that could be undertaken over the 1995-2010 horizon (see the box below). Capital spending for the plan amounts to $4.9 billion, 75 percent for roads and 25 percent for transit. Average annual spending is projected at $522 million, with 66 percent allocated for roads and 34 percent for transit. Note again that the SEWRPC plan covers only "regional" roads—those under regional planning jurisdiction, not including the other local roads in the region that are managed by cities, towns, and counties.

The long-range plan includes road measures such as maintenance of exiting region roads, conversion of some presently local roads to regional status, and improvements along existing roads, as well as major capacity expansions by adding lanes and new roadways. For example, one major item is upgrading the Milwaukee area freeway system, at an estimated cost of $1.5 billion. Further details on road plans are given by county in SEWRPC (1994b, 534, 581ff). Significant new transit investments are part of the plan, including what would be the first transit in the region operating on exclusive right-of-way routes, such as busways and light rail. Light rail would extend from the Milwaukee central business district westward to the regional medical center and northeast to the university, with a projected capital cost of $0.8 billion. Potential exclusive busway and HOV facilities are identified along 49 miles of the most congested freeway corridors. Finally, various traffic management approaches are intended to ease congestion but largely do so by effectively increasing road capacity. Examples are freeway

Major Elements of the SEWPRC Regional Transportation System Plan for 2010

Measures	Capital Cost (billion 1994$)	Average Annual Cost (million 1994$)
Regional Road System Capacity expansions, including freeway and parkway additions, major arterial widening and system refurbishment, plus operations and maintenance.	$3.7	$343
Regional Transit System Expanded rapid and express transit services, including light rail and busway construction, improved local transit services, plus O&M.	$1.2	$179
Transportation Systems Management Traffic and incident management, TDM, motorist advisory systems, and operations control systems.	(not separately broken out)	
TOTAL	**$4.9**	**$522**

Source: SEWRPC (1994b, 546; 1994e, 37).

incident management techniques, curb-lane parking restrictions on urban arterials, and various "intelligent transportation systems" approaches. Some promotional efforts for demand management are also in the plan, but no significant pricing or incentive approaches to controlling demand are included. The plan does not break out spending on traffic management items, but they are generally much less than the capital costs of road construction.

Cost Projections

Following the approach taken in the previous sections of this report, we start with an examination of costs that fall within the framework of the regional plans. We then extend the accounting to include estimates for the costs of local roads as well as private, indirect, and external costs of transportation in the region.

Public Costs

SEWRPC (1994b) presents expected finances for the regional system in terms of average annual costs over the 1995-2010 plan horizon, as broadly summarized in the preceding box. SEWRPC's cost and revenue summary is reproduced here as Table 4.2. Figure 4.3 provides a schematic breakdown of the table, illustrating the road and transit shares and sources of financing based on current shares by level of government as assumed by SEWRPC. As noted earlier, spending on local roads is not included. SEWRPC projected the average annual public cost of the plan, including the construction and maintenance of highways, arterial roads, and transit, at $522 million. The commission estimated revenues for the plan using "base year" values, that is, assuming the same levels as currently obtained from federal and state

transportation funding programs. Thus, they are using the term revenue differently than we do here when reporting estimates of revenues collected in the region whether or not they are used for transportation within the region. SEWRPC refers to funding (revenues allocated) rather than revenues likely to be collected; their estimate of this average annual funding level is $300 million. On this basis, the plan anticipates an annual shortfall of $222 million, as indicated at the bottom of Table 4.2. The future financial picture is recast in Table 4.3—an analogue of Table 2.1—using our projections of revenues likely to be collected in the region.

Regional roads. On the public expenditure side, two-thirds of regional system spending is for roads, amounting to an annual average of $343 million. Approximately 80 percent of this projected road spending is for capital improvements. The SEWRPC plan calls for the addition of 1,191 new lane miles of roadway to the 9,112 miles now comprising the region's arterial street and highway system, for a 13 percent expansion, by 2010 (SEWRPC 1994b, 535-542). Of this expansion, 337 lane miles would be new roads and 854 lane miles would be based on widening or otherwise improving existing routes. Major projects include 22 route miles of new freeway and 109 miles of new arterial roadways. In Table 4.3, we allocate the $343 million of regional road spending to federal and state highway programs using the same shares as occurred in 1992, yielding expenditure estimates of $99 million and $244 million, respectively. This annual average of combined federal and state road spending in the region is a substantial increase (45 percent) over the 1992 level of $237 million (Table 2.1).

Local roads. SEWRPC does not provide estimates of the implications of its plan for spending on local roads, which will rise due to continued sprawl development and place increasing burdens on local government budgets. WDOT (1994a) noted recent statewide trends in state aids for local roads, which have somewhat exceeded general inflation on a statewide basis; however, the report did not make projections for either total local road cost trends or state aid contributions, let alone the balance that would have to be made up by local general revenues. As noted earlier, most of the road mileage is under only local jurisdiction (rather part of the regional system), although SEWRPC estimates that only 10 percent of VMT is carried on local roads. Several approaches can be used to estimate the future cost of local roads:

(a) Assume proportionality to increases in regional road system costs. As noted above, federal and state spending on regional roads increases by 45 percent. This large increase includes major capital improvements and urban freeway refurbishment projects, and so probably overstates future local road spending (unless a great deal of neglected maintenance has left many of the regions local streets and roads in need of rebuilding).

(b) Assume proportionality to regional system lane-mile expansion. As also noted above, the number of lane miles in the regional system is projected to increase 13 percent by 2010. A cost increase of this level is suggested if local road lane miles increase in proportional to those of the regional system and unit costs remain constant in inflation-adjusted terms.

(c) Assume proportionality to changes in urban land use. SEWRPC (1994b, 237) projected regional land-use changes based on the recently updated land-use plan (SEWRPC 1992a), indicating a 23 percent increase in urbanization regionwide in 2010 compared

to 1985. This projection suggests a 16 percent increase by 2010 relative to an interpolated level for 1992, the base year for our analysis. If local roads increase in proportion to urbanized area and the cost of local roads (capital and maintenance) keeps pace with general inflation, a 16 percent increase in local road costs are implied. The plan also projected a 19 percent increase in land used for "transportation, communication, and utilities" from 1985-2010 (SEWRPC 1994b, 237); interpolating this growth suggests a 13.5 percent increase, similar to that suggested by growth in regional lane-miles.

The latter approaches all suggest a local road cost rise in the 13 percent-16 percent range; the most specific are the regional lane-miles and "transportation, communication, and utilities" land-use estimates, so we adopt an estimate of 13 percent over the 1992 level. This assumption yields a value of $220 million, shown for local government road expenditures in Table 4.3.

Transit. Improvement and maintenance of the region's public transit services accounts for 34 percent of average annual spending under the plan. As noted above, SEWRPC slates increases in express, rapid transit, and local transit service throughout the region. The planning study expects that, with inflation-adjusted fares held at 1994 levels, these service expansions will lead to ridership increases, with regionwide bus PMT rising 14 percent and the transit share of trips rising from 3.0 percent in 1992 to 3.2 percent by 2010 (SEWRPC 1994b, 549). Our transit cost estimates were taken directly from SEWRPC (1994b, 546), and we allocated expenditures by level of government according to the 1992 shares. Changes in federal transit funding programs-now in flux-could significantly change the allocation, of course. In any case, projected annual average regional transit expenditures amount to $216 million by 2010 (including $38 million in farebox collections), essentially doubling the 1992 level of $105 million.

Overall public spending. The total line of Table 4.3 summarizes expected public finances for transportation in Southeastern Wisconsin in 2010. The revenue side is discussed further below. On the expenditure side, the total annual spending by all levels of government spending for transportation in the region is expected to average $780 million (1992$) by 2010, a 45 percent increase over the 1992 level. Spending breaks down as 72 percent for roads, 28 percent for transit, reflected a shift toward transit, which received a 19 percent share in 1992. Under the assumption that federal and state governments cover the same proportions of major regional programs for both road and transit, the local government general revenue share of expenditures would be 34 percent, down from the 39 percent share estimated for 1992. As noted by SEWRPC, however, planned spending exceeds the current funding allocations from state and federal sources. If the planned spending levels are to be met, state legislative action would be needed to greatly increase transportation fund allocations to the region and covering these increases is likely to require raising fuel taxes and other user fees.

Other Costs

To estimate future values for the many other costs associated with transportation, we used SEWRPC (1994b) projections for travel demand, vehicle ownership, occupancy, and related parameters plus various trend extrapolations and other assumptions regarding how unit

costs are likely to evolve over the next 15 years. Here we briefly summarize our approach, highlighting key assumptions that affect the major cost items. All results are presented in constant 1992$ and are summarized in Table 4.4, the 2010 analogue of Table 3.2. Further details are provided in the spreadsheet model documented in Appendix B.

We assumed that the private fixed costs of car ownership would increase at rate of 1 percent per year above general inflation. Over the past two decades, the average fixed costs of a car ownership increased at over 2 percent per year over inflation (AAMA 1995, 58; adjusted with CPI-U from CEA 1995, 341). However, the rate of vehicle price increases appears to have moderated recently, so we assume a slower, 1 percent per year real rate of increase for the future. The resulting projected annual capital cost of cars in 2010, $1,661 (1992$, 20 percent higher than in 1992), is multiplied by the projected number of cars in the region, 1.3 million (29 percent more than in 1992) from SEWRPC (1994b, 549). We based future fuel costs on the gasoline price forecast of $1.38 per gallon in 2010 from EIA (1995) and an assumption of no improvement in average fuel economy, which has been on an essentially flat trend since the early 1980s. The modest average gasoline price rises are unlikely to generate significant market interest in higher vehicle efficiency. Immediate prospects for stronger fuel economy regulations appear poor, although this situation could change given perennial concerns about oil imports and energy security as well as growing concerns about global warming. Driven by the expected higher-than-inflation increases in both the fixed and variable consumer costs of owning and operating personal cars and light trucks, this item grows in its share of total cost, accounting for 42 percent in 2010 compared to 34 percent in 1992, at an expected regionwide cost of 3.8 billion.

For parking, we assumed that all unit costs (per car, per VMT, and per commute) grow in step with general inflation, remaining fixed in constant dollars. Parking costs then increase with the SEWRPC (1994b) projections of auto ownership, VMT, employment, and commuting vehicle occupancy. The result is a projected $816 million in regionwide parking costs in 2010, a 22 percent increase over the 1992 estimate.

For accident and auto insurance costs, we assumed that average premiums remain the same in constant dollars and that the share of monetary costs covered by premiums also stays the same as in 1992. Regionwide monetary costs of accidents then rise with the increase in car ownership. For the non-monetary losses of life and of quality of life, we extrapolated from the declining trend in traffic fatalities noted earlier, so that the assumed cost factor drops from the 1992 estimate of $0.113 per VMT to $0.086 per VMT (1992$) in 2010. Nevertheless, at a projected $2.6 billion in 2010, accident costs remain a major item, still second only to private vehicle owning and operating costs in the region's total transportation cost picture.

Environmental costs are expected to slightly decline in spite of growing traffic because of ongoing improvements in vehicle emissions controls. The 1990 Clean Air Act Amendments mandated a new round of tighter vehicle emissions standards which are just now being phased into new vehicles and will continue to be phased into the total on-road stock as newer vehicles replace older ones in-use. To project air pollution costs, we scaled the 1992 damage cost estimates upward by 3 percent to account for population growth (a greater number of people

exposed to air pollution in the region). For emissions rates, we used Ross et al. (1995) projections for passenger cars in 2010; these estimates are consistent with EPA's MOBILE5 model. The result is an estimated 52 percent decline in pollution damage cost per mile. For buses, we assumed emissions damage cost per mile would drop by 50 percent, also due to improvements in emissions control technology and operations. Greenhouse gas emissions, noise, and water pollution unit cost factors (per VMT) are held constant at their 1992 level, so that these external costs grow in proportion to growth in vehicle use. Under these assumptions, environmental damage costs decline to $499 million by 2010, 8 percent below our 1992 estimate of $540 million. Given the large uncertainties associated with estimating environmental damage costs, this decline cannot be considered significant. It would be more reasonable to conclude that overall environmental externalities associated with the region's transportation system will be similar in 2010 to their level in 1992. Under the assumptions used here, the declines in criteria air pollution, due to strengthened emissions control regulations, are offset by rising greenhouse gas emissions, for which no meaningful control strategy is yet in place.

The remaining cost items are the indirect and external costs associated with congestion and supplying oil for motor fuel. For these items, we also use the same unit cost factors for 2010 as for 1992, and so their costs change with the projected changes in vehicle use. Under their recommended plan, SEWRPC projects that congestion drops from 11.8 percent in 1992 to 4.6 percent in 2010 (proportion of system having traffic over design capacity; SEWRPC 1994b, 545). Thus, projected congestion costs fall from our 1992 estimate of $441 million to $394 million by 2010 in spite of the growth in overall traffic. On the other hand, external costs associated with oil supply rise by 25 percent, in step with the projected increase in fuel consumption. As noted above, however, the plans road capacity expansions may lead to additional automobile travel not accounted for in SEWRPC's projections. If such induced travel demand offsets some or much of the congestion relief projected by SEWRPC, future congestion costs could be higher than the projections shown here.

Overall, the total cost of transportation for the region rises to $9.2 billion in 2010, a 27 percent increase over our 1992 estimate of $7.3 billion. The largest part of the increase is actually in the private costs of car ownership; it is driven by the SEWRPC projections of rising car use and our assumption of a continuing rise in the real (after inflation) cost of ownership. If car ownership (excluding fuel) costs remained constant in real terms, our total cost estimate for 2010 would drop by $360 million. Transit system public costs have the greatest proportionate rise (doubling), but still remain a small share (about 1 percent) of the regional total cost picture. The other costs contributing to the overall rise are mainly those associated with auto use, including road and parking costs, accident costs, and the petroleum-related external costs of greenhouse gas emissions and oil supply. The costs projected to decline are criteria air pollution and congestion. In 1992, their combined share of the estimated total cost was 10 percent; by 2010, we project it to drop to 6 percent. The cost items having an increasing share of the total are the public costs of the road and transit system plus that largest item, the privately borne costs of owning and operating cars and light trucks.

Future Transportation Payments

As noted above, SEWRPC's revenue estimates for 2010 assume the same levels as currently obtained from federal and state transportation funding programs. Thus, the estimates reproduced here in Table 4.2 reflect neither growth in user fee collections due to higher VMT and gasoline use nor changes in fee levels that could be made to provide adequate funding for the long-range plan. The resulting transportation revenue projection for the region is $300 million (average annual level by 2010), breaking down as $97 million from federal sources and $203 million from the state of Wisconsin. Increasing these estimates by the 24.9 percent VMT increase projected by 2010 yields estimates of $121 million and $254 million from federal and state sources, respectively, or a total of $375 million. Although state transportation budget allocations would have to change to provide such funding levels, these estimates represent the revenues potentially available to support transportation based on growth of user fee collections and allocation to the Southeastern Wisconsin region in the same proportion as transportation are presently allocated. Note that projections are given here in constant 1992$; the state gasoline tax is indexed to the consumer price index (CPI) and so inflationary effects are not an issue.

For purposes of completing the projected social cost picture, the needed estimates are of user fees likely to be collected in the region regardless of the extent to which they are allocated back to the region. Thus, in Table 4.3, our 2010 projections of road-derived revenues are derived by increasing the 1992 estimates directly in proportion to VMT. The resulting estimate of $461 million is 23 percent higher than an estimate reflecting VMT growth and allocations proportional to current patterns and 54 percent higher than SEWRPC's $300 million dollar level, which does not account for any growth in user fee collections. Including transit farebox revenues of $38 million (SEWRPC 1994b, 546) completes the 2010 revenue projection. The resulting total is $499 million, equal to 64 percent of the $780 million projected average annual cost of the plan. Since gasoline taxes are the largest revenue source, the projection is sensitive to average motor vehicle fuel economy as well as to VMT. As noted earlier, while immediate trends do not indicate fuel economy increases, public concerns could result in new policies to increase fuel economy. The result would be a savings to region in the form of lower gasoline prices, but also a drop in gasoline tax collections, unless the tax rate were adjusted upward to compensate for the decrease in fuel consumption per mile of travel.

To project the need for local government general revenues for transportation, we used our expenditure projections and assumed that local governments would cover the same proportion of the transit spending requirements (expenses less fares collected) as in 1992. Including local road spending, estimated by using the 13 percent scale-up described above, brings total local government transportation spending to the $299 million level shown in Table 4.3. Subtracting farebox revenues (the only local source of transportation user fees in the region) yields an estimate of $261 million in local non-road related taxes that would be needed for transportation. This projected value is 24 percent higher than the 1992 estimate of $211 million. Note again that this projection assumes funding share responsibilities by level of government similar to the 1992 situation.

We projected other payments, mainly the private costs directly paid by drivers, for 2010 in the same manner as we developed the estimates for 1992, working from projections of population, vehicle ownership, VMT, and so on. The calculations were systematized in our spreadsheet model as described in Appendix B. Projected private user payments amount to $4.6 billion (1992$) in 2010, including $3.8 billion in vehicle capital and fuel costs, Table 4.5, which summarizes the overall social cost projection.

Shortfalls in Transportation Finance

SEWRPC (1994b) identified a shortfalls in the ability to fund the plan by comparing needed expenditures with current funding levels. Increasing VMT, resulting in higher gasoline purchases, could ameliorate the shortfall, since such growth is expected statewide and would generate a larger revenue base for allocate to the region as well as elsewhere in the state. However, other trends and policy changes work in the other direction and could lessen available revenues, especially from the federal government. Of particular concern are reductions in transit funding due to changing Congressional priorities.

SEWRPC identifies a $222 million shortfall in average annual funding available for the long range plan. Of the total expenditures, state highways are expected to consume 44 percent, county highways 22 percent, and transit 34 percent. However, the shortfall is distributed differently, with state highways accounting for 38 percent, county highways 19 percent, and transit 43 percent (SEWRPC 1994b, 611). For roads in the regional system (including state and county highways but not the strictly local roads), the $126 million funding shortfall represents 37 percent of the $343 million in planned expenditures. For transit, on the other hand, the $96 million shortfall amounts to 54 percent of the $179 million in planned annual average expenditures (net of farebox revenues).

At a regionwide gasoline consumption level of 670 million gallons per year (the average of consumption rising with VMT over 1995-2010), each $10 million of funding shortfall could be met with a 1.5¢ per gallon increase in the gasoline tax applied within the region. A statewide transportation plan, "Translinks 21," proposes increasing user fees (e.g., higher gasoline taxes) to provide more funding than currently available for various transportation programs throughout the state. The plan proposes $108 million in additional funding for roads in the region (compared to the $129 million SEWRPC plan shortfall). However, the state plan allocates a disproportionate amount ($95 million) to state highways-even more than is needed to cover that portion of the shortfall (SEWRPC 1994b, 611). Thus, county roads that are part of the regional system would still be left with an average annual shortfall of $15 million. For transit, the state Translinks plan (combined with prior new transit revenues) would yield $25 million toward the shortfall. SEWRPC has proposed a transit capital assistance fund that could generate $14 million annually for the region. SEWRPC also assumed an increase in federal monies averaging $40 million (SEWRPC 1994b, 615). Combining these proposed federal and state fund yields nearly $79 million per year. Compared to the SEWRPC plan's transit shortfall of $96 million, this additional funding would leave $17 million to be made up by local sources in the region.

The state of Wisconsin has undertaken a program better align road jurisdictions with their functional usage (WDOT 1994a). Rationales include greater equity in highway financing, so that the higher costs of a higher-order road more closely match tax base supporting the facility, and a better approach to long-term investments. Realignment shifts financial responsibility among levels of government. If the number of miles associated with local governments should increase, then maintenance of those roads could require a greater portion of property tax revenue than at present. Conversely, a shift to state responsibility would lower the funds which local governments must allocate to roads, potentially reducing the drawn on property taxes dollars or other general revenues at local governments' disposal.

Table 4.5 shows the number of road miles under each jurisdiction, state, county, and local within the region in 1991 and as proposed for 2010 in SEWRPC (1994b). There is a 10 percent overall increase in the number of road miles, from 3,274 to 3,607. The proposed changes show a shift in jurisdictional responsibility is from the state and local (city, town, village) levels to counties, which would increase their share of road miles from 33 percent to 44 percent. Even though counties obtain state road aids, such a shift may still increase the need to draw on local general revenues. As shown earlier in Table 2.3, there has been a slight trend towards using county rather than state revenues to fund county roads; such a shift would be consistent with the jurisdictional realignment targets. If such changes in financial responsibility result in a greater need for counties to use local general revenues for roads, it will conflict with citizen concerns regarding property taxes, which are often viewed as too high and increasing more quickly than the services provided.

Moreover, examining the broader changes in transportation funding at the federal level leads to a bleaker picture than shown in SEWRPC's plan. Recent budget negotiations in Congress have emphasized reducing federal transit support while increasing road funding. Although the new federal funding picture is far from resolved at the time of this writing, transit proponents are anticipating difficult fights on upcoming transportation appropriations bills and the reauthorization of ISTEA. Some recent proposals have called for phasing out transit operating assistance, eliminating new rail transit capital grants, reducing the federal match for remaining projects to 50 percent from the current 80 percent, and eliminating support for transit research and planning. Such cuts in federal support would severely curtail the region's current transit system, not to mention eliminating the hoped-for increases in transit facilities proposed by SEWRPC. Because the regional plan relies heavily on transit to lessen the increases in VMT growth, the potential federal funding cuts severely jeopardize the plan's provision of alternatives to driving and are likely to result in higher than projected levels of road traffic, congestion, and attendant social costs. In short, the currently anticipated funding shortfalls are not modally balanced. The risk to transit of not being fully funded is substantially greater than the risk to roads.

To eliminate the funding gap for transit and county highways, the creation of a regional transportation authority was considered in 1993 but was unable to progress politically. SEWRPC recommended state legislation to permit counties to impose a supplemental transportation taxes in the region in the form of gasoline taxes, sales taxes, or a combination thereof, with the amount of tax varying by county because the needs vary by county. A notable proposal made at a public

hearing called for the removal from county and local property taxes all existing burdens associated with building and maintaining the arterial street and highway system. This proposal would require an increase in the gasoline tax averaging 7.1¢ per gallon within the region but varying somewhat by county (SEWRPC 1994b, 618). Addressing the shortfall in the SEWRPC long range plan would require an additional 5.3¢ per gallon, which bring the total gasoline tax increase in the region to 12.4¢ per gallon, if this means were to be used for both property tax relief and covering spending shortfall in the plan. Alternatively, SEWRPC noted that similar revenues could be raised by a 0.8 percent increase in the general sales tax within the region.

The gasoline tax increase levels needed to either close the budget shortfall or offset property taxes devoted to transportation are much less than the cost of externalities associated with gasoline use, which we identified in Section 3 (for example, 37¢ per gallon for greenhouse gas emissions and 45¢ per gallon for petroleum supply related costs). Of course, if the funding shortfalls for transit and county roads are greater due to lower federal funds and shifts in state funding, even higher local option taxes may be needed to make the planned transportation investments feasible. A local option tax already authorized in Wisconsin but to date unused in the region is the "wheel tax," a type of local vehicle registration fee. Exercising the wheel tax could supplement local funds and lessen the amount of gasoline tax increase needed to adequately fund transportation programs. Gasoline taxes of less than about 50¢ per gallon are likely to do little to motivate sales of more efficient vehicles, but would create some incentive for alternatives to driving and help reduce VMT. If the wheel tax were differentially applied according to vehicle efficiency (i.e., a lower than average rate on more fuel efficient vehicles balanced by a higher than average rate on gas guzzlers), the resulting incentive for a more efficient vehicle mix would help reduce gasoline use and emissions related costs (additional state legislative authorization may be needed for a variable rate wheel tax).

Summary of Trends

SEWRPC's intermediate growth scenario projects the population of the seven county area to increase 6 percent between 1990 and 2010. Also expected is an ongoing shrinkage in average household size and steady jobs growth. The region is doing little to avoid continued sprawl development and has no effective policies to insure coordination of land use with transit. The result will be continued automobile dependence, with a VMT increase of 35 percent (nearly six times the population growth) projected for 1991-2010. Auto-related costs, both direct and indirect, will increase accordingly. Moreover, if the 13 percent capacity expansion planned by SEWRPC results in induced demand, future VMT and associated costs may be higher and congestion relief could less than promised.

SEWRPC's proposed plan entails $4.9 billion in capital spending, with a 75 percent/25 percent roads/transit split, and average annual spending of $522 million, with a 66 percent/34 percent roads/transit split, between now and 2010. We estimate an additional average annual cost of $220 million for local roads in the region managed by cities, towns, and counties; counting these local roads implies 76 percent/24 percent roads/transit split for average annual spending. Overall, annual spending by all levels of government for both roads and transit in the region is expected to average $780 million by 2010, a 46 percent increase over the 1992 level. Our social

cost calculations are summarized in Table 4.7, which compares the projections for 2010 with the estimates for 1992. We project the total social cost of transportation in the region to rise to $9.2 billion in 2010, a 27 percent increase over the $7.3 billion estimate for 1992. The largest portion and largest growth is in the private costs of car ownership. Most other items associated with auto use also show rising costs. The exceptions are lower criteria air pollution, since vehicle emissions controls are expected to compensate for increased VMT, and congestion, which SEWRPC expects to be alleviated by road building and better transit services.

Based only on current revenue collection levels and allocations, SEWRPC estimates annual average available funding of $300 million, $222 million short of projected expenditures (excluding local roads). However, adjusting for VMT growth and counting gross user fee collections, average annual transportation revenues in the region would total $461 million. Proposed changes in state programs could provide more transportation funding throughout the state. State plans call for allocating an additional $95 million to state highways in the region, more than needed to cover their projected funding deficit. However, the state plans leave county roads and especially transit with considerable funding deficits. Much of what SEWRPC identifies for added transit funding is less certain than the state proposals for added road funding, especially given the possibility of lower rather than greater federal transit support.

SEWRPC considered but rejected a plan that would place greater emphasis on transit and be bolstered by a shift to substantially higher road user fees (e.g., higher fuel taxes); such a plan would have been more financially robust as well as create incentives for better balance in mode choice. Southeastern Wisconsin faces a choice of future transportation and land use development paths that will shape the region for the generation to come. What we have shown here is that pursuing the current route, a continuation of past sprawling and auto-subsidizing trends, will yield substantially rising costs. Subsequent analysis is needed to examine how the transportation cost picture is likely to look under a transit-oriented plan backed by fairer road user fees, an approach that offers hope of a more efficient, equitable, and lower cost system for the region.

Table 4.1: Demographic and Travel Trends in Southeastern Wisconsin, 1963-2010.

	Historical			Projected
	1963	1972	1991	2010
Population (10^6)	1.654	1.811	1.798	1.911
Households	481,200	557,300	676,153	774,300
Jobs	630,900	748,800	981,400	1,102,100
Average daily VMT (10^6)	—	20.124	33.070	44.520
Average weekday person trips (10^6)	3.795	4.682	5.912	6.100
Average weekday vehicle trips (10^6)	2.568	3.416	4.894	5.270
Person trips by automobile (10^6)	3.151	4.124	5.132	5.618
Person trips by transit (10^6)	0.324	0.186	0.178	0.195
Transit share of total trips	8.5%	4.0%	3.0%	3.2%
Average vehicle occupancy, work trips	1.21	1.17	1.06	1.03
Average vehicle occupancy, non-work trips	—	1.48	1.31	1.22

Source: SEWRPC (1994b): 148, 549.

Table 4.2: Summary of Projected Regional Transportation System Financing from the Southeastern Wisconsin Long Range Plan for 2010 (SEWRPC 1994b, p. 546).

Table 4.3: Projected Transportation Finances in the Southeastern Wisconsin Region in 2010.

Level of Government	(Millions of 1992$, projected for 2010)						
	Revenues			Expenditures			
	Road	Transit	Total	Road	Transit	Total	Share
Federal	153	0	153	99	35	133	17%
State	308	0	308	244	103	347	45%
Local	0	38	38	220	79	299	38%
TOTAL	461	38	**499**	563	216	**780**	100%
Increase, 2010/1992	*25%*	*10%*	*24%*	*31%*	*107%*	*45%*	

Total user fee revenues as fraction of total expenditures: 64%

Local general funds needed as fraction of local expenditures: 34%

Table 4.4a: Social Costs of Light-Duty Vehicles in Southeastern Wisconsin (2010).

Table 4.4b: Social Costs of Transit in Southeastern Wisconsin, 2010

Table 4.5: Jurisdictional Responsibilities for Roads in Southeastern Wisconsin and Realignment Proposed in the Long Range Plan.

(a) Existing Jurisdictional Distribution, 1991

Jurisdiction	Road Miles	Share
State	1,261	39%
County	1,079	33%
Local	934	29%
Total	**3,274**	**100%**

(a) As planned in the Long Range Plan for 2010

Jurisdiction	Road Miles	Share
State	1,167	32%
County	1,584	44%
Local	856	24%
Total	**3,607**	**100%**

Source: SEWRPC, Tables 4, 23, 32, 35, 260

Table 4.6: Transportation Social Cost Analysis Summary, 1992 and 2010.

Figure 4.1: Regional Trends in Demographics and VMT (1960-2010).

Figure 4.2: Distribution of Developed Residential Acreage by Density (1970, 1985, and 2010).

Figure 4.3: 2010 Long Range Transportation Plan Resource and Expenditure Allocation.

5. CONCLUSION

Our analyses of both the current status of transportation economics in the Southeastern Wisconsin region and of future trends under current plans reveal imbalances and inequities that underlie inefficiencies and high social costs. Section 2 examined public costs of the regional system and how it is financed, including both local roads as well as the regional roads and transit elements comprising the formally planned transportation system. Public costs averaged $777 per household annually in 1992, the base year for our study. The analysis showed the extent to which total transportation revenues fail to cover expenditures, resulting in the need for general revenues, such as property and sales taxes, to support local roads. Local government general revenues cover 39 percent of transportation system costs in the region. We also delineated the extent of net outflow of transportation user fee revenues from the region, even though the metropolitan area's transportation needs are arguably greater by virtue of population and travel.

Section 3 broadened the scope of analysis to include other costs, monetary costs such as the owning and operating costs of private vehicles as well as indirect and non-monetary costs including parking, economic toll of accidents, environmental externalities, and congestion. In this context, public costs are only a small part of the picture. We estimated total social costs at an annual average of $10,500 per household in 1992. The largest cost share is attributed to the private expenses associated with car ownership; costs associated with auto accidents are the second largest portion. Overall, 98 percent of regional passenger transportation costs are associated with cars and light trucks; 2 percent is associated with transit.

In Section 4 we turned to future projections of both public and social costs through 2010 based on the long-range plan issued by SEWRPC in 1994. Although the region's population is expected to increase by only 6 percent over this time frame and the number of households by 15 percent (based on mid-range projections), VMT is projected to grow 35 percent by 2010. We estimated that the total social cost of passenger transportation in the region will then increase by 27 percent. Aspects of SEWRPC's plan critical to holding costs down, namely, transit investments, are underfinanced and state commitments to secure sufficient funds appear weak. At the same time, the regional plan calls for road expansion and the state's plan points to even greater investments in new roads than the region needs. Fiscal imbalances and high social costs are likely to grow under current plans, which continue an auto-dependent paradigm.

Alternative Directions

A growing body of evidence support that notion that metropolitan regions would be better served by a stronger system of public planning that can insure the coordination of land-use with transportation facilities more appropriate to urban settings. In contrast to sprawling, auto-dependent development, such transit-oriented development ("TOD") would result in less rather than greater need for auto travel. TOD emphasizes creating a richer set of more efficient options for people to access work, school, shopping, and each other. Mixed-use, denser development around transit hubs, as opposed to segregated, sprawling development served mainly by roads, results in less need for auto travel, better transit utilization, and a significant share of travel needs met through walking and bicycling. Pricing reforms, implemented by shifting auto-related

costs that are now subsidized, hidden, or externalized onto equitable user fees, would be an important complement to TOD planning. Together, such a different approach to the region's transportation future promises to reduce vehicle use and its attendant costs.

Much of the evidence for the lower vehicle use (and energy and emissions intensity) for TOD compared to sprawling, auto-dependent development comes from cross-sectional comparisons, as exemplified, for example, in the summary by Newman and Kenworthy (1989). Attoe (1988) presents case studies on how TOD has successfully shaped land-use and reduced vehicle intensity in a number of North American cities. Although limited regional-scale longitudinal work has been done, studies of increasing residential densities in commercial districts have shown significant degrees of avoided traffic growth, compared to traffic that would have been generated if residential growth was segregated in outlying suburbs requiring commute trips into urban cores (e.g., Nowlan and Stewart 1991). Comparisons of differential development patterns within regions also show the promise of TOD over auto-dependent development for reducing VMT and associated costs (Holtzclaw 1990; Pushkarov et al. 1982).

Our analysis provides a region-specific confirmation of transportation cost studies (reviewed in Section 1) showing how automobile travel is directly and indirectly subsidized. In the absence of pricing reforms that create more balanced and equitable incentives among transportation modes, TOD alone is likely to have limited success. This supposition is borne out by much experience throughout the United States showing lagging transit ridership while automobile use continues to grow. And this experience has, in fact, been the situation in the Southeastern Wisconsin region over the past several decades, as documented by the travel trends reviewed by SEWRPC (1994b). SEWRPC identified a planning alternative placing greater emphasis on transit complemented by pricing reforms (equivalent to doubling the gasoline tax). This "Alternative 1" plan was found to result in reduced VMT compared to the adopted plan, and also showed a better benefit/cost ratio. An approach based on that plan, with even less road expansion, better defined and more concerted measures for coordinating land use development and transportation investments, plus supportive pricing reforms, promises lower overall costs for the region than the still largely auto-dependent scenario adopted by SEWRPC and analyzed here.

This report lays the groundwork for further analysis to cost out a TOD scenario for the region. Although a definitive answer awaits results of that work, the nature of costs identified here and their strong linkage to auto ownership and use suggests likely confirmation of the hypothesis that TOD plus more equitable pricing and financing will yield a system that is less costly to the region than a continuation of sprawl development, road expansion, and subsidized automobile use.

APPENDIX A. SOUTHEASTERN WISCONSIN REGIONAL TRANSPORTATION REVENUES AND EXPENDITURES FROM 1987 TO 1992

Readily available SEWRPC TIP documents and WDOT documents covering transit systems provide data on transportation finance in Southeastern Wisconsin for recent years. Here we review information for 1987 to 1992 to examine fluctuations from year to year as well as to develop an understanding of the magnitude of expenditures in the region. Table A.1 and Figure A.1 summarize the results of this multi-year review. The data presented here for 1992 are slightly different from those presented for the same year in Table 2.1. These differences are caused by methodological differences necessitated for the multi-year review, as described below.

Revenues include transportation user fees, such as fuel taxes, and transit fares, as collected by all levels of government. Revenues totaled $2,087 billion over the six-year period, 64 percent of which was collected by the state. Expenditures include all funds spent on roads and transit by all levels of government and totaled $2,840 billion of the same period. Thus, transportation related revenues were on average equal to 73.5 percent of expenditures for 1987-92, a share that was reasonably consistent over the period. The low and high values of this ratio, 68.3 percent in 1990 and 76.3 percent in 1991, correspond to an increase in the federal fuel tax rate. Government shares were also fairly consistent through the period. On average, federal funds accounted for 15.0 percent of expenditures, state 36.5 percent, and local governments 48.5 percent. The following discussion details the methodology used to calculate transportation related revenues and expenditures and highlight the differences between Table A.1 and Table 2.1. We discuss sources of estimates by level of government (note that federal and state governments collect no transit user fees and the only transportation-derived local revenues in the region are transit fares).

Revenues

Federal

The 1995 TIP showed that the SE Wisconsin region accounted for 30.51 percent of road user revenues in the state in 1993 (SEWRPC 1994c, H-2). This rate was applied to federal road user receipts to derive the region's share. In Table 2.1, the amount shown of $122 million was calculated by applying the 30.51 percent to the total federal highway user fee collections in Wisconsin of $401 million, from FHWA (1994, IV-8). Note that this statewide sum differs from deposits to the federal highway and transit accounts, which amounted to $327 million in 1992 and represent net funds used for federal transportation programs after subtracting the portion of receipts applied to non-road uses such as deficit reduction.

Beginning with the 1993 *Highway Statistics* report, FHWA started including a table (Table HDF) showing total revenues by state before any diversions were made (data in Table HDF are lagged by one year, e.g., the 1993 edition presents data for 1992). However, such data were not available for earlier years. Therefore, we developed a scaling method to estimate total federal user revenues collected in the region in prior to 1992. The method divides

total deposits to the highway and transit accounts by the percentage of the federal gas tax that is dedicated to road or transit use, thereby scaling up the revenue estimate to account for funds diverted to non-transportation uses. This percentage shifts over time as the federal gas tax is changed. To this amount was added other excise tax income. The resulting figure was compared to the FHWA reported amount of all federal road user generated income, available for 1992 and 1993, to see how accurate the method was in estimating total road user income. For 1992, the method yielded an estimate of $393 million, about 2 percent lower than $401 million value reported by FHWA (1994, IV-8); for 1993, the method yielded an estimate about 4 percent higher. This method was then applied to all study years, 1986 to 1993, to estimate total federal road user revenues generated in Wisconsin, which were then apportioned to the SE Wisconsin region using the 30.51 percent share.

State

The region's share of state-generated road user fees is based on the same 30.51 percent discussed above. In Table 2.1 the estimated total state revenue derived by averaging the 1991 and 1993 values found in the TIPs (SEWRPC 1992b, G-2; SEWRPC 1994c, H-2), since 1992 data were not reported. This process produced an estimate of $247 million of state revenue derived from road user fees collected in the SE Wisconsin region. FHWA's *Highway Statistics* tabulates total state-level road user revenues derived from state user fees (Table DF). The amount listed for Wisconsin in Table DF does not match the amount published in the TIP for 1991 and 1993, the two years available. For 1991, FHWA reports $766 million in state collections while $760 million are reported in the TIP. For 1993 the difference is more dramatic, with FHWA reporting $889 million and the TIP reporting $859 million. Inquiries to state officials could not account for the difference and updated estimates of the revenues were not available from WDOT at the time of this writing. Thus, for Table A.1, FHWA data were used for state generated road user revenue for all years. The regional portion of 30.51 percent was applied to this amount to derive the regional dollar value. For 1992 this amount came to $259 million, $12 million more than the Table 2.1 methodology, a difference of about 5 percent.

Local

Local governments in the Southeastern Wisconsin region collect no road user fees. The only local revenues generated from transportation sources are those from transit fares and advertising; these are complied from WDOT (1992), using the same approach as noted in Table 2.1.

Expenditures

Federal

Federal road expenditures are as listed by SEWRPC (1994c) and consistent with those presented in Table 2.1. Transit operating funds are from WDOT (1992, 26). Transit capital funds for are from WDOT (1992, 43) and show grants awarded; capital funds listed in Table A.1 are drawn from Section 15 reports, which show funds actually spent.

State

In Table 2.1, state road spending was estimated based on information from SEWRPC (1994c) supplemented by tabulations provided WDOT staff (see notes to Table 2.1). Table A.1 uses the SEWRPC data supplemented by the "State Highway Aid" from WDOR (1992 and earlier years). The difference between the two sources amounts to only $50,000 (0.03 percent) for 1992. For transit, WDOT (1992, 26) is used as the source for state operating funds. The state does not typically give capital grants.

Local

Table 2.1 and A.1 are based on the same approach for calculating local road expenditures, namely, subtracting state aids from local road expenditures as reported in the WDOR series. A difference for 1992 arises from using WDOR data instead of the special 1992 tabulations obtained from WDOT. For transit spending, Table A.1 and Table 2.1 use same source for farebox revenues and local government operating support (WDOT 1992, 26). Local government capital funding estimates for 1992 in Table 2.1 are based on grants awarded as reported in WDOT (1992, 43). The multi-year compilation of Table A.1 is based on Section 15 reports, which show funds actually spent.

Table A.1: SE Wisconsin Transportation Revenues and Expenditures for all Levels of Government, 1987–92.

Figure A.1: Total SE Wisconsin Transportation Revenues and Expenditures in Constant and Nominal Dollars, 1987-1992.

APPENDIX B. REGIONAL TRANSPORTATION COST ACCOUNTING MODEL AND PARAMETERS APPLIED FOR THE SOUTHEASTERN WISCONSIN REGION

To carry out the full social cost analysis of a regional transportation system as presented in this report, ACEEE developed a spreadsheet model to systematize cost accounting calculations. The model covers passenger transportation, both light vehicle (car and light truck) and transit bus modes. The cost estimation and accounting procedures were inspired by and drawn from the recent literature on social costs of transportation, drawing in particular on the studies by Ketcham and Komanoff (1992), Miller and Moffet (1993), Apogee (1994), Litman (1995), and Poorman (1995). The model is set up to have a hierarchical calculation structure, allowing key inputs to be changed to represent different regions in different years. The multi-worksheet model is set up to maintain two sets of time-varying input parameters (for two different years) and automatically update tables to present results for a given year. A summary table of major cost items allows comparison of results for the two years (e.g., as shown in Table 4.7 of this report for the Southeastern Wisconsin in 1992 and 2010).

The following two tables list the key model input parameters used for analyzing the Southeastern Wisconsin region; discussion of costing rationales and sources of information are provided in Sections 3 and 4 of this report.

Future Refinements Needed

The major areas not covered by this first version of the transportation cost accounting model are freight transportation modes and cost allocation among modes. Model development and applications work in this regard has recently been done by DeCourla-Souza et al. (1996), who addressed both freight and passenger transport, and Qin et al. (1996), who focused on passenger transport but address cost allocations among modes. Nevertheless, our more limited initial accounting framework provides useful information about the costs of a regional system, since most investments are driven by capacity needs associated with passenger travel. Model refinement to address cost allocation among passenger modes (e.g., the heavier pavement damage and therefore greater road maintenance costs associated with buses compared to cars) would be straightforward; extension to adequately address freight modes would be more involved but a worthy step. Both of these modeling developments will be pursued, resources permitting.

In addition to these major areas of future cost modeling, a number of technical refinements could be in order for items covered in the present version of our model. As noted in Section 3, many social cost estimates have high uncertainties. Some are based on simplifying assumptions which could be refined if better data were obtained and analyzed. Ongoing work in the field of transportation economics, environmental economics, and social cost analysis can be tapped to provide improved estimates. In particular, emissions estimates could be refined through mobile source model runs accounting for vehicle types and usage. Emissions damage costs are a current area of research, particularly regarding impacts of fine particulates; we expect that updated (and possible higher) cost factors will become available shortly. The accident cost

estimates could be refined by combining region-specific data with costs estimates by accident severity level. Another area where improvement is needed is for estimates of the hidden costs of parking. The estimates with which we had to work are relatively coarse, particularly for non-workplace and non-central business district parking; if more detailed region-specific or relevant survey data could be obtained, much better estimates should be developed. Finally, many of the cost items, particularly the more uncertain, would be amenable to sensitivity analysis. A more accurate picture could be drawn that includes an explicit recognition of uncertainties, e.g., by citing ranges for various cost items. Nevertheless, during the literature review pursued to assemble the estimates provided here, we attempted to select values that appeared to be in the middle of reported ranges. Therefore, although refinements and sensitivity analyses would strengthen this study, we feel that the main conclusions and general breakdown of costs by relative magnitude are unlikely to change greatly, particularly in terms of the policy implications.

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