The Positive Impacts of Transportation Investment

NCHRP Project 8-36, Task 22

compilation of working papers

prepared for

National Cooperative Highway Research Program
Transportation Research Board
National Research Council

prepared by

Cambridge Systematics, Inc.

February 2002

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Preface

The objective of NCHRP Project 8-36, Task 22 is to produce an easily understandable document that effectively communicates the positive impacts of investments in this nation's transportation system. The work will be used by AASHTO in its TEA-21 reauthorization efforts.

To achieve this goal, Cambridge Systematics prepared the four working papers in this document, each covering an important aspect of the positive impacts of transportation investment, as follows:

1. Economic Benefits of Transportation Investment;

2. Environmental Benefits of Transportation Investment;

3. Community and Social Benefits of Transportation Investment; and

4. The Benefits of Reducing Congestion.

At the end of this compilation of working pages is a compendium of the facts found in the pages.

Economic Benefits of Transportation Investment

Working Paper #1

Working Paper #1: Economic Benefits of Transportation Investment

Introduction

For over 200 years, our nation's economy has grown and prospered thanks to a reliable, robust, and safe transportation network. Transportation investments and the introduction of new transportation technologies have profoundly affected the growth and development patterns of the United States. In 1800, the cost to move a ton of goods 30 miles inland was comparable to moving it across the Atlantic Ocean. By the 1850s, the railroads had reduced the cost of delivering goods by as much as 80 to 90 percent.[1] Clipper ships and maritime trade helped finance the industrial revolution, the Erie Canal spurred the development of the Midwest and established New York City as a center for commerce, and railroads connected the country's coasts while hastening the rise of Chicago as a major city.

"Space without adequate transport facilities presents a barrier; it is transport which breathes economic life into space."

– J.B. Thompson
Geographer

At the turn of the twentieth century, streetcars "decongested" the cities, allowing millions of people to move from crowded, often dirty urban neighborhoods to the suburbs, yet continue to commute to their downtown jobs. Paved roads, coupled with the invention of the automobile, introduced still greater levels of mobility, access, and flexibility, facilitating the movement of both goods and people. After the Second World War, the Interstate Highway System linked the nation east to west and north to south. Today, the nation's newest jobs, homes, and businesses – as well as the lowest unemployment rates – are found in close proximity to the Interstates.[2] Since the 1980s, deregulation of the rail and motor carrier industries has squeezed even greater efficiencies out of the nation's transport network. Average rates for

[1] James M. McPherson, Battle Cry of Freedom: The Civil War Era (New York: Oxford University Press, 1988), 11.

[2] Peter T. Kilborn, "In Rural Areas, Interstates Build Their Own Economy," The New York Times, 14 July 2001.

Class I railroads, adjusted for inflation, have decreased by nearly half.[3] Trucking industry rates have also fallen.[4]

Volume and Costs

The sheer volume of freight in motion in the United States underscores the importance of the transportation system to the national economy. In 1997, the country's roadways, rail lines, airways, waterways, and pipelines shipped 11.1 billion tons of freight valued at nearly $7 trillion. In fact, the value of all the goods shipped annually in the United States is more than four-fifths as large as the entire U.S. gross domestic product (GDP). Some 2.7 trillion ton-miles of freight traffic moved over an average shipment length of 472 miles.[5]

In 1997, the country's roadways, rail lines, airways, waterways, and pipelines shipped 11.1 billion tons of freight valued at nearly $7 trillion.

Transportation facilities are no less critical to personal mobility. Each year, Americans take over 600 million airplane trips, nine billion transit trips, and drive over two trillion miles.[6] This movement of people is essential for reaching jobs, schools, shops, services, and a host of other personal and professional travel destinations.

Total transportation expenditures related to the movement of people and goods in the United States accounted for about six percent of gross domestic product (GDP) in 1998, having declined from over seven percent of GDP in 1977.[7] This decline is largely attributable to deregulation in the trucking, railroad, and airline industries, which resulted in improved route structures to better suit business needs and greater efficiencies gained from industry consolidation.

Although transport costs have declined significantly (a trend that occurred throughout the 20th century), they still comprise an important part of the total cost of certain goods (see Figure 1). Not surprisingly, agriculture has the highest transportation cost per dollar among the comparison industries illustrated. In addition to costs for energy, fertilizers,

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[3] Association of American Railroads, *Analysis of Class I Railroads, 1980* (Washington, D.C.: 1981); Association of American Railroads, *Analysis of Class I Railroads, 1999* (Washington, D.C.: 2000).

[4] Cass Annual Session of Logistics Management, 13 October 1998, available at http://www.cassinfo.com/bob_clm_annual.html as of September 2001.

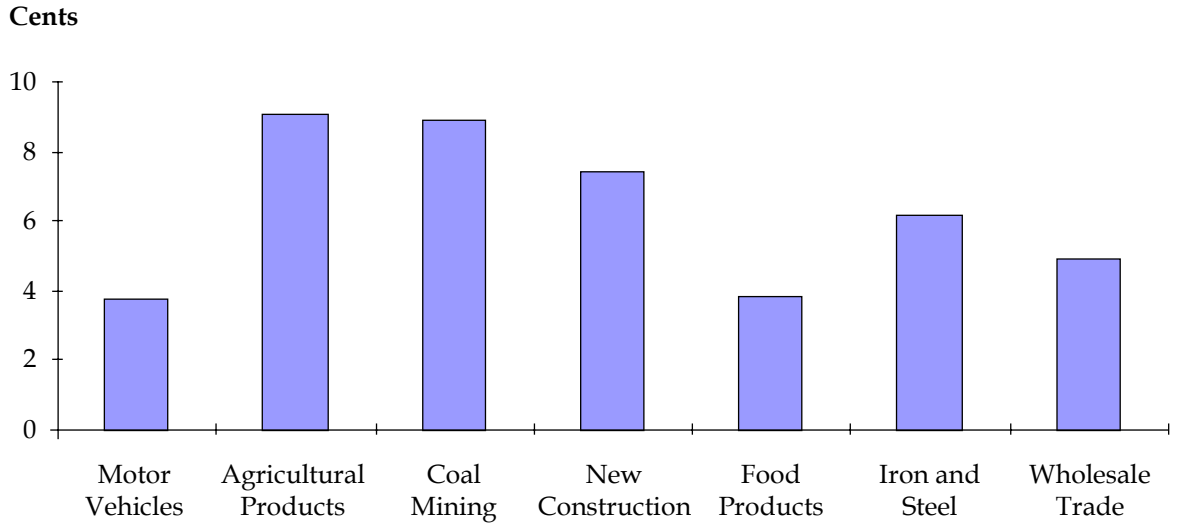
[5] U.S. Census Bureau, 1997 Commodity Flow Survey, available at http://www.census.gov/econ/www/se0700.html.

[6] Federal Highway Administration, *National Personal Travel Survey, Summary of Travel Trends, 1969, 1977, 1983, 1990, 1995*; Air Transport Association of America, *Air Transport, Facts and Figures*, annual; American Public Transportation Association, *APTA Transit Ridership Report*, http://www.apta.com/stats/ridershp/riderep/history.pdf.

[7] Cass/ProLogis, *Tenth Annual State of Logistics Report*, 1998.

seeds, machinery, and employee compensation, agricultural production also requires about 9.1 cents in transportation services per dollar of output. In other words, the *movement* of grains, fruits, vegetables, and industrial crops comprises almost 10 percent of the output value in the agricultural products sector.

Figure 1. Transportation Requirements per Dollar of Industry



Certain industries – coal mining, construction, and certain manufacturing sectors chief among them – also rely heavily on transport services. For example, manufacturing motor vehicles, iron, steel, and food products (any food item that has been manufactured or processed such as beverages, breakfast cereal, cut meats, and frozen vegetables) requires between 3.7 cents and 6.1 cents of transportation services per dollar of output. Although these commodities have some of the highest transportation costs relative to the overall value of the good, growth in the movement of high-technology products and high-value goods has become a distinguishing trend in U.S. freight transportation. Reflecting the adoption of just-in-time logistics practices and the blossoming of technology industries, growth in U.S. freight shipments has been led by smaller, more frequent shipments of high-value, low-weight goods.[8] For these

In 1999, the typical household spent just over $7,000, or 17 percent of its after-tax income on basic transportation needs, excluding air travel.

[8] According to the Bureau of Transportation Statistics' Commodity Flow Survey, shipments below 1,000 pounds accounted for about 18 percent of the value of all shipments in 1977. By 1997, this had grown to about 32 percent. Reebie Associates' TRANSEARCH data shows that the growth of high value, lower volume shipments made air, truck, and rail intermodal grow the fastest among the various transportation modes (in terms of the rate of tonnage increase) between 1990 and 1998.

reasons, technology companies, such as computer manufacturers, also monitor transportation costs very closely. Transport costs also account for a significant percentage of the typical household budget. In 1999, the typical household spent just over $7,000, or 17 percent of its after-tax income on basic transportation needs, excluding air travel.[9]

Categories of Benefits

It is helpful to divide the economic benefits of transportation investment into seven broad categories. Each of these categories is discussed in detail in this paper.

1. **Transportation Investment Boosts Industry Competitiveness –** A strong transport network reduces costs of production and distribution. It does so by lowering barriers to mobility, giving the manufacturing, retail, and service sectors access to varied, specialized, and productive sources of labor; a diverse selection of inventory and raw materials; and a broad customer base, both at home and abroad.

2. **Transportation Investment Enhances Household Welfare –** A strong transport network gives households access to a broader range of higher-paying jobs, a wider selection of competitively priced consumer goods and housing options, and a convenient selection of health and human services. Well-maintained roads can reduce personal vehicle repair costs, while efficient public transport networks reduce costs associated with driving and automobile ownership.

3. **Transportation Investment Strengthens Local, Regional, and State Economies –** The benefits of transportation investment are not limited to the microeconomic level, that is, at the level of firms and households. Transportation spending benefits local, regional, and state economies as well by energizing city centers, breaking the isolation of rural areas, and boosting state employment and tax revenues.

4. **Transportation Investment Boosts Business and Leisure Travel –** Both business and leisure travelers depend on our nation's transportation infrastructure for access to activities and destinations such as conferences, trade shows, national parks, beach resorts, and everyday business meetings and social events.

5. **Transportation Investment Reduces Economic Losses Associated with Accidents –** Each year, traffic accidents cost $580 for every American man, woman, and child in lost productivity, property damage, and medical expenses. Investments to improve the safety of the nation's transport infrastructure can mitigate these losses.

6. **Transportation Investment Reduces Economic Losses Associated with Congestion –** The time delays and fuel consumption associated with congestion in the nation's

[9] Bureau of Labor Statistics, 1999 Consumer Expenditure Survey, available at http://stats.bls.gov/csxhome.htm?H3 as of September 2001.

largest urban areas alone reached $78 billion in 1999.[10] Investments that reduce traffic delays benefit businesses and households alike.

7. **Transportation Investment Creates Jobs in the Transportation Sector –** Nearly 11 million people are employed in for-hire transportation and transportation-related industries in the U.S. This includes some 236,000 people in the railroad industry, 147,000 school bus drivers, close to 1.9 million people in motor freight, and nearly 1.3 million people in air transportation.[11]

It is important to distinguish between two kinds of investments, both of which generate important economic benefits. On the one hand, constructing new roads, bridges, and transit lines expands capacity, reduces congestion, and improves access, thus helping speed the flow of people and goods. Intelligent transportation systems (ITS) such as electronic highway management centers, make more efficient use of existing capacity, improve business logistics, and enhance safety.

On the other hand, maintaining and preserving the existing transportation infrastructure also generates important economic benefits. Maintenance and preservation not only improves travel speed, capacity, and safety, but protects and extends the service life of taxpayer-funded investments. Repairing an aging bridge, for example, may save a government the cost of building a new bridge sometime in the future. Repaving a roadway can increase weight-bearing capacity and reduce wear and tear on vehicles. Upgrading a rail line can extend vertical clearances to permit double-stack freight cars and improve track safety to permit faster passenger trains. Reconstructing sidewalks and intersections can improve pedestrian access and safety.

1.0 Transportation Investment Boosts Industry Competitiveness

By lowering barriers to mobility, a strong transport network reduces costs of production and distribution. As a result, the manufacturing, retail, and service sectors gain access to varied, specialized, and productive sources of labor; they are able to draw upon a diverse selection of inventory and raw materials; and they can build a broad customer base, both at home and abroad. These benefits allow firms to produce more efficiently and maintain competitiveness in the global marketplace.

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[10] David Schrank and Tim Lomax, *The 2001 Urban Mobility Report* (College Station, Texas: Texas Transportation Institute, 2001).

[11] U.S. Department of Labor, Bureau of Labor Statistics, Current Employment Statistics, Average Annual Averages for 2000, http://www.bls.gov/sahome.html.

Transportation is, and will remain, critical to the nation's economic competitiveness even as the U.S. economy's traditional manufacturing base becomes more diversified. Today, the retail, finance, insurance, real estate, and service sectors of the economy make up a larger percentage of the GDP than ever before. The growth of these sectors has placed added burdens on transportation networks, particularly those at a regional or local level.

A manufacturer of heavy machinery may ship its products to a customer thousands of miles away in a container that takes weeks to reach its final destination, but a restaurant or cinema serves customers who live just a few miles down the road and who are generally unwilling to travel more than half an hour before choosing another establishment. The rise in mail-order and Internet shopping in recent years has also increased the importance of local and regional transportation because goods purchased from a catalogue or over the World Wide Web must be delivered quickly and cheaply straight to peoples' doorsteps. Indeed, the demand for small package shipments is rising in the U.S. while business-to-business, high-volume, direct container loads is declining for some national intermodal carriers. Other services, such as finance, consulting, corporate management, and law, also contribute to the demand for transportation. Despite conveniences such as e-mail, fax machines, teleconferencing, and videoconferencing, the need for face-to-face business meetings shows little sign of weakening.[12]

Finally, an increasing reliance on just-in-time (JIT) delivery to cut costs is also boosting the need for a fast, reliable transport network. It is estimated that 28 percent of U.S. production is already based on JIT production practices, and this figure is expected to rise. JIT saves businesses money by reducing inventory costs. Transportation, in conjunction with other strategies such as manufacturing requirements planning, is integral to improving supply chain management and minimizing inventory.[13] As inventory levels are better optimized to reflect the needs of manufacturers, wholesalers, and retailers, inventory spends less time sitting on the shelf. Instead, it quickly becomes part of the production process or becomes more readily available for final sale to consumers. Reflecting the greater use of JIT, average inventory turnover rose from 8.0 turns to 10.4 turns between 1995 and 1998, a 30 percent increase. By 2000, turns were expected to have reached 13.2, a 65 percent increase over 1995.[14] Without a transportation system that can deliver goods reliably at a competitive cost, this increase would not have been possible. In short, the

[12]Regional Financial Associates, "Technology and the Future of Business Travel," February 2000. Excerpted article available at http://www.dismal.com/print_happy.asp?aid=512.

[13]Manufacturing requirements planning (MRP) is a system that optimizes the flow of goods to distribution and sales channels. MRP is used to ensure that raw materials or components arrive just in time for manufacturing and are coordinated with orders or sales.

[14]Warehousing Education and Resource Council, *Warehouse Inventory Turnover: Trends, Change Driven Measurers, Using the Data,* October 1999. Inventory turns are a measure of how quickly a company replenishes its entire stock of materials or merchandise annually. Rapid turnovers mean inventory spends less time sitting idle, which helps improve cash flow.

new economy and modern production practices are bolstered by efficient regional transportation systems and hindered by congestion and lack of access.[15]

Transportation Investment Reduces Costs of Production

Highway investment is particularly important to U.S. industrial productivity. A 1988 FHWA study of 35 industry sectors showed that a $1.00 increase in highway capital historically generates about 30 cents of production cost savings *per year* over the lifetime of the road improvement.[16] Highway investments have the most pronounced effects on extractive/transformative sectors such as construction and manufacturing. These investments have also been shown to stimulate, although to a lesser extent, non-transformative sectors such as services, trade, finance, insurance, and real estate.[17] For these reasons, highway accessibility is rated as one of the most important factors in the site location decisions of manufacturing firms. Economic development agencies, such as those in Georgia, South Carolina, and Texas, as well as utilities such as Columbia Gas in Maryland, include explicit questions about highway proximity preferences on their site location assistance forms. In New York, proximity to an interstate interchange is a requirement for warehouse properties wishing to participate in Empire State Development's "Build Now-NY" program, a program that presents prospective companies with an inventory of preapproved, permitted sites to ease the development process. In Chicago and Philadelphia, a recent study found that reducing travel times for all trips by 10 percent would generate important productivity savings because businesses would be able to draw on a much broader labor pool. The annual savings in labor costs to Chicago and Philadelphia area businesses would reach $350 million and $200 million, respectively.[18]

A 10 percent reduction in travel times for all trips made throughout the Chicago and Philadelphia areas would save the respective business communities an estimated $350 million and $200 million in labor costs each year.

On Interstate 84 south of Boise, a partnership between the Idaho Department of Transportation and Micron Technology Inc., a manufacturer of semiconductors, allowed

[15] Reebie Associates, *From a Manufacturing to a Service Economy*, report for the Office of Freight Management and Operations, Federal Highway Administration, 2000 (draft).

[16] Ishaq Nadiri and Theofanis P. Mamuneas, *Contribution of Highway Capital to Industry and National Productivity Growth* (Washington, D.C.: Federal Highway Administration, Office of Policy Development, September 1996).

[17] Terrence Rephann and Andrew Isserman, "New Highways as Economic Development Tools: An Evaluation Using Quasi-Experimental Matching Methods," *Regional Science and Urban Economics* 24 (1994): 727.

[18] Glen Weisbrod, Donald Vary, and George Treyz, *Economic Implications of Congestion*, National Cooperative Highway Research Program Project 2-21 (Washington, D.C.: Transportation Research Board, February 2001).

for the construction of a new interchange that will allow for the expansion of high-tech businesses. The new Isaac's Canyon interchange eased congestion and improved safety for vehicles on the interstate while providing additional capacity that will accommodate the growth of Micron and other companies in the area. Prior to the completion of the new interchange, vehicles going from Boise on Interstate 84 to the Micron Technology plant would cause backups on the freeway, creating safety problems and slowing traffic. A planned expansion by Micron or other companies in the area would only exacerbate the existing traffic problem. The Isaac's Canyon Interchange, dedicated in December 1997, alleviated this problem and will handle future economic growth in the region.[19] With reduced congestion on the highway, Micron Technology and other nearby companies will also benefit from improved logistics when supplies arrive with greater timeliness and outgoing shipments reach customers more reliably.

Transportation Investment Reduces Costs of Distribution

Transportation investment provides timely, reliable, low-cost access to domestic and foreign markets. Distribution delays prevent products from reaching wholesalers, retailers, and households in a timely manner and add to business costs that are passed on to consumers in the form of higher prices. Transportation investments that remove or reduce these delays improve the nation's productivity by turning these added costs into savings for businesses and consumers alike. The Chicago and Philadelphia area study cited above also notes that reducing travel times for all trips by 10 percent would result in a 2.5 percent decrease in travel *costs*. This would save businesses $980 million annually in Chicago and $240 million annually in Philadelphia.[20]

The efficient movement of goods to and from the nation's ports is a critical component of the nation's distribution system. Two of the nation's busiest ports are those of Los Angeles and Long Beach, which together handle about one-quarter of *all* U.S. waterborne trade. They are served by the 20-mile-long Alameda Corridor, a key conduit for rail and motor freight traffic that links the Los Angeles and Long Beach ports with each other and with the rail marshalling yards in East Los Angeles, where connections are made to the national rail network. From these rail yards, goods unloaded at the ports can quickly reach national distribution hubs in Dallas and Chicago. Construction is now underway to reduce congestion on the Alameda Corridor by separating rail and motor freight from local vehicular traffic, allowing trains to move without the disruptions caused by at-grade crossings. Parts of the Alameda Corridor project have already been completed, including dozens of new bridge crossings and rail line expansions that are increasing the corridor's capacity to handle additional freight traffic. Other improvements will be completed by

[19] Cambridge Systematics conversation with Jeff Stratton, Idaho Transportation Department, Office of Public Affairs, description of Isaac's Canyon Interchange.

[20] Weisbrod and others, *Economic Implications of Congestion*.

2002. These improvements will benefit businesses throughout the U.S. that import or export goods through the ports of Los Angeles and Long Beach.[21]

> **"Transportation and shipping here at Silicon Mountain are outstanding [thanks to the port of Montana]. We can reach our customers fast, and they can get to us easily, too."**
>
> **– Tod Higinbotham**
> **Advanced Silicon Materials, Inc.**

In Montana, another freight project that reduces distribution costs has been completed. A new intermodal freight terminal in Butte has given a boost to the State's forest, mining, and agricultural industries. Opened in 1988 and expanded in 1994, the port of Montana combines rail, trucking, and air facilities to efficiently move freight into and out of western Montana. Three hundred new jobs are tied directly to the facility, which is located at the junction of two Interstates (I-90 and I-15) and two Class I railroads (Burlington Northern and Union Pacific). The costs of shipping timber, minerals, and grain have fallen and local industries have improved their competitiveness as a result of better transportation access to the region. Lower freight costs have strengthened the lumber industry in particular, increasing its ability to ride out future down cycles in the market. The port has also attracted a number of trucking firms, which have increased the feed onto the rail lines serving the facility. The increase in truck traffic has attracted an additional rail carrier to the Port of Montana. Increased rail competition, in turn, has benefited the region's farmers by reducing the rates charged by the railroads to transport agricultural products.[22]

International trade is a growing part of the U.S. economy (see Figure 2). The surge in trade volumes has been especially large with North American Free Trade Association (NAFTA) trading partners, Mexico and Canada, as well as with the Far East. The volume of U.S. merchandise trade (imports and exports of goods) more than doubled (in nominal terms) from $976 billion in 1992 to nearly $2 trillion in 2000. These increases would not have been possible without a robust transport network; highways and rail play a critical role in ensuring that U.S. products reach ports and airports prior to being shipped to overseas destinations.

Surface trade between the United States and Mexico has increased markedly since the advent of the North American Free Trade Agreement (NAFTA), rising from $90 billion in 1994 (the first year of NAFTA) to $211 billion in 2000. One inland port, Laredo, Texas, has absorbed a disproportionate share of this growth, handling nearly 40 percent of *all* U.S.-Mexico surface trade in 2000. Commensurate with the increase in trade volume, Laredo has witnessed a sharp upsurge in truck traffic.[23] In order to accommodate the rising

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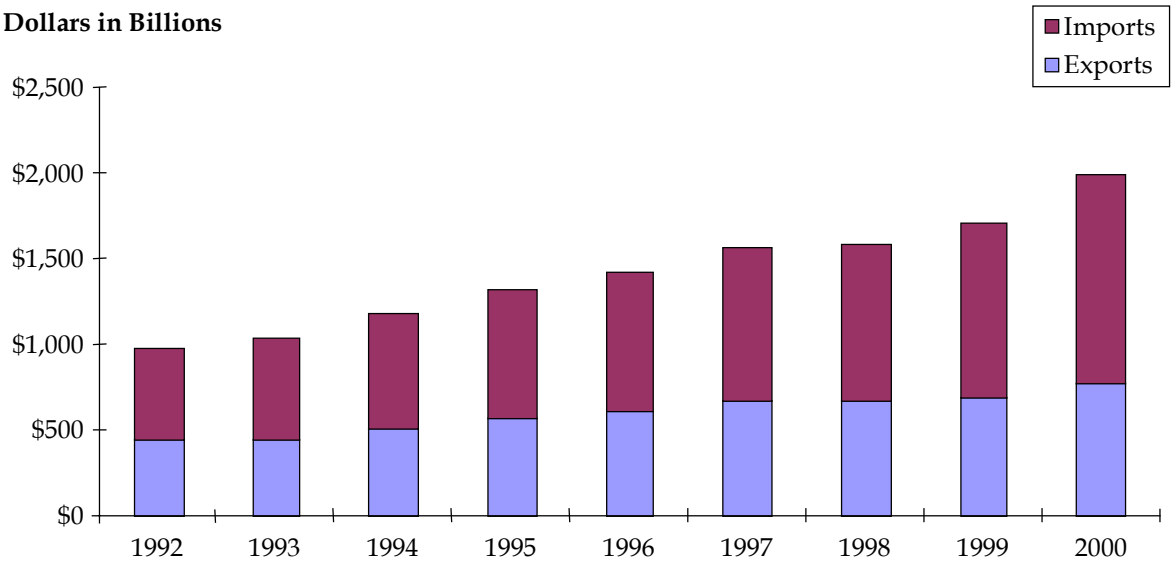
[21] Alameda Corridor Transportation Authority, www.acta.org.

[22] Butte Local Development Corporation, "Butte/Silver-Bow: Transportation Hub of the Rocky Mountains," www.buttemontana.org/tran.htm.

[23] According to Texas A&M International University, truck crossings in Laredo increased from 900,000 units in 1994 to slightly over three million in 2000.

volumes of imports and exports carried by truck at its border crossing, a new bridge, the Laredo World Trade Bridge, was inaugurated in April 2000. The eight-lane, $128 million cargo-only bridge funded by local, state, and federal governments is providing the additional capacity needed to more effectively move goods between the United States and Mexico.

Figure 2. Growth in U.S. Imports and Exports
1992–2000



2.0 Transportation Investment Enhances Household Welfare

By some estimates, the tangible benefits of personal vehicle travel alone exceed the total social costs attributed to travel by $2 trillion or more per year.[24] These benefits include creation and access to jobs, better living conditions by facilitating suburb to downtown access, higher productivity and greater range of consumer choice through trade. An analysis of data from 98 countries showed a significant and positive correlation between per capita gross national product and per capita length of paved road network. The study also showed a correspondence between road condition and relative levels of economic development.[25]

[24] Thomas Hogarty, "The Untold Benefits of Road and Travel," *Consumers' Research* (July 1999): 11

[25] Cesar Queiroz and Surhid Gautam, "Road Infrastructure and Economic Development: Some Diagnostic Indicators," World Bank, 1992, cited in HLB Decision Economics, Inc. and KPMG LLP,

(Footnote continued on next page...)

Transportation Investment Provides Access to Jobs, Schools, and Hospitals

By providing safe, convenient access to millions of jobs, educational opportunities, and healthcare services, the nation's transport network helps people remain healthy, productive members of society. In the state of Washington, for example, the placement of health facilities and roadways permits 98 percent of the population to reach an acute care hospital within 30 minutes.[26] The National Highway System, which serves 90 percent of the counties in the U.S. and connects all state capitals and urban areas with populations of 50,000 or more, is the backbone of the transport network. While largely complete, the system requires maintenance, improvements, and modifications to ensure it continues to serve those areas experiencing significant job growth.

In the state of Washington, the placement of health facilities and roadways permits 98 percent of the population to reach an acute care hospital within 30 minutes.

In Salina, Kansas, a new interchange is facilitating access to schools and jobs while paving the way – quite literally – for new employment opportunities. During the 1990s, Salina enjoyed moderately fast population increases, but with flood plains limiting development potential in many parts of the city the majority of new construction was concentrated to the south. Population growth and commercial expansions in the area led to increasing congestion problems. Access to a vocational school and the Aviation Branch of Kansas State University, both located at a former air force base converted into a multi-use complex, including an industrial park, became increasingly difficult. In 1998, a new interchange at the junction of Interstate 135 and Magnolia Road alleviated congestion while spurring the opening of new businesses, retail facilities, and restaurants in the area. Today, access to the vocational school and university branch has been improved, together with access to many large employers in the industrial park, such as Raytheon, Tony's Pizza (one of the nation's biggest makers of frozen pizzas), and Eldorado National (a maker of transit buses). Following the completion of the interchange, distribution centers for automotive parts and batteries have also expanded operations or have located in the area.[27]

Transit also provides access to employment and educational opportunities, particularly in urban areas where parking shortages and traffic congestion making commuting by personal vehicle difficult and costly. Transit also allows the "transportation disadvantaged" – people without access to autos or unable to drive because of disabilities or poverty – to actively participate in the workforce. By lessening this group's dependency on welfare,

Public Policy Impacts on Freight Productivity: Final Report With Annotated Bibliography (Washington, D.C.: Federal Highway Administration, October 1999), 7.

[26]Washington Department of Health, "Access to Essential Health Services," 1996.

[27]Cambridge Systematics interview with Salina Area Chamber of Commerce, Salina, Kansas.

transit benefits society as a whole.[28] For example, during late 2000 and early 2001, the Southeastern Pennsylvania Transit Authority (SEPTA) enhanced service to Bucks County by adding two new bus routes and expanding six others. This was SEPTA's largest expansion program in 15 years, nearly doubling the number of bus stops in Bucks County from 325 to 605. For the first time, Bucks County Community College is part of the transit network, as is St. Mary Medical Center in Middletown and half a dozen industrial parks. Three new bus hubs were established at shopping malls, as well as one in Bristol Township. SEPTA also created connections to its regional rail and elevated rail service.[29] For job seekers, students, and senior citizens without cars, the new service is invaluable. SEPTA is predicting ridership will increase by 35 percent as a result of its improved service.[30]

"We hear over and over again that there are jobs that can't be filled because employees can't get there."

– John K. Leary
General Manager, SEPTA

Transportation Investment Lowers Personal Costs of Travel

Average operating costs per vehicle-mile for all vehicles fall from 30.1 cents per mile for poor pavement to 24.2 cents per mile for good pavement.

Investment in roadway maintenance, preservation, and rehabilitation can reduce vehicle repair, insurance, and gasoline costs. In 1999, the average U.S. household spent $664 on vehicle repairs and $1,055 on gasoline and motor oil.[31] Filling potholes and repairing broken pavement can prevent serious tire, rim, and suspension damage, and can prevent accidents caused by motorists swerving to avoid these obstacles. In fact, average operating costs per vehicle-mile for all vehicles fall from 30.1 cents per mile for poor pavement to 27.1 cents per mile for fair pavement to 24.2 cents per mile for good pavement.[32] Repainting faded lane markings, replacing missing signs, and upgrading inadequate or high-glare lighting can also prevent accidents that lead to higher vehicle maintenance costs. Investment in congestion mitigation can reduce both repair costs and fuel costs. Excessive stop-and-go driving increases brake and transmission wear and lowers gas mileage. For more on the economic benefits of accident reduction and congestion mitigation, see Sections 5.0 and 6.0, below.

[28] Jon E. Burkhardt, James L. Hedrick, and Adam T. McGavock, *Assessment of the Economic Impacts of Rural Public Transportation*, Transit Cooperative Research Program (TCRP) Report 34 (Washington, D.C.: Transportation Research Board, National Academy Press, 1998): 140.

[29] SEPTA Bucks County, available at www.septa.com as of July 2001.

[30] Jere Downs, "SEPTA To Open Five Bus Routes In Bucks," *The Philadelphia Inquirer*, 15 November 2000.

[31] Bureau of Labor Statistics, 1999 Consumer Expenditure Survey.

[32] Estimates developed by Cambridge Systematics by applying the Highway Economic Requirements System to 1999 data from FHWA's Highway Performance Monitoring System.

Investing in transit can also reduce personal mobility costs. In 1999, the average household owned 1.9 motor vehicles and spent $6,614 – or $3,481 per vehicle – to purchase, maintain, and insure them.[33] However, households with access to transit can often make do with one fewer vehicle than they would otherwise need. Three-car households can become two-car households, and two-car households can become one-car households. In some cases, the need to purchase even a single vehicle can be eliminated or postponed. Since the cost of one year of vehicle ownership is nearly $3,500, households with fewer vehicles have significantly lower transportation costs.

In some cities, mortgage financing is being made more accessible for people living close to transit stations, reflecting the reduced costs of motor vehicle ownership and repair for residents who commute to work by transit and rely on local shops, services, entertainment, and recreation. The Location Efficient Mortgage (LEM), a new mortgage product being offered by Fannie Mae, provides additional mortgage financing of $15,000 to $50,000, allowing applicants who would not have qualified otherwise for a traditional mortgage to become home owners.[34]

Transportation Investment Boosts Home Values

Efficient highway and transit networks boost home values because commuters value their time very highly – about $20 per hour according to a recent study. For this reason, transportation investments that help speed travel times between home and work tend to have a positive impact on residential real estate prices. For example, the value of homes in Southern California tends to decline as their distance from the central business area increases. A study in the late 1980s showed that buyers would travel an additional 15 to 30 minutes to save $10 to $15 per square foot on the cost of a single-family house. The study compared two similar-sized houses in Orange County, one in close proximity to major employment, retail, and cultural centers and the other 20 miles away. The closer house sold for around $600,000, compared to $320,000 for the farther house. This was a difference of $14,000 per mile or $11,200 per minute of extra commute time. A similar study in Riverside County revealed smaller, but nonetheless significant price differences between closer-in and farther-away homes. In this instance, the difference was $3,600 per mile, or $2,400 per minute of commute.[35]

Over the past four decades, nearly all metropolitan area residents have come to enjoy convenient access to at least one highway. Hence, the increases in property values have largely been realized and today are spread evenly throughout a metro area, manifesting

[33] Bureau of Labor Statistics, 1999 Consumer Expenditure Survey.

[34] Location Efficient Mortgages as cited by the Natural Resources Defense Council, available at http://www.nrdc.org/cities/smartGrowth/qlem.asp as of September 2001.

[35] Robert T. Dunphy, *The Cost of Being Close: Land Values and Housing Prices in Portland's High-Tech Corridor*, ULI Working Paper Series Number 660 (Washington, D.C.: Urban Land Institute, October 1998).

themselves in terms of proximity to the central business area rather than proximity to a specific highway interchange. However, access to a rail transit station or multi-use trail is less common, and can place an additional premium on the value of residential property. Moreover, because access to a station or trail is more localized, the benefits can be measured block by block, rather than mile by mile.

For example, in Alameda County, California, statistical models developed to analyze the impact of rail transit on property values showed that a home's value (based on 1990 sales figures) increased by more than $2.00 for each meter it was closer to a Bay Area Rapid Transit (BART) station. According to the models, a house within a short walk of a BART station (but not immediately adjacent to BART) would sell for close to 38 percent more than an identical house several miles away. In suburban New Jersey, the median price for homes in proximity to the rail lines operated by the Port Authority Transportation Corporation was 10 percent higher than the price for homes farther away from the rail line. Similarly, in Philadelphia, the sale price of homes served by the Southeastern Pennsylvania Transportation Authority (SEPTA) commuter service has averaged 3.8 percent more than the price of homes not directly served by commuter rail. In Portland, Oregon, just two years after the completion of the Eastside Metropolitan Express (MAX) light rail line, residential properties within 500 meters of stations in the East Burnside area were worth 10.6 percent more than properties located beyond 500 meters.[36] In Brown County, Wisconsin, homes adjacent to the 83-mile Mountain-Bay Trail have sold faster and for an average of nine percent more than homes farther from the trail.[37]

In Philadelphia, the sale price of homes served by the Southeastern Pennsylvania Transportation Authority (SEPTA) commuter service has averaged 3.8 percent more than the price of homes not directly served by commuter rail.

3.0 Transportation Investment Strengthens Local, Regional, and State Economies

Transportation investment has both microeconomic effects such as those described above and macroeconomic effects. Transportation investment benefits not only individual firms and households, but entire neighborhoods, cities, regions, and states.

[36] Roderick B. Diaz, "Impacts of Rail Transit on Property Values," APTA Rapid Transit Conference Proceedings Paper, May 1999, 2–3.

[37] Brown County Planning Commission, *Recreation Trails, Crime, and Property Values: Brown County's Mountain-Bay Trail and the Proposed Fox River Trail* (Green Bay, Brown County Planning Commission, 1998).

Transportation Investment Strengthens Local Economies

Transportation investment strengthens local economies. For example, a highway widening project is fostering economic development in the Four Corners area of northern New Mexico, where Utah, Colorado, Arizona, and New Mexico come together. The project is the key to improving economic development and tourism opportunities in San Juan County, which has income levels only two-thirds the U.S. average.[38] A 120-mile stretch of the two-lane highway, NM 44, is being expanded from two to four lanes to improve access, reliability, and safety. The widening project is close to completion with many four-lane segments already open. When completed in November 2001, the highway will be renamed U.S. 550 and northwest New Mexico will have direct four-lane access to the Mexican border in Santa Teresa. San Juan County is expecting a tourism boost from the project and manufacturers in the Farmington area (including those involved in the production of conversion vans, utility trailers, anti-aircraft missiles, and hydrocoils) already have expanded in anticipation of the improved productivity that will result from better access to suppliers and markets. Agricultural producers in the region also expect to benefit from the highway improvement by being able to effectively access more distant markets. In addition to promoting tourism and economic development, the NM 44 project has had a high level of community involvement and has generated jobs for underemployed workers. Contractors working on NM 44 received various tax and rebate credits by hiring those who qualify for programs such as Welfare-to-Work. In addition, training programs for Commercial Drivers Licenses and the use of heavy equipment were made available to local residents so they could take advantage of the income generating opportunities offered by the project. By early 2000, over 200 people had been trained with higher skill levels using these programs.[39]

For every taxpayer dollar spent on transit, the economic return on investment is at least four or five to one.

Transit revitalizes neighborhoods and downtown areas by fostering "agglomeration economies" – benefits, savings, or average cost reductions resulting from the clustering of activities.[40] Density adds efficiency to urban labor markets by providing businesses with a large and varied pool of employees, and an improved chance to match specialized jobs with appropriately skilled workers.[41] Transit plays a role in agglomeration economies by providing a fast and reliable means for large volumes of people to move about in congested, densely settled areas where parking is in short supply. A sustained program of transit capital investment will generate in the short run an annual increase of $2 million in

[38] Bureau of Economic Analysis, "Local Area Personal Income," www.bea.doc.gov/bea/regional/reis.

[39] Cambridge Systematics interview with San Juan Economic Development Service, San Juan County, New Mexico.

[40] Economic Geography Glossary, University of Washington, available at http://faculty.washington.edu/krumme/gloss/a.html as of September 2001.

[41] Federal Transit Administration, *Commercial Property Benefits of Transit, Transit Benefits 2000 Working Papers* (Washington, D.C.: U.S. Department of Transportation, 2000), 87.

business output and $0.8 million in personal income for every $10 million invested. In the long run (20 years), these benefits accumulate to $31 million and $18 million for business output and personal income, respectively.[42] Overall, for every taxpayer dollar spent on transit, the economic return on investment is at least four or five to one.[43]

The Central Ohio Transit Authority (COTA), which operates a fixed-route urban mass transit system that logs over nine million miles a year, plays an important role in providing job access in the Columbus area. One COTA initiative, "COTA Works," focuses on developing new COTA routes and fine-tuning existing routes with an eye to reducing employee shortages that businesses face. COTA is also contributing to economic development through the construction of new transit centers. In partnership with other public and private entities, COTA constructed a state-of-the-art transit center in the Linden area that provides a 24-hour day care center, a bank, and a medical clinic in addition to transportation services. The center, which opened in 2000, is stimulating development in the neighborhood, creating jobs, helping parents who work non-traditional hours, and increasing the convenience of using mass transit. Opportunities for Linden residents have improved with the opening of the transit hub, as 25 percent of the neighborhood presently has no access to automobiles and unemployment is high. The center is also a key to urban revitalization. An existing building is being rehabilitated to house a restaurant, a grocery store, and other services, as well as to stimulate surrounding retail growth. The transit center provides amenities and job opportunities to turn the Linden area into a viable and functional economic destination, not just a place people pass through on their way to someplace else. In the Easton area, COTA is in the process of building a second transit center, slated for completion in 2002. A third center is planned for the near-east side of Columbus.[44]

"What this does is give people within the [Linden] neighborhood much better access to jobs all over the city. With 11 intersecting bus lines plus circulating shuttle buses in the neighborhood, the ability to get to a job increases so much."

– David Baker
President, Columbus Urban Growth Corp.

The Washington D.C. area has had some of the most successful examples of transit-oriented development in the United States, particularly with regard to office development. This is the result of Metro, one of the most extensive and comprehensive passenger rail systems in North America. The Metro system, operated by the Washington Metropolitan Area Transit Authority (WMATA), currently stretches 103 miles and includes 83 stations.

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[42] Cambridge Systematics, Inc. and Economic Development Research Group, *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact* (Washington, D.C.: American Public Transit Association, October 1999).

[43] Donald H. Camph, *Dollars and Sense: The Economic Case for Public Transportation in America* (Washington, D.C.: The Campaign for Efficient Passenger Transportation, 1997).

[44] Kathy L. Woodward, "Linden Confident COTA Center Just the Start," *Business First*, 30 July 1999; Central Ohio Transit Authority web site, http://www.cota.com.

It links activity centers within the D.C. area and provides suburban commuters with convenient access to downtown Washington. The Metro now handles about 16 million riders per month. The convergence of Metro lines downtown has resulted in a better labor market for employers and has encouraged more downtown development than what would have otherwise occurred. For example, in 1970 Montgomery County started planning for the areas around future Metro stations. Since the opening of a Metro station in 1978, the Silver Spring central business district has added almost three million square feet of office space, 188,000 square feet of retail space, and 640 dwelling units – all within a quarter mile of the station. Similarly, commercial and office space in the Rosslyn-Ballston Corridor in Arlington has more than tripled since a Metro station opened in 1979. A substantial increase in residential population along the corridor has also ensued as Arlington officials used Metro as a way to encourage growth and to revitalize the city's commercial core.[45] Metrorail's success at focusing development around transit stations is in large part due to supportive land use planning and development policies by local jurisdictions, and especially by WMATA, which has a program to solicit development proposals around rail stations. Since its inception, the Metrorail has spurred an estimated $15 billion in private investment in station areas.[46]

Applying context-sensitive design principles to main street and urban street reconstruction projects also provides economic benefits. Sidewalk replacement, tree planting, curb improvements, landscaping, and the addition of "street furniture" – benches, bicycle racks, and decorative street lamps – draw pedestrian traffic and boost the value of commercial and residential properties. For example, to reinvigorate its historic city center, Indianapolis embarked on a major redesign of Washington Street in the early 1990s. Once a thriving shopping district, Washington Street declined in the postwar period as a result of competition from shopping malls on Indianapolis' urban fringe. To reverse this trend, a "pedestrian friendly" streetscape was created through extensive landscaping and sidewalk expansion. Without restricting vehicle flow, pedestrian access to theatres, museums, and retail stores was enhanced. By following Americans with Disabilities Act guidelines, Indianapolis ensured that all visitors and workers would be accommodated with ease. The improvements stimulated economic activity along Washington Street, including the return of many retailers. A new shopping complex known as Circle Centre, two city blocks long and four stories high, received 6.2 million visitors during its first four months of operation, 50 percent more than developers expected.[47] Another recent downtown enhancement is a CMAQ-funded bicycle/pedestrian path, which runs along a canal flowing through the heart of the city.

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[45] City of Seattle Strategic Planning Office, "Transit-Oriented Development Case Studies," available at http://www.ci.seattle.wa.us/planning/todstudy/cs000toc.htm as of September 2001.

[46] Washington Metropolitan Area Transit Authority, "Metro Means Business in the Washington Metropolitan Area."

[47] Joe DiStefano and Matthew Raimi, *Five Years of Progress: 110 Communities Where ISTEA is Making a Difference* (Washington, D.C.: Surface Transportation Policy Project, 1996), 100-1.

Transportation Investment Strengthens Regional Economies

Regional economic growth occurs when a region is able to sell its goods and services outside of the region, thereby bringing income into the region. Transportation, by providing access to markets, is the critical link. More subtle links exist as well, between the level of transportation service (and the choices available to businesses) and the diversity of a region's economy, and between congestion and the perceived quality of life in a region.

Between 1969 and 1991, 110 Appalachian counties with development highways grew 49 percent faster in earnings, 69 percent faster in income, and six percent faster in population than statistical "twins" outside the region.

For many rural regions in particular, access to transportation networks can mean the difference between isolation and inclusion. Highways connect rural residents to jobs, shopping, health care, and educational opportunities. For example, all but one of 13 counties touching Interstate 40 in Arkansas grew in population in the 1990s, and four doubled in population since 1960, when the new Interstate began opening in segments. In the Texas Panhandle, both counties (Potter and Randall) that comprise the Amarillo metropolitan area grew by 16 percent in the 1990s, faster than the nation's 13 percent gain and far more than the Panhandle as a whole.[48] Amarillo's location, on a key cross-country corridor, I-40, is seen as a chief contributor to this growth.[49]

The Appalachian Development Highway System (ADHS), now under construction, is providing portions of 13 southern and mid-Atlantic states with improved access to national markets as well as better intraregional linkages between key economic centers within the region.[50] With 12 corridors and 1,400 miles of the proposed 3,025-mile network completed, the ADHS is creating thousands of new employment opportunities in retail, industry, and tourism; improving safety; and improving access to social services, health care, education, and shopping. These benefits, estimated at $5.5 billion between 1965 and 2025, exceed highway construction and maintenance costs, estimated at $4.1 billion over the same period. In addition, the ADHS highway corridors are expected to produce travel efficiencies nationwide valued at $4.9 billion between 1965 and 2025. These savings are the result of a greater number of lanes, improved road conditions, and higher highway speed limits. By 1995, the ADHS corridors

All but one of 13 counties touching Interstate 40 in Arkansas grew in population in the 1990s, and four doubled in population since 1960, when the new Interstate began opening in segments.

[48] Peter T. Kilborn, "In Rural Areas, Interstates Build Their Own Economy," *The New York Times*, 14 July 2001.

[49] U.S. Census Bureau, 2000 data, available at http://factfinder.census.gov/home/en/pldata.html as of September 2001.

[50] The states are Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

were estimated to have generated 16,000 jobs. By 2015 this number is expected to rise to 42,000. These are jobs that are dependent on highway investment and would *not* have been created without the ADHS. They are highly diversified, with a distribution across the construction, manufacturing, services, and retail trade sectors.[51] Comparing counties in Appalachia with statistical "twin" counties outside the region offers additional evidence of the positive economic impact of highway building. Between 1969 and 1991, 110 Appalachian counties with development highways grew 49 percent faster in earnings, 69 percent faster in income, and six percent faster in population than their statistical "twins."[52]

The economic benefits of transportation investment in an urban region are evidenced by the profound impacts that Washington's Metrorail has had on growth in parts of Virginia, Washington, D.C., and Maryland. By improving access to jobs, Metrorail has allowed large research and office complexes to blossom throughout the area. Today, the Washington D.C. metropolitan area ranks among the wealthiest in the United States. Higher wages and property values following the development of Metrorail have translated into improved fiscal health. For example, in Northern Virginia, it is estimated that tax revenues will grow by $1.2 billion (the net increase in government revenues, fully accounting for the government's contribution to transit) for the 1978 to 2010 period because of Metrorail.[53]

Transportation Investment Strengthens State Economies

The importance of transportation to economic competitiveness has been recognized by state departments of transportation throughout the United States, and several states have introduced programs that explicitly tie roadway investment with economic development needs and priorities. For example, the Illinois Department of Transportation's "Economic Development Program" provides state assistance for highway improvements that are needed to provide access to new or expanding industrial, distribution, or tourism developments.[54] Mississippi has also initiated a statewide highway investment program largely for the purposes of economic development. The addition of over 700 miles of four-lane highways in Mississippi is partially responsible for the growth of Tupelo as a furniture

[51] Wilbur Smith Associates, *Economic Impact of the Appalachian Development Highway System*, Columbia, South Carolina, 1998. The study cautions that the economic development impacts ($5.5 billion) and the travel efficiency impacts ($4.9 billion) were calculated differently and should not be summed to form a larger figure.

[52] Andrew Isserman and Terrence Rephann, "The Economic Effects of the Appalachian Regional Commission: An Empirical Assessment of 26 Years of Regional Development Planning," *Journal of the American Planning Association*, Summer 1995.

[53] Cambridge Systematics, Inc. and Apogee Research, Inc., *Measuring and Valuing Transit Benefits and Disbenefits*, Transit Cooperative Research Program (TCRP) Report 20 (Washington, D.C.: Transportation Research Board, National Academy Press, 1996).

[54] Illinois Department of Transportation, *The State of Transportation in Illinois: Lifelines to the Economy*, March 1997.

manufacturing center and is believed to have been an important contributor to the State's overall economic growth since 1987.[55]

In 1988, Wisconsin introduced its "Corridors 2020" plan to create a statewide network of roads that would connect all communities of over 5,000 people. The importance of these roadways is underlined by the fact that between 1990 and 1997, 87 percent of all new or expanding manufacturers in the state chose to locate within five miles of a Corridors 2020 highway. In addition to serving key trade, manufacturing, agriculture, forestry, and recreation centers that support the State's economy, the road network has greatly expanded trade and tourism. Exports of state products grew 130 percent between 1988 and 1996, and accounted for nearly 225,000 jobs in Wisconsin. The State's exports were valued at some $10.5 billion in 2000. This initiative also led to the creation of a statewide network of roads to support tourism expansion. The Wisconsin tourism industry had receipts of $6.6 billion in 1996, supporting 183,000 jobs which accounted for about seven percent of total state employment.[56]

Between 1990 and 1997, 87 percent of all new or expanding manufacturers in Wisconsin chose to locate within five miles of a Corridors 2020 highway.

In response to growing concerns about the loss of mobility on its highways and the economic ramifications of this decline, Minnesota completed its "Interregional Corridor Study" in 1999 to guide the management of key transportation links between the State's regional trade centers. The improvement and protection of these connections between regional trade centers is part of a strategy to enhance the economic competitiveness of the State. The strategy to link regional centers recognizes the relative importance of these centers to the State economy; these centers are the engines of Minnesota's economic growth and are showing population increases more than one-third higher than the State average. Minnesota seeks to ensure that the roadways between its trade centers provide quick, safe, and predictable travel for individuals, tourists, and businesses.[57]

Oregon is also aware of the positive statewide impacts of transportation investment. A recent study showed that each $1 million in highway construction spending generates, directly and indirectly, an additional $531,000 in personal income, $2.0 million in economic output, and $59,000 in general revenue taxes.[58]

[55]State of Mississippi, *1987 Highway Program*; Cambridge Systematics interviews with Mississippi Department of Transportation.

[56]Thomas Hogarty, "The Untold Benefits of Road and Travel," *Consumers' Research* (July 1999): 12.

[57]Minnesota Department of Transportation, *Better Connections for Minnesota's Future: Interregional Corridor Study*, www.oim.dot.state.mn.us/projects/irc.

[58]E.D. Hovee and Company, *Economic Impacts of New Highway and Street Expenditures in Oregon* (Salem, OR: Oregon Department of Transportation, June 1996).

4.0 Transportation Investment Boosts Business and Leisure Travel

Both business and leisure travelers depend on our nation's transportation infrastructure for access to a variety of activities and destinations. Perception about accessibility influences the decisions of event coordinators and travel agents, businesspeople and tourists. Whether to schedule a meeting in city A or city B, or to take the family on a skiing trip to Mountain X or Y depends heavily on quality – perceived or actual – of the travel experience. The travel experience also influences whether travelers recommend a destination to others or choose to make a return trip in the future.

Millions of people each year travel by road, rail, and air to reach meetings, trade shows, conventions, and other business functions. Despite the increasing popularity of teleconferencing and videoconferencing as alternatives to face-to-face meetings, business travel boomed during the 1990s. According to the Travel Industry Association of America, 43.9 million adults in the United States took some 272 million business trips during 1998.[59] The large volume of business travel in the United States translates into significant local economic impacts.

In Dallas, one of the nation's leading convention cities and corporate travel destinations, visitors spend about $8.5 billion annually. These visitors help employ more than 47,000 hotel workers and generate $2.2 billion in wages for workers in the Dallas area.[60] Key to the success of the city's business and convention-related travel industry is Dallas's strong transportation network – essential to business travelers for reaching events, hotels, and restaurants. Since 1996, this network has been further strengthened by a 20-mile light rail service operated by Dallas Area Rapid Transit (DART). Ridership has increased steadily since the service opened, reaching 11.4 million passenger trips in 2000. In response, DART is planning an expansion to double the size of the system. Development around DART light rail stations has also shown a marked increase, even around stations that have yet to be completed. The clustering of residential and commercial activities around DART stations and the renovation of a number of empty buildings has a number of beneficial impacts on

> **"DART is the reason we did this project [the Adam's Mark Hotel]. That light rail line is our life blood – our connection to the [Dallas] Convention Center."**
>
> **– Fred Kummer III**
> **General Manager,**
> **Adam's Mark Hotel**

[59] Travel Industry Association of America, "Survey of Business Travelers," 1999. As cited in Regional Financial Associates, "Technology and the Future of Business Travel," February 10, 2000. Article available at http://www.dismal.com/print_happy.asp?aid=512.

[60] Hotel/Motel Association of Greater Dallas, "Dallas Hospitality Industry Facts," 1999, www.greaterdallashotels.com/industry_facts.htm.

the livability and sustainability of the city. It has led, for example, to the conversion of an abandoned office building complex into a new hotel. The site was chosen specifically because it is served by DART rail line, which provides convenient access for guests to the Dallas Convention Center. The Convention Center itself is undergoing a major expansion, so that by 2002 its floor area will have increased by roughly 50 percent over its present 525,000 square feet. DART rail has spurred the development of another business travel-related project in Dallas: the Galatyn Park Urban Center, due to be completed by 2002. The Center includes a hotel and conference center, an auditorium, and other mixed-use development that will offer inner-city living amenities such as shopping, entertainment, employment, and of course light rail access.[61]

The leisure tourism industry also benefits greatly from transportation investment. In 2000, Americans took 998 million domestic trips, generating $471 billion in expenditures. The same year, the United States attracted 51 million international visitors.[62] Recent increases in domestic tourism have more or less tracked at the same rate as the country's population growth, while the volume of international visitors entering the country has risen more quickly. Between 1990 and 2000, the number of international tourists arriving in the United States increased from 39.4 million to 50.9 million, a 29 percent gain. Total tourism spending in the United States by international visitors was estimated to be $103 billion in 2000.[63]

Transportation investment helps generate greater tourism earnings by making tourist destinations more accessible. Traffic congestion, construction delays, poor road conditions, absent or confusing signage, inadequate parking facilities and scenic turnouts, barriers to people with disabilities, and lack of public transport alternatives all diminish the drawing power of a tourist attraction. By addressing such deficiencies, transportation investment helps increase tourist volumes, lengths of stay, and spending per visitor-day while reducing tourist transportation costs. As a result, investment in new facilities such as hotels, restaurants, or entertainment venues may also take place.[64]

For example, in West Virginia, the construction of U.S. 19 between Sutton and Beckley has caused a tourism boom in the region. U.S. 19 was completed in 1978, and over the next 16 years average daily traffic counts increased fourfold, from 2,800 vehicles to more than 10,000. By the mid-1990s, with traffic volumes well above official predictions, it became

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[61] Dallas Area Rapid Transit, "Dart Economic Impact," study available at http://www/dart.org/economicimpact.asp as of September 2001.

[62] Travel Industry Association of America and International Trade Administration, U.S. Department of Commerce. A domestic trip is defined as the travel of one person more than 50 miles away from home and/or overnight.

[63] Travel Industry Association of America and International Trade Administration. Includes spending by international visitors traveling to the U.S. on U.S. flag carriers.

[64] Greenhorne & O'Mara, Inc. and others, *National Cooperative Highway Research Program (NCHRP) Report 419: Tourism Travel and Transportation System Development* (Washington, D.C.: Transportation Research Board, National Research Council, 1998), 42.

necessary to widen the road in places where two lanes had been built instead of four. New interchanges were added as well, further increasing tourism opportunities and the benefits to the local economy. Today, tourists come from across the country to take advantage of the region's spectacular natural beauty and recreational opportunities such as white water rafting. Nearly 250,000 people a year raft the New River, the Gauley River and three other West Virginia rivers. In all, some 40 rafting businesses generate nearly $75 million a year. The less adventuresome come to admire the New River Gorge Bridge, the world's longest single-arch steel bridge. A symbol of U.S. 19's success as a tourist magnet, the bridge began drawing curious tourists even before its completion.[65]

"Getting here used to be the biggest obstacle. Before the Interstates and U.S. 19 were complete, it took seven and a half hours to get here from Pittsburgh. Now it takes four and a half hours, and it's a lot easier to get here from places like Washington."

– Chris Dragan
Wildwater Expeditions Unlimited,
West Virginia

Transit, by reducing automobile use in and around popular tourist destinations, creates a more attractive environment for tourism and increases the number of tourists who are able to access a site. For example, Acadia National Park, Maine receives nearly three million visitors each year, a number that the National Park Service (NPS) estimates could double by 2020. Already, NPS officials are concerned that growing traffic and parking problems are limiting park access, detracting from the visitor experience, and negatively impacting the environment.[66] In response, the park introduced a free seasonal shuttle bus service in 1999 called the Island Explorer. A total of six routes link destinations inside the park to hotels, inns, campgrounds, shops, restaurants, and the Bar Harbor Ferry terminal, which provides high-speed catamaran service to Nova Scotia. The service is funded by the NPS, the U.S. Department of Transportation, the Maine Department of Transportation, Mount Desert Island towns, Friends of Acadia, and private businesses. During the summer of 2001, the Island Explorer carried 240,000 riders, a 25 percent increase over 2000 and a 75 percent increase

"Keep it [the Acadia shuttle bus service] the way it is! Clean, on-time, non-polluting, comfortable, easy, and commerce-bringing."

– Acadia National Park visitor

[65] James Casto, "West Virginia's Corridor L Opens the Door to Tourists," *Appalachia* (May–August 1996); Margie Mason, "Whitewater Rafting in West Virginia a Young but Exuberant Pastime," *Outside* (20 August 1998).

[66] Samantha Coit, "Acadia Transit System Rolling, *Bangor Daily News*, 22 June 1999; National Park Service, *Acadia National Park Commercial Services Plan* (Washington, D.C.: U.S. Department of the Interior, 2000), 3.

over 1999.[67] The bus allows the Acadia area to maintain the economic benefits of the national park while not overtaxing the transportation infrastructure.

In Natchez, Mississippi, one of the oldest cities in North America, a new visitor and intermodal center is helping grow tourism while simultaneously alleviating traffic and parking problems in the nearby historic downtown. The visitor center, which opened in 1998, is a cooperative effort of the city of Natchez, the state of Mississippi, the Federal Highway Administration, and the National Park Service. Strategically located so that it is the "first stop" for arriving visitors, the center offers an orientation video and assistance planning sightseeing itineraries in Natchez. Tour buses and trolleys depart directly from the center, providing access to the historical parts of the city while offering tourists an incentive to leave their cars behind.[68] Since the visitor center's opening, annual shuttle service ridership has grown steadily, and tourism in Natchez has increased by approximately 3.0 percent each year. In contrast, tourism in nearby communities has actually declined. The Natchez Convention and Visitors Bureau believes the new facility is directly responsible for the town's growing popularity.[69]

Sometimes the journey itself is a form of recreation in its own right, such as a scenic train ride, a bicycle excursion, or a drive along country roads during fall foliage season. The positive economic impact of these activities on local communities should not be underestimated. "Leaf peeping" is a $400 million a year industry in New York state alone.[70] With this in mind, some of America's finest roads from a scenic, historic, recreational, cultural, or archeological point of view are marketed to the public as tourist destinations through the Federal Highway Administration's National Scenic Byways Program. Today, there are a total of 15 "All-American Roads" and 57 "National Scenic Byways," including the Big Sur Coast Highway in California, the Las Vegas Strip in Nevada, Historic Route 66 in New Mexico, the Blue Ridge Parkway in North Carolina, and the Merritt Parkway in Connecticut. The National Scenic Byways Program has benefited from about $139 million in federal funds, with about $25 million available annually through 2003. The program has helped boost local tourism in a number of ways. It has helped develop and implement scenic byway marketing plans and disseminate tourism information to the public; it has helped improve recreational area access from scenic byways; it has helped construct pedestrian and bicycle facilities, rest areas, turnouts, scenic overlooks, shoulders, and

[67] Acadia Free Shuttles web site, http://www.exploreacadia.com.

[68] Joe DiStefano and Matthew Raimi, *Five Years of Progress: 110 Communities Where ISTEA is Making a Difference* (Washington, D.C.: Surface Transportation Policy Project, 1996), 12–13; "Cochran Speaks at the Dedication of the Natchez Visitor and Intermodal Center," press release available at Senator Thad Cochran (R-MS) web site, http://www.senate.gov/~cochran/index.htm, as of September 2001.

[69] Cambridge Systematics conversation with Natchez Convention and Visitors Bureau.

[70] North East State Forester's Association, *The Economic Importance of New York's Forests*, 2000, available at http://nefa.conknet.com/publications/nefany.pdf as of September 2001.

passing lanes on scenic byways; and it has made safety improvements to scenic byways that have become necessary when traffic levels increased following their designation.[71]

Another transportation facility that doubles as a tourist venue is San Francisco's network of historic cable cars and President's Conference Committee (PCC) streetcars, operated by the San Francisco Municipal Railway (MUNI). Three cable car lines climb and descend the city's steep hillsides: The Powell-Mason line, which runs over Nob Hill and down to Fisherman's Wharf; The Powell-Hyde line, which runs over both Nob and Russian hills before ending at Aquatic Park near Ghirardelli Square; and the California Street line, which runs east-west from the Financial District, through Chinatown, and over Nob Hill, stopping at Van Ness Avenue. Tickets allow hop-on-hop-off riding, and thrill-seekers can even hang on to special poles on the outside of cars. Nearly 10 million tourists and locals ride the cable cars each year. On its recently extended F-Market Street Line, which connects Fisherman's Wharf to downtown, MUNI operates a fleet of historic trolley cars from transit agencies across the United States. The cars are beautifully restored and maintained by the Market Street Railway volunteer organization. With annual ridership increasing, MUNI's system is generating tremendous tourist revenue in hotels, restaurants, and entertainment establishments.

In York County, Pennsylvania, a new multi-use trail is also providing important economic benefits to local establishments. The 21-mile Heritage Rail Trail, completed in 1999 with the help of Transportation Enhancements (TE) funds, winds its way south from York to the Maryland border, where it connects to the Maryland Northern Central Rail Trail. Based on the popularity of this adjoining trail, which attracts over 365,000 visitors each year, local entrepreneurs in York County are gearing up for increased demand for lodging, food, and athletic gear. A number of new businesses have opened up along the Heritage Rail Trail, including two bed and breakfasts, two bicycle shops, a delicatessen, and a gift shop. A survey conducted shortly after the trail's inauguration suggests this optimism is warranted: 60 percent of respondents had made a food purchase on their last visit averaging $6.64 per person, while 65 percent of respondents acknowledged that their use of the trail had influenced a purchase in the past year, mainly of cycling-related equipment.[72]

5.0 Transportation Investment Reduces Economic Losses Associated with Accidents

Transportation-related accidents are a drain on the U.S. economy. In 1999, there were nearly 44,000 transportation-related fatalities and nearly 3.3 million transportation-related

[71] National Scenic Byways Program web site, http://www.byways.org.

[72] National Transportation Enhancements Clearing House, *Communities Benefit! The Social and Economic Benefits of Transportation Enhancements* (Washington, D.C.: NTEC, 2000), 10-11.

injuries in the country.[73] The vast majority of these occurred on roadways. While the pain and anguish that results from injury and loss of life is difficult to measure, the economic costs associated with accidents – medical care expenses, insurance administration, loss of earnings, loss of workplace productivity – can be measured. In 1994, the most recent year for which government data is available, the costs associated with accidents were estimated at $150 billion.[74] Transportation investment can help make the roadways safer through a variety of actions: maintaining the pavement integrity of existing roadways; improving road geometrics; improving street lighting; improving signage and pavement markings; eliminating at-grade rail crossings; redesigning dangerous intersections; improving facilities for pedestrians and cyclists; funding transit initiatives; and educating drivers. When accidents do occur, intelligent transportation systems can mitigate their effects by improving the response time of emergency vehicles.

For example, over 11,000 of the 37,000 fatal crashes that occurred in the U.S. in 1997 were single-vehicle run-off-the-road crashes. To address this serious safety problem, departments of transportation have begun to install continuous shoulder rumble strips along the edges of highway travel lanes. By transmitting sound and vibration through a vehicle, the rumble strips alert inattentive drivers that they are in danger of running off the road. Following the installation of rumble strips along 457 kilometers of rural and urban highways in Illinois between 1990 and 1993, a study was conducted to measure the safety benefits. The study determined that single-vehicle run-off-the-road accidents declined by approximately 18 percent. On the basis of these results, it further determined that the investment in rumble strip technology was extraordinarily cost-effective. When continuous shoulder rumble strips are rolled into the pavement during resurfacing and shoulder rehabilitation projects, their cost is just $217 per kilometer. Over the same one-kilometer stretch, every three years, rumble strips can prevent one single-vehicle run-off-the-road accident at an average cost of $62,200.[75]

Converting rural two-lane roadways to four-lane divided roadways also reduces accidents. This is because passing is made safer and because access, particularly across the median strip, is limited. A study of crash rates in four states – California, Michigan, North Carolina, and Washington – showed that converting a two-lane road to a four-lane divided road results in a crash per kilometer reduction of roughly 40 to 60 percent.

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[73] Bureau of Transportation Statistics, *National Transportation Statistics 2000* (Washington, D.C.: U.S. Department of Transportation, 2001), 99–104.

[74] National Highway Traffic Safety Administration, *The Economic Cost of Motor Vehicle Crashes, 1994* (Washington, D.C.: U.S. Department of Transportation, 1995).

[75] Federal Highway Administration, "Safety Evaluation of Rolled-In Continuous Shoulder Rumble Strips Installed on Freeways, Summary Report," *ITE Journal* 70 (June 2000): 37–42.

On residential streets, investment in "traffic calming" measures to slow speeding traffic reduces economic losses associated with pedestrian and cyclist injuries, as well as losses associated with vehicle and property damage. Features such as intersection neckdowns, speed tables, textured crosswalks, and miniature traffic circles, are incorporated into street redesigns across the U.S. with increasing frequency. In Seattle, Washington, officials estimate that the city's widespread use of inexpensive and easily maintained traffic circles on residential streets prevented 273 accidents over four years, preventing $1.7 billion in property and casualty losses.[76] The safety benefits of a more modern variant of the traffic circle, the roundabout, are discussed in Working Paper 3, *Community and Social Benefits of Transportation Investment*. A study of 11 intersections in the U.S. where roundabouts have been constructed showed a 37 percent reduction in the number of crashes and 51 percent reduction in the number of injuries.[77] For this reason, the Insurance Institute for Highway Safety and State Farm Insurance, the nation's largest auto insurer, encourage the widespread use of roundabouts.[78]

A study of crash rates in four states – California, Michigan, North Carolina, and Washington – showed that converting a two-lane road to a four-lane divided road results in a crash per kilometer reduction of roughly 40 to 60 percent.

Safety can also be improved using Intelligent Transportation Systems (ITS). For example, loop detectors embedded in the roadway, together with surveillance cameras mounted on major traffic arteries, provide early warning of accidents, reducing response time of emergency vehicles. Such a system was deployed over 26 miles of Highway in San Antonio, Texas beginning in 1995. Called TransGuide, the system was developed by the Texas DOT with federal funding and will eventually cover 191 miles. TransGuide uses loop detectors, high-resolution color video cameras mounted on poles, variable message signs, lane control signals, and a digital communications network to transmit data to an operations control center. The loop detectors measure the speed and density of traffic on each highway lane and detect any disruptions in flow. This information is displayed graphically on color-coded maps. Incident managers in the control center use this data, coupled with the live video feed, to notify emergency response personnel, and also to adjust the variable message and lane control signals to notify travelers as soon as an incident occurs. During its first year of operation, the number of accidents on the segments of TransGuide-equipped highway fell by more than

Seattle's widespread use of inexpensive and easily maintained traffic circles on residential streets prevented 273 accidents over four years, averting $1.7 billion in property and casualty losses.

[76] Surface Transportation Policy Project, *Mean Streets 2000: Pedestrian Safety, Health, and Federal Transportation Spending* (Washington, D.C.: Surface Transportation Policy Project, June 2000), 23.

[77] Georges Jacquemart, *Modern Roundabout Practice in the United States, National Cooperative Highway Research Program Synthesis of Highway Practice 264* (Washington, D.C.: National Academy Press, 1998), 25.

[78] "Many Crashes Could Be Avoided With Low-Cost Improvements," article available at State Farm Insurance web site, http://www.statefarm.com/media/lowcost.htm as of September 2001.

a third and emergency vehicle response time fell by 20 percent. This translated into and average delay savings of 700 vehicle hours and reduction in fuel consumption of 2,600 gallons per major incident. In economic terms, based on highway accident frequency rates, TransGuide saved individuals and taxpayers $1.65 million during its first year of operation alone.[79]

For more on the safety benefits of transportation investment, see Working Paper 3, *Community and Social Benefits of Transportation Investment*.

6.0 Transportation Investment Reduces Economic Losses Associated with Congestion

In 1999, the total cost of congestion in 68 metropolitan areas (those that were the subject of a recent Texas Transportation Institute Study) was a staggering $78 billion. This reflects the economic drain of 4.5 billion hours of delay and 6.8 billion gallons of wasted fuel.[80] More than half of the $78 billion was attributed to the 10 metropolitan areas with the highest congestion costs. To reduce congestion – as well as fuel consumption and air pollution – policy experts recommend four approaches:

1. Adding capacity through the addition of new roads, new highway lanes, new transit vehicles, and new transit lines;

2. Improving transportation demand management through efforts to reduce travel at peak periods – encouraging ridesharing, flexible work schedules, transit use, and sustainable land use practices;

3. Improving transportation system management through intersection and traffic signal improvements, electronic toll collection, and better handling of incidents and special events; and

4. Improving management of construction and maintenance projects to minimize delays.[81]

For example, in the Minneapolis-St. Paul metropolitan area, a system of ramp meters is in place on nearly 200 miles of highways. Ramp meters are special traffic signals at highway entrance ramps, timed to allow just one car at a time to proceed up the ramp during peak periods. The frequency of the signal cycle – and hence the number of vehicles allowed to enter the highway at a given interchange each minute – depends on the time of day and

[79]Federal Highway Administration, *Intelligent Transportation Systems Benefits: 1999 Update* (Washington, D.C.: U.S. Department of Transportation, 1999), 36.

[80]Schrank and Lomax, *The 2001 Urban Mobility Report*.

[81]Ibid.

level of congestion. Recently, to study the system's effectiveness, the ramp meters were shut off for a period of several weeks and vehicles were allowed to merge with highway traffic in continuous streams. The experiment showed that the meters reduce peak-hour traffic volumes by 14 percent, provide over 25,000 person-hours in time savings annually, and help prevent over 1,000 accidents each year. The benefit to cost ratio for the entire ramp metering system was estimated at five to one.[82]

A ramp metering system in the Twin Cities reduces peak-hour traffic volumes by 14 percent, provides over 25,000 person-hours in time savings annually, and helps prevent over 1,000 accidents each year.

In Houston, an incident management system known as TranStar helps keep traffic flowing smoothly over 127 miles of the local highway network. On the I-10 Katy Freeway, ramp meters are used to prevent traffic from locking up at highway entrance ramps. Each day, the meters are estimated to save 2,875 vehicle-hours, resulting in a $37,030 benefit to Houston area commuters. TranStar also uses video cameras to monitor traffic flow to determine whether an accident or unusually high-demand warrants the lifting of restrictions on high-occupancy vehicle (HOV) lanes. In 1996, these restrictions were lifted seven times, saving nearly 13,000 vehicles as much as 27 minutes of travel time, for a cost savings estimated at between $42,500 and $85,100.[83]

High-occupancy toll (HOT) lanes are another option for reducing highway congestion, especially in urban areas. HOT lanes are high-occupancy vehicle (carpool and bus) lanes in which single occupant vehicles are permitted in exchange for a toll payment. By paying for the privilege to reach their destinations more quickly, solo drivers using HOT lanes reduce congestion on the remaining lanes and increase revenues available for other transportation investments. On an eight-mile stretch of Interstate 15 outside of San Diego, extra HOV space is sold to solo drivers according to scarcity. Officials monitor traffic, adjust tolls, and post them on electronic readers. The price for using HOT lanes varies depending on the distance traveled and the actual or expected congestion so that constant free flow conditions are maintained. HOT drivers might pay $1.50 in moderate conditions, and $4.00 in peak hours. The tolls can rise to even higher levels during extreme peak periods (e.g., around Thanksgiving). The goal of the variable fees is to keep the lanes free-flowing while maximizing their use. On most days, about 2,500 solo drivers, nearly a quarter of HOV volume, pay to use San Diego's HOT lanes. In San Diego, about 75 percent of the vehicles using the lane are high-occupancy vehicles and 21 percent are single occupancy vehicles who pay to use the lane. Daily traffic on the HOT lanes has increased steadily since their opening in 1996.[84]

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[82] Cambridge Systematics and others, *Twin Cities Ramp Meter Evaluation* (St. Paul: Minnesota Department of Transportation, February 2001).

[83] Federal Highway Administration, *Intelligent Transportation Systems Benefits: 1999 Update.*

[84] California Legislative Analyst's Office, "HOV Lanes in California: Are They Achieving Their Goals?" January 2000.

When vehicles become disabled in highway travel lanes, they impede the flow of traffic, create hazardous driving conditions, and cause traffic jams that cost thousands of dollars in fuel and lost productivity. In response, many communities have created quick-response tow truck services that continuously patrol the highways. In Los Angeles County, the Metro Freeway Service Patrol (MFSP) has successfully kept traffic moving following breakdowns and accidents since 1991. The average response time for MFSP drivers to reach stalled vehicles is only five minutes, compared to more than 20 minutes for a private towing company. The time savings translate into significant economic benefits for the region. It is estimated that the service prevents 22 million vehicle hours of traffic delays each year, with a potential annual savings of $218 million in lost wages, sales, and productivity.[85] The Minnesota Highway Helper Program, like the MFSP, quickly dispatches tow trucks to the scene of a breakdown in order to restart or move a stranded vehicle before serious traffic tie-ups can occur. Each year, the $600,000 program helps avoid an estimated $1.4 million in delays.[86] In northern Virginia, in one recent year, the Virginia Safety Service assisted more than 200,000 disabled vehicles.[87]

Investment in public transportation also reduces congestion. In large metropolitan areas, on any given weekday, commuter trains, subways, streetcars, and buses help reduce the number of motor vehicles vying for roadway and parking spaces. Both those who use transit and those who do not save time and money. For example, a recent study examined regions with commuter rail service and analyzed benefits relating to congestion reduction, fiscal impacts, job impacts, and other impacts (e.g., reduced fuel consumption) resulting from commuter rail investment. The benefits from reduced congestion – time and fuel cost savings – ranged from $247 to $865, annually, to each commuter rail rider. Reduced metropolitan congestion due to commuter rail was also shown to result in $300 to $450 million in annual savings, at a national level, to the truck and motor freight industry.[88] The recently opened Virginia Railway Express (VRE), connecting suburban areas of Northern Virginia with job centers in Alexandria, Arlington, and downtown Washington, D.C., is already handling over 10,000 riders per day, with ridership growing by two-thirds since 1997.[89] By removing commuters from area highways, the VRE alleviates a portion of the congestion on Northern Virginia's roadways, allowing trucks and other vehicles to save time as they travel the heavily trafficked region.

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[85] "L.A.'s Metro Freeway Service Patrol Viewed as Most Successful Program for Reducing Congestion," *The Urban Transportation Monitor* (14 September 2001): 7.

[86] Federal Highway Administration, *Intelligent Transportation Systems Benefits: 1999 Update*.

[87] "Technology Improves City Transportation Flow, Safety," *Nation's Cities Weekly*, 3 July 2000.

[88] The Carmen Group, *Commuter Rail: Serving America's Emerging Suburban/Urban Economy*, 1997 as cited in Cambridge Systematics, Inc. and Economic Development Research Group, *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact* (Washington, D.C.: American Public Transit Association, October 1999).

[89] Virginia Railway Express, "VRE Ridership, July 1997-July 2001," www.vre.org/about/performance/sld001.htm.

Finally, sustainable land use strategies reduce congestion by reducing people's reliance on automobiles by reducing the distance they must travel between home, work, and shops. A project in Charlottesville, Virginia under the Transportation and Community System Preservation Pilot Program evaluated various combinations of future transportation networks and development patterns. After four scenarios were defined through a public involvement process, travel demand forecasts were conducted for each scenario. The forecasts showed that a transportation network consisting of a grid of urban streets, transit, and pedestrian and bicycle connections in conjunction with clustered development showed lower congestion levels than a dispersed land use pattern and supporting transportation network. At the same time, the capital investment cost of the urban network was estimated at roughly half the cost of the dispersed system.[90]

7.0 Transportation Investment Creates Jobs in the Transportation Sector

Lastly, transportation investment creates employment for millions of Americans. In 1999, some $980 billion worth of transport-related goods and services comprised over 10 percent of the U.S. gross domestic product. Some 4.4 million individuals were employed in the service sector as bus drivers, airline employees, dock workers, railway workers, taxicab drivers, and truck drivers (see Figure 3). Nearly two million were employed in transportation equipment manufacturing as automotive assembly line workers, aircraft manufacturers, and ship builders. And nearly 4.4 million in other related industries as automobile mechanics, gasoline service station attendants, and automotive retailers. In total, nearly 11 million individuals were employed in transportation and transportation-related industries in 1999.[91]

Employment in Transport Services by Mode, 2000

Air Transport	**1,281,300**
Public Transit	**476,200**
Railroads	**235,500**
Trucking	**1,855,600**
Water Transport	**195,800**

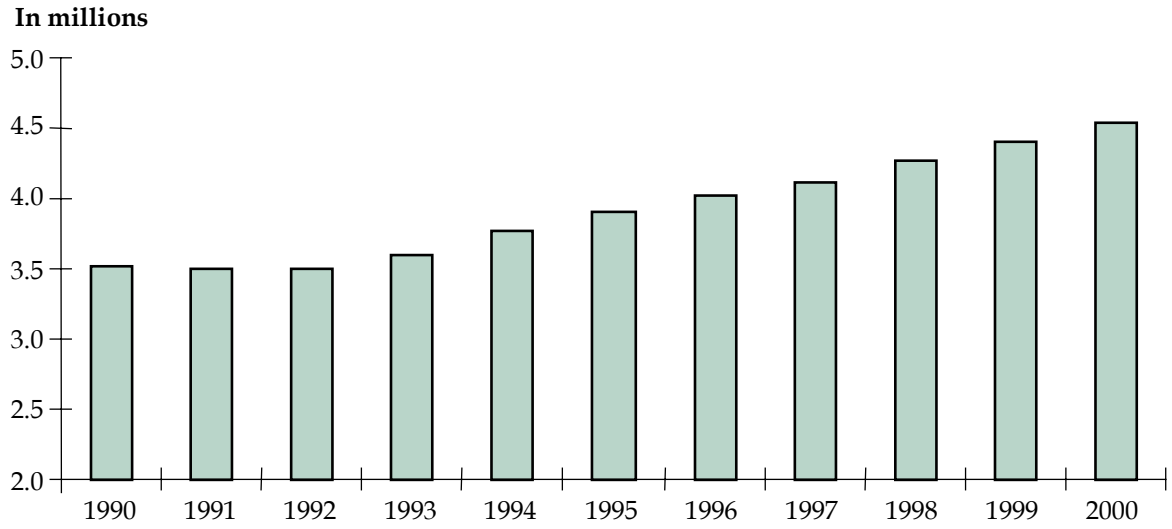
Due to its higher employment growth rate, the share of total U.S. jobs in transportation services rose from 3.2 percent in 1990 to over 3.4 percent in 2000. Although this increase may not seem significant, it does indicate that transportation services grew faster than the national economy during a period of extraordinary economic growth, overall, in the United States. Indeed, this figure includes only the "for hire" component of transportation services, for which historical data is readily

[90] Federal Highway Administration, TCSP Case Study #6, September 2001.

[91] Bureau of Transportation Statistics, *Pocket Guide to Transportation* (Washington, D.C.: U.S. Department of Transportation, 2000): 20, 24.

available. The Bureau of Economic Analysis (BEA) provides a more complete picture of transportation services' contribution to the U.S. economy by also including the contribution of "in-house" (own account) transportation services. Using these data from the BEA that are only available for 1992 and 1996, transportation services accounted for a substantially greater share – about 5.0 percent of U.S. GDP. The total number of jobs in transportation services increased by 29 percent during the 1990s, while total U.S. employment increased by just over 20 percent during the same period.[92] A strong commitment to future transport investment will ensure that this sector remains an engine of economic growth and a source of employment for millions of Americans.

Figure 3. Transportation Employment in the United States, *1990-2000*



Conclusion

Transportation plays a critical role in the U.S. economy. Well beyond its direct contributions to U.S. output, transportation's inextricable link to the functioning and competitiveness of the U.S. economy is noteworthy. The illustrations and case studies included in this working paper show clear connections correlating the nation's roadway and transit systems with productivity, property values, jobs, urban revitalization, and

[92]U.S. Department of Commerce, Bureau of Labor Statistics, Current Employment Statistics, www.bls.gov/sahome.html.

business investment. The present form and condition of U.S. transportation infrastructure and services are the results of decades of planning, investment, construction, and use. Continued investments in transportation infrastructure help maintain current levels of performance and better accommodate future economic growth. Underlining the importance of these investments, this working paper demonstrates how economic growth is impeded by increasing congestion and declines in transportation service levels. Transportation, in combination with education, utilities, technology, capital, and workforce constitutes the foundation on which the rest of the U.S. economy works. Well-directed investments to preserve and to expand the nation's transportation system will be an essential element of future economic growth.

Environmental Benefits of Transportation Investment

Working Paper #2

Working Paper #2: Environmental Benefits of Transportation Investment

Introduction

Whether we are building new transportation infrastructure or expanding existing facilities and services, a common perception exists that such activities have negative impacts on the environment. In many instances this is not the case, and the activity has provided new opportunities for environmental protection, remediation, and even enhancement. Indeed, transportation investment can benefit not only the natural environment, but the built and cultural environment.

These benefits may be divided into a number of broad categories, each of which will be discussed in more detail in this paper.

1. **Transportation investment can improve air quality and energy efficiency –** Investments in clean vehicle technology, clean fuel technology, and congestion relief projects can reduce emissions and contribute to energy efficiency. Investments in ridesharing programs, transit, pedestrian, and bicycle facilities can reduce vehicle miles traveled.

2. **Transportation investment can reduce noise pollution –** New automobiles are far quieter than their predecessors thanks to advances in engine technology. Erecting "green" roadway sound barriers can muffle the sound of passing vehicles.

3. **Transportation investment can protect wetlands and safeguard clean water supplies –** Wetlands mitigation programs can ensure that the total acres of wetlands lost to new transportation projects is less than the number of new wetland areas created elsewhere. Controlling storm water runoff and soil erosion near roadways can reduce groundwater contamination.

4. **Transportation investment can reduce light pollution –** Installing fully shielded, full cutoff streetlights can not only save energy and reduces unwanted glare on roadways, it can help ensure our view of the night sky is not lost to sky glow.

5. **Transportation investment can help reclaim brownfields and provide a market for recycled materials –** Brownfields – polluted and abandoned industrial sites – are being cleaned up and rehabilitated for use as intermodal centers and other transportation-related facilities. The transportation industry uses a high percentage of recycled products, from asphalt cement to household plastics.

6. **Transportation investment can provide historic and ecological preservation benefits –** Transportation projects are subjected to rigorous state and federal environmental analyses, including archeological research that can broaden our understanding of North American history and prehistory. Moreover, responsible transportation investment need not adversely impact wildlife and ecosystems. Through mitigation measures such as ecoduct construction, the effect of new transportation projects on the natural environment can be minimized.

A sense of environmental stewardship is guiding the decisions of transportation departments across the U.S., with positive benefits for both the environment and the nation's transportation system.

1.0 Reduced Air Pollution and Improved Energy Efficiency

The nation's air quality has improved considerably in the past 30 years, due in part to a reduction in motor vehicle emissions. Cars and trucks today run cleaner than ever before and emit significantly lower levels of carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOC, also called hydrocarbons, or HC). The introduction of unleaded gasoline has meant that emissions of lead have dropped to virtually zero. Tremendous strides in engine technology mean that the average car today produces 60 to 80 percent less pollution than the average car did in the 1960s. Overall, CO emissions from on-road vehicles fell 43 percent between 1970 and 1999. In contrast, CO emissions from non-transportation sources declined only 11 percent. VOC emissions fell 59 percent, twice as fast as non-transportation VOC sources. Only NOx emissions have increased, but by a modest 16 percent (see Figures 1 through 4).[1]

Tremendous strides in engine technology mean that the average car today produces 60 to 80 percent less pollution than the average car did in the 1960s.

These statistics are all the more impressive in light of three distinct trends. First, since 1970, vehicle miles traveled increased 140 percent – four times faster than the population. Second, congestion has worsened in areas of every size across the nation. Because vehicle emissions rise sharply when speeds fall below 20 mph, increased congestion often means increased pollution. Third, motor vehicle fuel efficiency has remained unchanged over the past decade. Since 1991, it has, in fact, declined.[2]

[1] Environmental Protection Agency, Office of Transportation and Air Quality, http://www.epa.gov/otaq.

[2] In 1999, the U.S. highway vehicle fleet (including all cars, light trucks, and heavy trucks) averaged 16.8 miles per gallon, less than five miles per gallon better than it averaged a half century earlier. Energy Information Administration, *Annual Energy Review 2000* (Washington, D.C.: U.S. Department of Energy, August 2001), 57.

Figure 1. On-Road Vehicle Carbon Monoxide Emissions

1970-1999

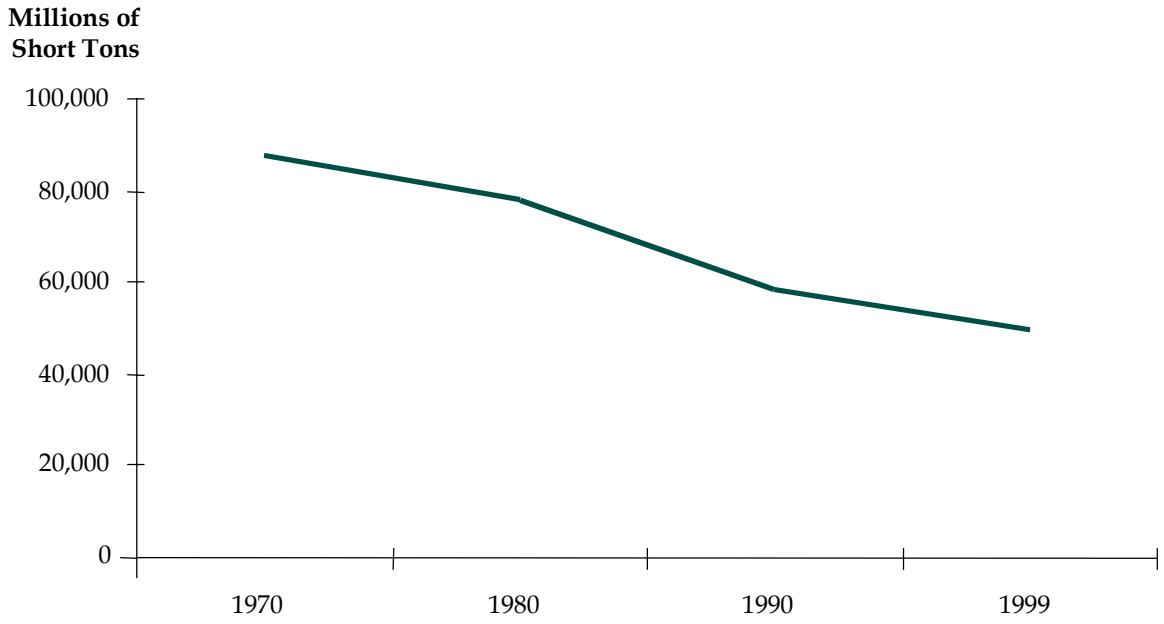


Figure 2. On-Road Vehicle Lead Emissions

1970-1999

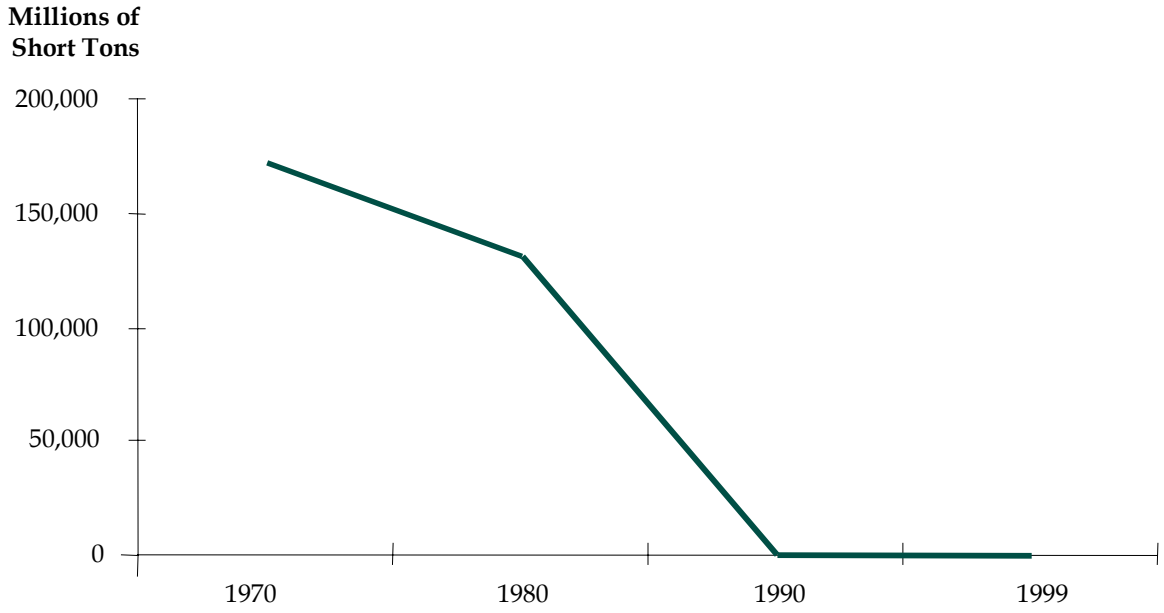


Figure 3. On-Road Vehicle Nitrogen Oxide and Volatile Organic Compounds Emissions

1970-1999

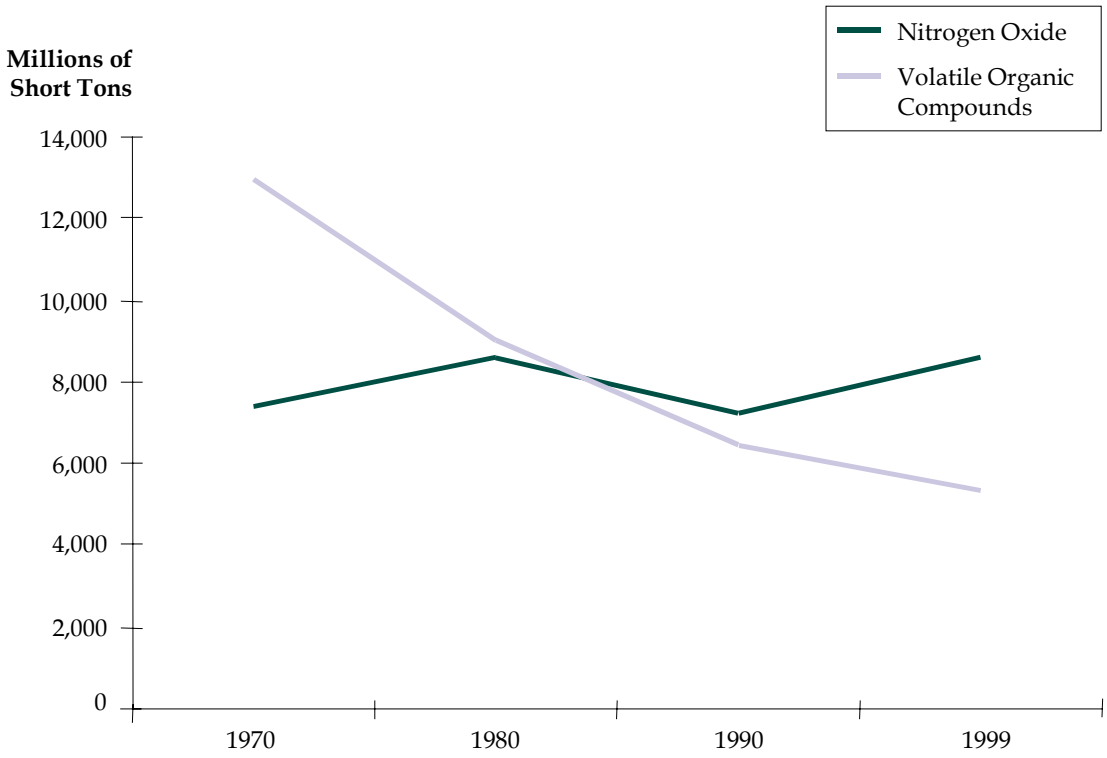
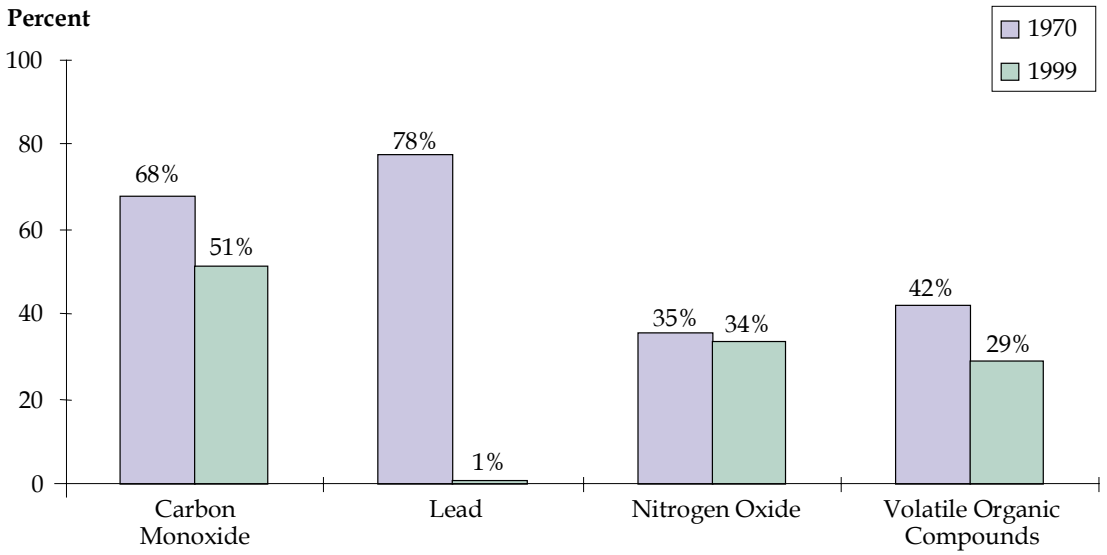


Figure 4. On-Road Vehicle Pollutant Emissions as a Percentage of U.S. Total

1970-1999



Continued investment in transportation is needed to ensure that the strong gains continue. Fuel combustion – mainly gasoline – is responsible for emissions of 70 percent of smog precursors and for 90 percent of carbon monoxide in urban areas.[3] In fact, 39 percent of the U.S. population lives in "non-attainment" areas, areas that fall below the standard set by the National Ambient Air Quality Standards for one or more of six criteria pollutants. Ground-level ozone (O_3) is chief among these, formed from a combination of NOx, VOCs, and sunlight.[4]

Transportation is also an important contributor to carbon dioxide (CO_2) emissions, since CO_2 is the product of gasoline and diesel fuel combustion. Carbon dioxide does not directly impair human health, but accounts for 83 percent of greenhouse gas emissions. Greenhouse gases trap the earth's heat and contribute to global climate change. While transportation-related CO and VOC emissions have fallen, CO_2 emissions have risen due to increased demand for gasoline and diesel fuel. Today, transportation-related activity accounts for one-third of total CO_2 emissions in the U.S. In 2000, transportation produced 515 million metric tons of CO_2, a roughly 50 percent increase over 1970 levels.[5] The Energy Information Administration predicts that in the coming years transportation sector CO_2 emissions will grow faster than residential, commercial, and industrial sector CO_2 emissions.[6]

Transportation investment can help reduce air pollution and improve energy efficiency in a number of ways. In many cities, transportation investment is hastening the change to vehicles that run on clean alternative fuels such as compressed natural gas (CNG). For example, the Los Angeles County Metropolitan Transit Authority is overhauling its entire bus fleet, systematically replacing old diesel buses with clean-burning natural gas buses. With over 1,000 CNG buses in operation, and another 1,000 to be delivered by 2004, the LACMTA boasts the nation's largest CNG bus fleet. Placing one CNG bus into service is the equivalent of removing the exhaust of 7.2 automobiles.[7] CNG buses produce less NOx, CO, and particulate matter than conventional diesel buses.

Placing one CNG bus into service is the equivalent of removing the exhaust of 7.2 automobiles.

In New York City, where taxis account for 10 percent of all vehicle miles traveled, a new Alternative Fuels Taxicab Program provides financial incentives for taxi owners to adapt their vehicles to run on CNG or to purchase new CNG vehicles. Taxi owners can bring

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[3] Transportation Air Quality Center, *Transportation Control Measures: Telecommuting* (Washington, D.C.: U.S. Environmental Protection Agency, July 1998), 1.

[4] Bureau of Transportation Statistics, *The Changing Face of Transportation* (Washington, D.C.: U.S. Department of Transportation, 2000): I-22.

[5] Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000* (Washington, D.C.: U.S. Department of Energy, November 2001), 21.

[6] Energy Information Administration, *Annual Energy Outlook 2001 with Projections to 2020* (Washington, D.C.: U.S. Department of Energy, December 2000), 97.

[7] Los Angeles County Metropolitan Transportation Authority, *MTA's State of the Bus System Report*, March 2001, available at http://www.mta.net as of September 2001.

their conventional vehicles to a certified conversion shop for conversion to a bi-fuel vehicle. In exchange for signing a statement promising to operate the vehicle exclusively on natural gas, the owner is reimbursed for the cost of the conversion. Alternatively, the owner can purchase a dedicated CNG vehicle and be reimbursed for the difference – about 6,000 dollars – compared to a conventional gasoline taxi. About 80 percent of the cost of reimbursement comes from the CMAQ Program, with the remaining 20 percent paid by private partners. As a result of the Alternative Fuels Taxicab Program, 300 CNG vehicles were operating in New York City by 1999, resulting in an annual reduction of over 18 tons of VOC and seven tons of NOx.[8] CNG-powered vehicles have another advantage over their gasoline-powered counterparts: On average, they emit almost 30 percent less CO_2 per mile traveled.[9]

Increasing average arterial speeds from 10 to 20 mph reduces HC emissions by roughly 40 percent and NOx emissions by roughly 20 percent.

Congestion relief measures on highways and at busy intersections and toll plazas can smooth the flow of traffic and reduced tailpipe emissions. Research has shown that hard acceleration and deceleration causes emissions to rise sharply. Moreover, studies by the Environmental Protection Agency suggest that increasing average arterial speeds from 10 to 20 mph, for example, reduces HC emissions by roughly 40 percent and NOx emissions by roughly 20 percent. Implementation of the EZ-pass electronic toll collection system on the New Jersey Turnpike in 2000 was estimated to reduce HC and NOx emissions on a typical weekday by 0.35 tons and 0.056 tons, respectively, as a result of reduced queuing and increased, steady speeds.[10] For more on the benefits of congestion reduction, see Working Paper 4, *The Benefits of Reducing Congestion*.

"[San Diego's vanpool program] is an excellent program which benefits the county, city, and the employees. It relieves freeway congestion, thereby reducing pollution. Vanpools provide a fast, comfortable, and reliable way to get to work for many individuals."

– Erlinda S. Soriano
San Diego vanpooler

Transportation investment can encourage environmentally-friendly modes of transport such as ridesharing, transit use, bicycling, and walking. Ridesharing reduces both congestion and vehicle miles traveled. A number of state, regional, and local incentives have been developed and funded in recent years to encourage ridesharing, and to encourage employers to promote ridesharing among their employees.

[8] Transportation Air Quality Center, *Creating Transportation Choices: Congestion Mitigation and Air Quality Improvement Program Success Stories* (Washington, D.C.: U.S. Environmental Protection Agency, August 1999): 19–20.

[9] Federal Highway Administration, *Transportation and Global Climate Change: A Review and Analysis of the Literature* (Washington, D.C.: U.S. Department of Transportation, 1997), 79.

[10] Wilbur Smith Associates, *Operational and Traffic Benefits of EZ-Pass to the New Jersey Turnpike, Executive Summary* (20 August 2001), available at the New Jersey Turnpike Authority web site, http://www.state.nj.us/turnpike, as of September 2001.

These incentives include area-wide commute organizations (or "third-party" agencies) that provide carpool and vanpool matching services, and state and local tax credit and subsidy programs. Federal funding, channeled through the states, has often come from the Congestion Mitigation and Air Quality (CMAQ) Program, a federal program created under the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. California has one of the most comprehensive set of tax incentives in the nation to encourage ridesharing. Employees receive a personal exemption of rideshare costs from gross income for carpooling, buspooling, and mass transit use, and a tax credit for non-employer-sponsored vanpool expenses. Employers receive a deduction or tax credit for a number of allowable expenses, including vanpool subsidies and the purchase of company buses or vans.[11]

Transit investments can also reduce air pollution. In St. Louis, the construction of a new light rail line in 1993 has reduced vehicle miles traveled by as much as 139,100 miles per day, translating into a daily savings of 7,130 gallons of fuel. During its first year of operation, the new line was estimated to have reduced carbon emissions by 4,500 to 9,600 metric tons. Because it is powered by electricity, the St. Louis light rail system is quiet, efficient, and exhaust-free.[12] In the Northeast Corridor, electrification of the main rail line between Boston and New Haven in 2000 allowed for faster intercity rail service. Amtrak ridership between Boston and Washington, D.C. is increasing steadily as new, high-speed Acela train sets are introduced. The Federal Railroad Administration estimates that as a result of this project, emissions of CO and VOC in the Northeast Corridor will fall by five percent, while NOx emissions will fall by 15 percent. These reductions come not only as a result of the switch from diesel to electric traction, but as a result of diversion from other, more polluting modes of travel.[13]

In St. Louis, the construction of a new light rail line in 1993 has reduced vehicle miles traveled by as much as 139,100 miles per day, translating into a daily savings of 7,130 gallons of fuel.

Transportation investment designed to encourage cycling for the purposes of commuting and running short errands can help reduce pollution and greenhouse gas emissions, since a bicycle is a zero-emissions vehicle. In 1995, just 0.9 percent of all trips were taken by bicycle. Yet according to a Harris survey, 17 percent of adults would sometimes bicycle to work if secure storage and changing facilities were available, 18 percent would bicycle commute if they were offered a financial incentive to do so, and 20 percent would bicycle commute if they could ride on safe bike lanes. Even with the relatively limited investment that has taken

According to a Harris survey, 20 percent of adults would sometimes bicycle to work if they could ride on safe bike lanes.

[11] Transportation Air Quality Center, *Transportation Control Measures: Commute Alternative Incentives* (Washington, D.C.: U.S. Environmental Protection Agency, July 1998): 1–8; Transportation Demand Management Institute, *TDM Case Studies and Commuter Testimonials* (Washington, D.C.: Association for Commuter Transportation, August 1997).

[12] Transportation Air Quality Center, *Transportation Control Measures: Improved Public Transit* (Washington, D.C.: U.S. Environmental Protection Agency, July 1998), 5.

[13] Federal Railroad Administration, *Intercity Freight and Passenger Rail: State and Local Project Reference Guide* (Washington, D.C.: U.S. Department of Transportation, April 2001).

place over the past 30 years, cycling – not just as a recreational activity but as a viable commuting mode – has grown steadily in popularity. Between 1977 and 1995 the number of person trips made by bicycle increased 30 percent.[14]

"I ride my bike 12 miles to meet the bus I take to my office. Why do I do it? For fitness, to reduce wear and tear on my car, and to lessen pollution. I'm doing it, too, for the kids who will be inheriting the planet. I want to do my part."

– Owen Barry
New Jersey bicycle commuter

One of the most ambitious programs in the nation designed to increase bicycle mode share is New York City's Bicycle Network Development project. Using CMAQ funds, the New York City Department of City Planning and the Department of Transportation are building a 900-mile city-wide bike network. The network includes on-street bike lanes as well as off-street dedicated bike paths, and focuses especially on river bridge crossings, transit access, and bike parking. Since the project's creation in 1994, cycling in Manhattan has increased 15 to 20 percent, translating into an annual emissions reduction of 45 tons of VOC and nearly 50 tons of NOx. In 1999, the Bicycle Network Development project won the Federal Highway Administration's Environmental Excellence Award for Non-Motorized Transportation.[15]

Investment in pedestrian facilities to make walking a safer and more attractive mode of transport has similar benefits. We all make at least part of every trip on foot, after all, even if it is only from our parked car to a shop on the other side of the street. The quality of the pedestrian environment therefore effects everyone. Pedestrian investment takes a number of forms: wide sidewalks, traffic lights that give pedestrians a "WALK" signal without requiring excessive waits, clearly painted "zebra stripe" crosswalks at intersections, benches, shade trees, good lighting and other streetscape amenities make walking enjoyable. Traffic calming devices such as speed tables, raised or textured crosswalks, chicanes, miniature traffic circles, and tight intersection curb radii that encourage cars to slow down as they round the corner also constitute investments with important pedestrian benefits.

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[14]Don Pickrell and Paul Schimek, *Trends in Personal Motor Vehicle Ownership and Use: Evidence from the* Nationwide *Personal Transportation Survey* (Cambridge: U.S. DOT Volpe Center, 23 April 1998): 10; Tod Litman, *Quantifying the Benefits of Non-Motorized Transport for Achieving TDM Objectives* (Victoria, BC: Victoria Transport Institute, 1999): 9; U.S. Environmental Protection Agency and U.S. Department of Transportation, The Commuter Choice Initiative National Standard of Excellence.

[15]Transportation Air Quality Center, *Creating Transportation Choices: Congestion Mitigation and Air Quality Improvement Program Success Stories* (Washington, D.C.: U.S. Environmental Protection Agency, August 1999): 21–22; Transportation Demand Management Institute, *TDM Case Studies*.

2.0 Reduced Noise Pollution

Transportation investment can reduce noise pollution. Since the 1970s, highway noise has been mitigated as a result of quieter engines, better vehicle mufflers, and the construction of roadside noise barriers. Noise barriers reduce noise levels by five to 10 decibels, cutting the loudness of traffic noise by as much as 50 percent. A 10-decibel reduction makes the sound of a passing tractor trailer no louder than that of a passing automobile. Sound barriers are most effective within 200 feet of a highway – typically the first row of homes. Studies have shown that, contrary to popular opinion, a sound barrier constructed on one side of a highway only does not increase noise levels perceptibly on the other side of the highway.[16]

Since 1970, 44 states and the Commonwealth of Puerto Rico have constructed over 1,600 miles of noise barriers at a cost of over 1.9 billion 1998 dollars.

Since 1970, 44 states and the Commonwealth of Puerto Rico have constructed over 1,600 miles of noise barriers at a cost of over 1.9 billion 1998 dollars. The pace of noise barrier construction is increasing; nearly a third of total expenditures have occurred since the mid-1990s. Noise barriers usually take the form of walls up to 25-feet high, made from a variety of materials including concrete, masonry block, wood, metal, and brick. For aesthetic purposes, a combination of materials may be used or the wall may be textured or decorated with murals.[17] This was the case with a 1.5-mile noise barrier along Highway 47 near Pueblo, Colorado. Local artists worked closely with transportation officials to design a wall that was both functional and visually pleasing.[18] Similarly, a noise barrier constructed parallel to the new Pima Expressway through Scottsdale, Arizona boasts Southwestern themes such as 40-foot purple lizards and giant cactus.[19] Plantings may be added in front of a wall to make it more attractive and to further reduce noise levels. Sound barriers may also be built of earth mounds or "berms." These are somewhat more effective than walls at blocking sound, but require a larger right-of-way.

"I was trying to tie it [the Highway 47 noise barrier] in with the environment, rather than have it be something that would conflict with the environment."

– Judith Williams
Pueblo, Colorado artist

Investment in electric vehicle technology can also reduce noise pollution. Electric trolleybuses, for example, such as the ones operated in Dayton, Ohio, produce 22 to 25 fewer decibels than conventional diesel buses. This means that a passing trolleybus is

[16] Federal Highway Administration, *Keeping the Noise Down: Highway Traffic Noise Barriers* (Washington, D.C.: U.S. Department of Transportation, February 2001).

[17] Federal Highway Administration, *Highway Traffic Noise Barrier Construction Trends* (Washington, D.C.: U.S. Department of Transportation, April 2001), 1–2.

[18] Malcolm Howard, "The Great Wall Debate," *Colorado Springs Independent*, 16 December 1999.

[19] Kim Sorvig, "A Sound Solution?" *Planning* (April 2001): 12.

roughly two to three times quieter than a passing diesel bus.[20] Similarly, Amtrak's new electric Acela trains are far quieter than the diesel-powered trains they replaced Between Boston and New Haven.

Other railway noises have been mitigated as a result of EPA noise standards. These apply to the operation of locomotives and rail cars in motion as well as to four major rail yard noises: locomotive load cell test stands, switcher locomotives, car coupling operations, and retarders. Rubber mats placed between the tracks at grade crossings also help reduce noise. But for many Americans, the most serious form of railway-related noise pollution is the sudden blast of a locomotive whistle and the clang of warning bells as a train approaches a grade crossing. Because studies have shown that the likelihood of a road-rail accident increases 62 percent when whistles are not sounded, the practice is a sensible one. However, investment in a variety of supplemental grade crossing safety measures, such as median barriers, four-quadrant gates, and vehicle proximity alert systems can allow communities the option of establishing "quiet zones."[21]

3.0 Wetlands Protection and Reduced Water Pollution

Transportation investment can help protect wetlands. In the 1970s, some 450,000 acres of wetlands were being lost each year, primarily to agricultural activity. Today, wetlands loss has been reduced to 50,000 acres per year, less than 10 percent of which is estimated to be from highway construction activities. However, the Federal-Aid Highway Program is actually creating 2.5 acres of wetlands for every acre it takes for road construction. This has resulted in a net gain of 11,628 acres of wetlands nationwide since 1996.[22]

One recent wetlands mitigation project carried out in Wayne County, Michigan, has been awarded a Design For Transportation National Merit Award by the U.S. DOT. In the mid-1990s, to replace wetlands lost to the expansion of the Detroit Metropolitan Wayne County Airport, a much larger wetland totaling nearly 1,000 acres was created. Pre-existing natural features were used in order to increase the likelihood that a viable, sustainable natural habitat would emerge. Dams were built, drains were redirected, basins were dug, thousands of tons of dirt were moved, and wetlands plants were introduced in a process that took over a year. The result was Crosswinds Marsh, which today blends several types of habitats and is home to 172 species of plants, 25 species of birds, 11

[20] Kevin Brown, *The Benefits of Clean, Quiet, Emission-Free Transit Service: Promoting the Trolleybus in Vancouver* (Vancouver, BC: The Tbus Group, February 2001).

[21] Federal Railroad Administration, *Intercity Freight and Passenger Rail: State and Local Project Reference Guide* (Washington, D.C.: U.S. Department of Transportation, April 2001); "Crossing Equipment Options: High-tech, Low-tech, No-Tech,: *Railway Age* (November 1996): 41.; Kristi Matoba, "Grade Crossings: A Look at the Future," *Railway Track and Structures* 96 (June 2000): 63.

[22] Bureau of Transportation Statistics, *The Changing Face of Transportation* (Washington, D.C.: U.S. Department of Transportation, 2000): I-25.

species of fish, and 28 species of mammals. A variety of low-impact recreational activities are now permitted in Crosswinds Marsh, including hiking, horseback riding, canoeing, and fishing, and the area is used as an outdoor classroom by elementary schools, high schools, and universities.[23]

The Beach Lake Mitigation Bank, located in the Stone Lake National Wildlife Refuge in Rancho Cordova, California, includes 90 acres of wetland and riparian woodland that have been restored to provide mitigation credits for future transport projects. This facilitates new projects and eliminates the need for a piecemeal approach to mitigation construction and monitoring. In Duluth, Minnesota, 2.5-acre park located on top of Interstate 35 is home to one of the few formal English Rose Gardens in the United States. The Leif Ericson Park Rose Garden contains 99 varieties of rose bushes and 2,000 plants, as well as trees, shrubs, and other flowers. It provides open space with a dramatic view of Lake Superior.

In Newport News and Norfolk, Virginia, the construction of nesting boxes for endangered peregrine falcons permitted the Virginia DOT to perform much-needed construction and maintenance work on the James River and Berkeley Bridges, while providing an environment for the birds that is both safer and more conducive to breeding. In 1998, the Beach Lake Mitigation Bank, the Leif Ericson Park Rose Garden, and the falcon nest boxes each received an FHWA Excellence in Highway Design Award under the category of Environmental Protection and Enhancements.[24]

The Federal-Aid Highway Program is creating 2.5 acres of wetlands for every acre it takes for road construction.

Transportation investment can also safeguard water quality by reducing pollution from storm water runoff from roadways and parking lots. Because these surfaces are impermeable, pollutants that collect on their surface can be washed into nearby lakes, ponds, and drinking water reservoirs. Parking lot runoff is especially harmful to the environment: A one-acre parking lot produces 16 times more runoff than a one-acre meadow, and usually contains more pollutants than runoff from other forms of impermeable cover because parked cars often drip fluids. Recent studies show that by channeling and filtering the water as it runs off the pavement, the most harmful pollutants can be removed before they enter the water supply. Open, natural drainage systems constructed or planted along the sides of roadways – detention and sediment basins, vegetated buffer strips, marshes, and ponds – have proven to be the most effective.

[23] *Design for Transportation National Awards 2000* (Washington, D.C.: U.S. Department of Transportation, 2000): 42; "Wayne County's Crosswinds Marsh Wins National *Design For Transportation* Award," press release dated 12 June 2000, available at http://www.waynecounty.com/airport as of September 2001.

[24] *Excellence in Highway Design 1998 Biennial Awards* (Washington, D.C.: Federal Highway Administration, 1998).

For example, field tests of a natural drainage system along a roadway near Orlando, Florida showed significantly reduced pollution runoff during a single season of large storms. Runoffs of suspended solids, lead, zinc, phosphorous, and nitrogen were found to have decreased between 59 percent and 91 percent on average.[25] In northern Virginia, similar benefits have been documented along State Route 7 at Goose Creek thanks to the construction of swales – vegetated depressions adjacent to roadways that provide storm water drainage and filtration. Field testing of a 275-meter long swale during the summer of 1997 revealed that 94 percent of suspended solids and 99 percent of total phosphorous flowing from the roadways during heavy rain were prevented from entering the groundwater.[26] In Austin, Texas, two vegetated strips treating highway runoff were also monitored to test their pollution removal effectiveness. In this instance, 85 percent of total suspended solids were removed, as well as significant percentages of other contaminants including zinc, iron, phosphorous, and lead.[27]

Field tests of a natural drainage system along an Orlando roadway showed decreases in runoffs of suspended solids – lead, zinc, phosphorous, and nitrogen – on the order of 59 to 91 percent.

Use of porous surfaces in transportation construction can also improve water quality by allowing contaminated rainwater to pass through the pavement and be absorbed by the soil below. Sidewalks, walkways, driveways, small parking areas, and low-volume roads can be constructed of lattice blocks or bricks set in sand, permitting water to pass through. For larger parking lots and somewhat higher traffic volume roadways, a porous layer of asphalt can be applied atop a stone reservoir. The rainwater passes through the asphalt, collects in the reservoir, and slowly percolates into the soil beneath. Porous surfaces filter sediment, trace metals, and other pollutants from the roadways before they contaminate nearby water supplies. They also provide roadside vegetation, urban street trees in particular, with a source of water. Because porous surfaces lack the strength and durability of conventional pavement, however, they are not suitable for use on major roadways.[28]

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[25] Environmental Protection Agency, *Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality* (Washington, D.C: U.S. Environmental Protection Agency, January 2001): 52–53.

[26] Jan-Tai Kuo, Shaw L. Yu, Elizabeth A. Fassman, and Henry Pan, "Field Test of Grassed Swale Performance in Removing Runoff Pollution," *Journal of Water Resources Planning and Management* 127 (May 2001): 161–71.

[27] M. E. Barrett, M. V. Keblin, P. M. Walsh, J. F. Malina Jr., and R. J. Charbeneau, *Evaluation of the Performance of Permanent Runoff Controls: Summary and Conclusions*, Center for Research in Water Resources Online Report 97-3 (Austin: University of Texas at Austin, 1997), 33.

[28] Environmental Protection Agency, *Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality* (Washington, D.C: U.S. Environmental Protection Agency, January 2001): 51–52.

4.0 Reduced Light Pollution

Excessive or misdirected lighting from streetlights and other man-made sources produces unwanted glare, light trespass, and uplight while using money, energy, and natural resources. Most seriously, it is threatening to obliterate forever our view of the heavens. Americans living in large cities have already been deprived of a view of a star-filled sky that humans enjoyed for thousands of years. For professional astronomers, the problem is particularly serious because many of the discoveries that advance the frontiers of their science require dark skies free of urban sky glow. Mount Wilson Observatory in Southern California is already in jeopardy. Fully 99 percent of people living in the continental U.S. never see a truly dark sky from where they live.

To reduce light pollution and lighting-associated energy costs, many transportation agencies can invest in better designed lighting fixtures that achieve a higher degree of lighting control. Poor quality existing fixtures are being replaced or retrofit, often with energy efficient low-pressure sodium fixtures. All new streetlights must be full cutoff with no direct uplight and little sideways light that can cause glare. The city of Tucson, 55 miles northeast of Kitt Peak National Observatory, converted from mercury vapor to sodium lights and installed downward-facing fixtures on 40,000 streetlights. Fifty other communities surrounding Kitt Peak have taken similar measures. As a result, urban sky glow visible from the observatory is abating and municipal power costs have been reduced. Despite the absence of a prominent observatory, the state of Maine passed legislation requiring that streetlights financed by the state be fully shielded and projected downward to prevent light trespass. Because lower wattage bulbs can be used to achieve the same roadway illumination, the Maine law is saving energy and taxpayer dollars. In all, six states have legislation limiting the use of outdoor lighting: Arizona, Colorado, Connecticut, Maine, New Mexico, and Texas.[29]

"We often light as if we were trying to water a flower pot with a lawn sprinkler."

– The International Dark Sky Association

5.0 Brownfields Reclamation and Recycling

A number of brownfields have been cleaned up and reused for transportation-related purposes, breathing new life into abandoned industrial sites spurned by private developers. The Environmental Protection Agency defines brownfields as "abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is

[29] International Dark Sky Association Information Sheet 1 (May 1996) and 60 (June 1999), available at http://www.darksky.org/ida/index.html as of September 2001.

complicated by real or perceived environmental consequences."[30] Because of the costs and liabilities associated with brownfield reclamation, site owners, developers, and lenders often avoid investing in them. As a result, the General Accounting Office estimates that in 1995 there were between 13,000 and 450,000 brownfields in the U.S.[31] Yet some transportation agencies have not shied away from returning brownfields to productive use. In the late 1990s, for example, three Massachusetts transportation agencies invested more than 35 million dollars to help transform a 245-acre site from a contaminated industrial wasteland to a thriving transportation, retail and office center. The site, located in Woburn, 10 miles north of Boston, had for more than a century been home to chemical concerns, leather tanneries, and manufacturing sites that left behind highly toxic soil contaminants including arsenic, chromium and lead. By the early 1980s, the site was given Superfund status and ranked among the most contaminated sites in the nation. Today, the site features a new Interstate 93 interchange and a regional transportation center. The new interchange is providing much-needed relief to the extremely congested I-93/I-95 (Route 128) interchange, one mile to the south. The 2,400 space transportation center provides a convenient, secure location for commuters to switch to carpools, vanpools, buses and trains and is helping the Massachusetts into compliance with the Clean Air Act. The public investment in the site spurred private development, resulting in more than 750,000 square-feet of hotel, retail, and office development in what was only a decade ago a highly undesirable location.[32]

In 1993, a Metrolink station was opened in the St. Louis suburb of Wellston, Missouri on a contaminated parcel of land once occupied by an electric utility company. The station quickly became a magnet for a variety of commercial and residential development projects, giving a much-needed boost to a faded city that had lost 60 percent of its population since the end of World War II. A 120,000-square-foot educational and training center, the Cornerstone Project, was first on the scene, occupying one of the former electric company buildings. A much larger technology park, including 825,000 square-feet of industrial space, 20,000 square-feet of retail space, and about 50 homes is now under construction on an adjacent 100-acre parcel. The park is anchored by four companies: Moog Automotive, General Electric, Interglobal (a specialty lighting manufacturer), and ViJon (a health and beauty care products manufacturer). This latter company has constructed a new gate to provide easier access to the Metrolink station.[33]

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[30] Environmental Protection Agency, Office of Solid Waste and Emergency Response, Brownfields Initiative quick-reference fact sheet, April 1996.

[31] U.S. General Accounting Office, *Community Development: Reuse of Urban Industrial Sites* (Washington, D.C.: U.S. Government Printing Office, June 1995).

[32] Massachusetts Highway Department, Massachusetts Port Authority, Massachusetts Bay Transportation Authority, "Transportation Investments Support Re-Development of Superfund Site in Woburn, MA." unpublished paper.

[33] Ann Eberhart Goode, Elizabeth Collaton, and David Smallen, *Brownfield Redevelopment and Transportation Policy* (Washington, D.C.: Northeast-Midwest Institute, undated), 10.

The transportation industry has long used recycled materials for highway construction. Waste products from oil refining are used in asphalt cement, while fly ash, fine particles of ash resulting from the combustion of coal, helps improve the quality and durability of Portland cement concrete. Additionally, 80 percent of asphalt removed during road widening and resurfacing projects is recycled each year.[34] The transportation industry also purchases a number products made from recycled materials, thereby saving money and providing new uses for a variety of cast-off household goods from empty plastic milk jugs to old tires. Recycled transportation products include channelizers (barrels or drums that direct traffic around areas of road repair or construction), delineators (temporary road markers that come in many shapes and sizes), parking stops (used in parking lots to keep vehicles from rolling beyond a designated parking area), traffic barricades, and traffic cones. For example, between 1993 and 1997, the states of Indiana, Maine, Massachusetts, Michigan, New Jersey, New York, Vermont, and Wisconsin collectively purchased 50,000 recycled-content traffic cones for highway and tunnel construction and airport use. The Kentucky Department of Highways purchased 3,000 flexible delineators in 1994, while the Texas Department of Transportation uses recycled-content channelizers on highways across the state.[35]

Eighty percent of asphalt removed during road widening and resurfacing projects is recycled each year.

6.0 Historic and Ecological Preservation Benefits

Transportation investment that acknowledges the unique history, architecture, and ecology of a site can ensure that historic structures, archeological remains, and wildlife habitats are preserved. Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of their undertakings on any "district, site, building, structure, or object that is included in or is eligible for inclusion in the National Register."[36] This means planners and developers must be careful to avoid damaging or destroying objects of archaeological or historic significance in the path of new transportation facilities. As a result, departments of transportation across the country employ a growing army of cultural resource specialists to survey proposed sites, determine their historical significance, and remove artifacts from the ground for safe keeping in museums.[37]

[34] American Road and Transportation Builders Association, *The Untold Story: Transportation and the Environment*, Washington, D.C., undated.

[35] Environmental Protection Agency, *1997 Buy-Recycles Series Transportation Products* (Washington, D.C.: U.S. Environmental Protection Agency, November 1997).

[36] National Historic Preservation Act of 1966, Section 6."

[37] Deborah Selinsky, "They Dig it When the Past Gets in the Future's Way," *Business North Carolina* 19 (September 1999): 18.

For example, on behalf of the Wyoming Department of Transportation, the Office of the Wyoming State Archeologist is excavating a site north of Laramie on the banks of Plumbago Creek and adjacent to State Highway 34. The site shows evidence of human habitation from Paleoindian through Late Prehistoric times, including chipped stone tools, flaking debris, and faunal remains.[38] Another Paleoindian site has been uncovered in the Brook Run area of Culpepper County, Virginia, by Virginia Department of Transportation archeologists. Tools made from jasper dating to 9500 BCE have been unearthed at the site, which was discovered in 1998 during the course of a cultural resources survey along Route 3. The highway will be widened to four lanes in 2006.[39] In Tucson, excavations conducted on a 12-acre archaeological site within an Arizona DOT right-of-way have uncovered over 60 houses from a large Hohokam village (600–1150 CE), as well as artifacts that date to the Early Ceramic period (100–600 CE) and the Early Agricultural period (1200 BCE–100 CE).[40] In Fort Meyers, Florida, a dig undertaken as part of a Florida DOT project to upgrade the approaches to the new Edison Bridge has yielded the remains of a U.S. military cemetery. On the site of Forts Harvie and Myers, which stood between 1841 and 1865, some 20 burial features were identified, and the partial remains of 17 individuals exhumed.[41]

TE-Funded Historic Preservation Projects (in millions)

Facility Type	Federal Funding	Number of Projects
Rehabilitation of active rail depots/intermodal centers	$117.1	177
Historic bridges	78.5	246
Historic streetscapes	67.0	236
Historic byways and tourism	118.7	360
Other historic transport facilities	231.7	581
Community revitalization	89.5	311
Archaeological planning	18.6	100

[38]Julie Frances, "Wyoming Archeology Awareness Month," available at http://www.cr.nps.gov/aad/statearc/wyoming/wyom99d.htm as of September 2001.

[39]Virginia Department of Transportation, "Brook Run Archeological Site One of the Earliest in North America," available at http://www.vdot.state.va.us/info/brookrun.htm as of September 2001;

[40]"Arizona DOT Projects Preserve History, Save Money," AASHTO web site document, available at http://transportation.org/aashto/success.nsf/allpages/AZPreservingHistory as of November 2001.

[41]Florida Department of Transportation, "Environmental Management Office Publication Abstracts," available at http://www.dot.state.fl.emo/pubs/abstract.htm as of September 2001.

Transportation investments can help ensure the more recent historical record remains intact as well. The Transportation Enhancements (TE) program in particular has helped fund the preservation and rehabilitation of numerous historic rail depots, historic bridges, historic streetscapes, historic byways, and other historic transport facilities such as canals, urban trolley systems, unused railroad corridors, waterfronts, rail infrastructure, and lighthouses.[42]

"The alarm went off when they came through here [Brook Run]…. Instead of finding one or two artifacts, they were getting 300 artifacts."

– Eric Voigt
Senior archaeologist,
Louis Berger

For example, a turn-of-the-20th-century railroad depot in Holly Springs, Georgia that has recently been renovated using TE funds now serves as a community center. Care was taken to ensure that the renovations did not alter the building's original design, in order that it qualify for listing on the National Register of Historic Places. The project has acted as a catalyst for the preservation of other historic properties in Holly Springs and the creation of a downtown historic district.[43]

In the river town of Wheeling, West Virginia, TE funds helped restore the historic customs house. Built in 1859 and now known as Independence Hall, the building was once an important intermodal transportation hub for traffic transferring between the Ohio River, the National Road, and the Baltimore and Ohio Railroad in Wheeling. Thanks in part to TE funds used for repairs and improvements to the roof, structure, and interior of Independence Hall has been given a new life as a museum and a gathering place for special events. The building is now a National Historic Landmark and is listed on the National Register.[44]

In the Adams-Figuroa Historic District in downtown Los Angeles, a commitment to historic preservation has ensured that a street widening project has not altered the historic look and feel of the neighborhood. Twenty-nine beautifully ornate streetlights dating to 1906 were removed so that construction could proceed, and were then replaced with 33 nearly exact reproductions following the project's completion. The same company that manufactured the original streetlights manufactured the new ones, using the original wooden molds that had been kept in a factory storage room for nearly a century. Large Sycamore trees were planted between the lights to replace the original trees. New sidewalks were also installed. The project, funded by the Federal Highway Administration,

[42] "Historic Preservation Enhancements: Recycling America's Transportation Past," *Connections: The Newsletter of the National Transportation Enhancements Clearinghouse* 1 (October 1997), 1–3.

[43] National Transportation Enhancements Clearinghouse, *Communities Benefit! The Social and Economic Benefits of Transportation Enhancements* (Washington, D.C.: NTEC, 2000), 12.

[44] Ibid., 22.

won California's 1999 Excellence in Transportation Award for historic preservation/ cultural enhancement.[45]

Ecological preservation is no less a concern than historic preservation. Millions of mammals, birds, reptiles, and amphibians are struck and killed by motor vehicles every year. Wide-ranging large carnivores such as wolves, grizzly bears, and mountain lions are particularly vulnerable as they cross roadways in search of food. Slow-moving animals such as turtles and salamanders are also at risk, especially when they attempt to cross roadways to reach mating or nesting sites on the other side. The population of one federally endangered cat, the ocelot, has been reduced to about 80 animals, in part as a result of roadkill. The federally-threatened grizzly bear occupies less than two percent of its former home-range in the U.S. The population of a unique coastal prairie grouse known as the Attwater's prairie chicken has declined from one million at the turn of the 20th century to just a few dozen today. Road building has fragmented their habitat into three isolated and unstable units that are hastening this bird's extinction. Fortunately, wildlife overpasses and underpasses – commonly known as ecoducts or "critter crossings" – can reduce roadkill while guarding against habitat loss and fragmentation.

"Underpasses like this one [in Lake County, Florida], together with land acquisition and habitat protection, are tools we can use to minimize the impacts of highways on wide-ranging mammals."

– Terry Gilbert
Florida Fish and Wildlife Conservation Commission

For example, the Florida Department of Transportation, together with the Florida Fish and Wildlife Conservation Commission, designed and built an underpass for black bears on a stretch of State Route 46 in Lake County. A dirt floor box culvert, 47-feet long, 24-feet wide, and eight-feet high, was built under the two-lane road. To give nervous animals a greater sense of security when using the culvert, the road was elevated to provide a clear sight line, a 40-acre tract of land was purchased in the bears' travel corridor, and rows of pine trees were planted on either side of the opening to provide protective cover. Not only do bears use the underpass, but 11 other species of animals, including bobcats, grey foxes, and whitetail deer. In Glacier National Park, Montana, a goat passage under a highway bridge serves a similar function. In Marion County, Florida, a "land bridge" planted with native vegetation allows animals to cross a busy highway by night and people to cross by day.[46]

[45]Patricia Reid, "FHWA Helps Restore Historic Neighborhood in Los Angeles," *Public Roads* 63 (July–August 1999): 29.

[46]Federal Highway Administration, "Critter Crossings: Linking Habitats and Reducing Road Kill," available at http://www.fhwa.dot.gov/environment/wildlifecrossings as of September 2001.

Conclusion

Over the past three decades, transportation investment has resulted in a number of important environmental benefits. Most impressive are the improvements in air quality that have come even as the number of vehicle miles traveled has increased, thanks to cleaner vehicles, cleaner fuels, and a variety of transportation control measures including improved transit, bicycle and pedestrian programs, traffic flow improvements (often relying on ITS), rideshare programs, and HOV lanes. Strides have been made to reduce transportation-related noise, water, and light pollution as well. At the same time, rigorous preservation measures ensure that new transport projects tread lightly on the land; indeed, were it not for some new projects, many important archeological and historical sites would go undiscovered and undocumented, and many contaminated industrial sites would remain vacant. In the future, the air we breathe will become even cleaner as vehicle emissions decline still further. The environment as a whole will benefit from an increasingly multimodal approach to transportation investment, which focuses not just on increasing vehicle movement, but on improving access for people and goods.

Community and Social Benefits of Transportation Investment

Working Paper #3

Working Paper #3: Community and Social Benefits of Transportation Investment

Introduction

Investments in our nation's transportation infrastructure can yield important community and social benefits. They can increase mobility and access, provide a greater choice of travel modes, improve safety, enhance the visual appearance of our communities, cities, and natural landscapes, and increase community cohesion. In short, transportation investments can improve the quality of life. While social benefits are more difficult to quantify than economic and environmental benefits, they are nonetheless every bit as important. Making a neighborhood, city, or region more livable can spur economic development by making it more attractive for businesses and residents to relocate there.

But what defines a "livable" community? While the term means different things to different people, most can agree that, at the very least, a livable place is one that is safe, clean, and healthy; offers a variety of stable job opportunities; has adequate housing, retail, and community services; has a sense of neighborliness; and offers cultural and recreational opportunities close at hand.[1]

With this broad definition in mind, it is easy to see why transportation investment can influence livability. A highway built through a rural community has much the same effect today as did a new railway line a century and a half ago. Overnight, the isolation ends; the community becomes a part of a network, and the number of destinations within an hour's travel time increases many fold. Similarly, an attractive, tree-lined main street, complete with wide sidewalks and "street furniture" – benches, bus shelters, trash cans, and the like – is a source of community pride and a magnet for walkers, shoppers, and tourists. In this way, both places become more livable – they become places where people want to be. Of course, transportation investment can make a place less livable as well if not done sensitively.

[1] Project for Public Spaces, *The Role of Transit in Creating Livable Metropolitan Communities*, Transit Cooperative Research Program (TCRP) Report 22 (Washington, D.C.: Transportation Research Board, National Academy Press, 1997).

In recent years, transportation professionals have begun to emphasize "context-sensitive design": projects that respond to the particular needs of a community, reflect local values, and are compatible with the natural or man-made environment.[2] Attention has been shifting from giving priority to moving motor vehicles as quickly as possible to improving accessibility through integrated land use and transportation actions, and through enhancing movement by all modes including non-motorized travel. Effective transportation planning also addresses the needs of low-income and minority groups so that they share in the benefits of transport investments and do not suffer high and adverse environmental impacts.

"Context-sensitive design is a way to integrate highways and communities. This concept encourages designers to balance the transportation goals of mobility and safety with community values by enhancing and preserving a community's cultural and natural resources, while not establishing any new geometric standards or criteria. Context-sensitive design is supported by provisions in the ISTEA, NHS Act, and TEA-21, which emphasize the importance of good transportation design that is sensitive to the human-made and natural settings."

– *Transportation and Environmental Case Studies*
U.S. Department of Transportation

Motorists, pedestrians, bicyclists, and transit riders all benefit from thousands of recently-completed transportation projects, from new bridges, highways, and rail lines to redesigned streetscapes featuring attractive sidewalks, street furniture, and public art displays. Using specific examples from the 1990s, this report describes how well-planned transportation investment is improving the quality of life for Americans.

The community and social benefits of transportation investment can be divided into five general categories, discussed in detail in this paper.

1. **Transportation investment increases mobility and access –** It is important to note that mobility and access, while often used interchangeably, are not the same. A strong, multimodal transport network helps overcome distances (greater mobility). It also helps us reach desired social and economic activities (better access).

2. **Transportation investment in a wide variety of modes provides is ensuring a more balanced transportation network –** A more balanced network provides travelers with less stressful alternatives to driving and flying while helping to reduce pollution and congestion.

3. **Transportation investment improves safety –** Redesigning roads and intersections, constructing pedestrian and bicycle facilities, improving education, and deploying a variety of intelligent transportation systems can help reduce crashes, which in 1999 claimed the lives of 44,000 people in the U.S. and injured 3.3 million more.

[2] Project for Public Spaces, *How Transportation and Community Partnerships Are Shaping America, Part II: Streets and Roads* (Washington, D.C.: AASHTO, 2000).

4. **Transportation investment can improve the appearance of an intersection, a street, or an entire neighborhood –** Across the nation, new and rehabilitated infrastructure is being designed with aesthetics as well as function in mind.

5. **Transportation investment can increase community cohesion and inspire a sense of togetherness –** It can stimulate social interaction, increase civic participation, foster closeness among neighbors, and increase people's sense of safety.

Government Initiatives and Funding Programs

Several government initiatives and funding programs are providing social and community benefits. These include:

- **The Transportation Enhancement Program.** Created in 1991 with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA), the Transportation Enhancement Program provides funding to help expand transportation choices, increase recreational opportunities, improve aesthetics, promote historic preservation, and mitigate pollution. ISTEA stipulated that 10 percent of federal funds distributed to the states through the Surface Transportation Program were to be dedicated to "enhancements." TEA-21 continued this commitment and increased funding by 40 percent, so that annual spending now averages 630 million dollars. Since 1991 more than 2.4 billion dollars has been invested in 12,000 enhancement projects. Bicycle and pedestrian facilities (including rails-to-trails projects) have made up more than half of programmed funds, followed by historic preservation and preservation of historic transportation facilities (22 percent), and landscape and beautification (14 percent).

  Since 1991 more than 2.4 billion dollars has been invested in 12,000 Transportation Enhancement projects.

- **The Transportation and Community and System Preservation (TCSP) Pilot Program.** The TCSP, created by the Transportation Equity Act for the 21st Century (TEA-21) and administered by the Federal Highway Administration, provides money to state, local, and tribal governments to develop innovative strategies that use transportation to build livable communities. Over the first three years of the program, nearly 200 grants have been awarded to all 50 states and the District of Columbia.

- **The Federal Transit Administration's Livable Communities Initiative.** The Livable Communities Initiative is designed to improve mobility and the quality of services available to residents of neighborhoods by strengthening the link between transit planning and community planning. It seeks to provide better access to employment, schools, and other community destinations through community-oriented transit nodes. Eligible recipients are transit operators, metropolitan planning organizations, city and county governments, states, and planning agencies. The active participation of non-profit, community, and civic organizations is also encouraged.

- **The Federal Highway Administration's National Scenic Byways Program.** This program recognizes roads across the nation that are significant from a scenic, historic, recreational, cultural, or archeological point of view. Today, there are a total of 15 All-American Roads and 57 National Scenic Byways, including the Big Sur Coast Highway in California, the Las Vegas Strip in Nevada, Historic Route 66 in New Mexico, the Blue Ridge Parkway in North Carolina, the Merritt Parkway in Connecticut, and the Acadia Byway in Maine. A voluntary program, anyone may nominate a road for inclusion in the list, but the nomination must be submitted through the state. The National Scenic Byways Program has benefited from about 139 million dollars in federal funds, with about 25 million dollars available annually through 2003.

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1.0 Mobility and Access Benefits

In the 19th and 20th centuries, transportation investment – first in railways and streetcars, then in highways – greatly expanded the areas that can be reached in a given travel time. This investment has made it easier to visit friends and family and to access a broad range of work, shopping, educational, health care, and recreational opportunities. A resident of Indianapolis is within an hour's drive of many of the nation's leading hospitals and universities, thousands of potential employers, and two million potential friends. Long-distance opportunities are as important as local opportunities. In a weekend, the same resident can drive to southern Indiana for fall foliage, take the train to Chicago to see an art exhibit, or fly to Philadelphia to visit his parents. New projects today may lack the magnitude of the opening of the transcontinental railway or the first non-stop transcontinental flight, but they are still of tremendous importance at a regional or local level.

"Until communities and businesses have access to markets and resources, until workers are able to reasonably commute to jobs, and until patients can be within safe reach of doctors and medical care, the people of Appalachia will never have a full seat at the table of American prosperity. The Appalachian highways are more than a road in the mountains – they are very much a lifeline."

– Jesse L. White, Jr.
Appalachian Regional Commission
Federal Co-Chairman

In Appalachia, a 3,000-mile highway system traversing the mountainous terrain of 13 states is slowly taking shape. To date, approximately 2,500 miles of the system, known as the Appalachian Development Highway System (ADHS), have been completed or are under construction, with a goal of 2,700 miles completed by the end of the decade. The ADHS has evolved in response to geographic necessity; because of the high cost of building roads through Appalachia's rugged landscape, the Interstate Highway System bypassed much of Appalachia completely. As a result, the

region has remained relatively isolated. As new segments of the ADHS are opened, development follows. For example, Corridor G (U.S. 119), linking Charleston, West Virginia and Pikeville, Kentucky, has helped attract a new industrial park and shopping center to Charleston's outskirts. For residents of the small towns to Charleston's southwest, Corridor G means improved access to education and health care. Southern West Virginia Community College has four campuses that serve residents in nine nearby counties. Instead of commuting two hours to take classes, some students have cut their commute to 15 minutes. Meanwhile, the time needed to reach emergency hospitalization has dropped from as long as two hours to just 30 minutes.[3]

In some parts of Appalachia, the time needed to reach emergency hospitalization has dropped from as long as two hours to just 30 minutes.

The H-3 highway in Oahu, Hawaii is another example of a recently-completed highway that ensures fast, efficient travel through mountainous terrain. The 16-mile, four-lane roadway, which opened to traffic in December 1997, connects the western and eastern sides of Oahu, Hawaii's most populous island. Designed to alleviate congestion on Oahu's other main roadways and stimulate trade and economic growth, the H-3 is by all accounts a success; within months of its completion, it was handling almost 30 percent of the vehicles crossing the Koolau Mountains. The H-3 enhances national security as well, providing direct access between the Pearl Harbor Naval Base and Kaneohe Marine Corps Air Station. An engineering marvel, the H-3 crosses over – and through – some of the most rugged and beautiful terrain in the United States. Extreme care was taken during the design and construction phases of the 1.3 billion dollar project to minimize its impact on the environment, making it a model for other environmentally-sensitive transportation projects.

Recent investments in transit have also resulted in greater ease and speed of travel for Americans. During the 1990s, three high-speed catamarans went into service in San Francisco Bay. Cruising at speeds of 45 mph (38 knots), the vessels have cut the travel time between San Francisco and its northern suburbs dramatically. Today, the *MV Del Norte* makes the run from the Larkspur ferry terminal in Marin County to San Francisco in just 30 minutes, compared to 45 minutes for a conventional ferry. Faster service means faster turnaround times, and hence more frequent daily service. Today, 43 trips a day are scheduled on this route. Harried commuters, anxious to escape gridlocked traffic, have responded by packing the ferries to capacity. Annual ridership on Bay ferries has increased 50 percent, from 2.6 million to 3.8 million. Further increases are likely when a fourth catamaran, the *MV Mendocino*, enters into service in late 2001. The new 8.5 million dollar vessel, now under construction, will carry up to 400 passengers, 75

"There's been such tremendous growth that the congestion just keeps getting worse. At this point ferries look like the only way to travel."

– Michael Fajans
Project Manager, San Francisco Bay Area Regional Ferry Plan

[3] Fred D. Baldwin, "Appalachian Highways: Almost Home but a Long Way to Go," *Appalachia* (May-August 1996).

more than the *Del Norte*. The Metropolitan Transportation Commission, which oversees public transport for the Bay Area, is calling for five new high-speed catamarans, several new routes, and major terminal improvements in the coming years.[4]

Investment in transit systems can dramatically increase mobility and accessibility for the young, the elderly, the poor, and the disabled. Investment in ADA-compliant light rail systems, fixed-route bus services, or demand response (dial-a-ride) services ensures their personal mobility. It gives them access to jobs, education, shopping, health care, and family and friends, particularly as development in the suburbs continues to outpace development in the older urban centers. Transit can break the social isolation felt by adolescents who are too young to drive, and by the elderly and disabled with impairments that make it impossible or unsafe for them to drive. For the elderly especially, access to transit can make the difference between being able to live independently or in an assisted living facility. Because a disproportionate number of people who depend on transit service are elderly, minorities, and low-income, transit investment also helps reduce social and economic inequality. For example, fully 94 percent of welfare recipients do not own an automobile.[5]

In recent years, a number of transit services have been expanded or improved to offer greater accessibility. Transit agencies around the country are replacing their aging buses – and even streetcars – with new low-platform vehicles that make entry and exit easier for the elderly and disabled, and for people with small children or baby carriages. Others are adding "access-to-jobs" service to make major regional employers accessible by transit.

For example, in late 1999, a route expansion took place in greater Cincinnati, where the Southwest Ohio Regional Transit Authority (SORTA) joined forces with the Butler County Regional Transit Authority (BCRTA) and Warren County Transit to provide a new service called JobBus. JobBus is a "reverse commute" program designed primarily to help low-income city residents reach good-paying jobs that have moved to the suburbs. It uses regular Metro and Butler County Regional Transit Authority service to take workers from downtown Cincinnati to five transfer locations, where passengers can transfer at no cost to smaller circulator vans and go directly to their job sites in southern Warren County, Fairfield and Sharonville.[6] JobBus and other reverse commute programs are especially important because they increase job access for minority groups that suffer disproportionately high-unemployment rates.

Transit helps reduce social and economic inequality. Fully 94 percent of welfare recipients do not own an automobile.

[4] Richard Martin, "Water Cure for Transport Ills: High-Speed Catamarans Revolutionize Commuter Ferries," ABCNEWS.com, 22 June 1999.

[5] *Using Public Transportation to Reduce the Economic, Social, and Human Costs of Personal Immobility*. TCRP Report 49 (Washington, D.C.: Transportation Research Board, National Academy Press, 1999): 3-13.

[6] SORTA information and press releases, available at www.sorta.com as of July 2001.

2.0 Benefits of Alternative Travel Modes

For a variety of reasons – historical, geographical, economic, social, and political – the transportation infrastructure that suits one city, state, or region well may be less suited to another; some communities may choose to spend more on transit and less on highways, and other communities may choose to do the opposite. ISTEA and later TEA-21 have given communities the flexibility to make these choices, thereby maximizing the social benefits they receive from transportation investment. By providing communities with greater leeway to set their own transportation spending priorities, and to reject a "one size fits all" solution, transportation policy is swiftly evolving to reflect local values.

"Investing in rail can benefit all modes. Think of our national transportation system as a three-legged stool. For the stool to stand, all three legs – highways, aviation and rail – must be strong and sturdy. Today, too much of the weight of travel demand rests on the highway and aviation legs, when a healthy and more efficient balance could be struck with the development of rail choices and alternatives in many markets."

– George D. Warrington
President and CEO, Amtrak

For several decades now, we have invested heavily in roadways and aviation and as a result most Americans enjoy a relatively high degree of mobility using these two modes. Now opportunities exist to increase mobility using other modes as well: rail, transit, bicycling, and walking. Investments in these modes provide a greater degree of balance to our transportation network, offering travelers less stressful alternatives to driving or flying while helping to reduce pollution and congestion. This, in turn, provides benefits for those who continue to drive and fly. A more balanced transport network is also in the nation's strategic interest, as the September 11 attacks on the World Trade Center and the Pentagon demonstrated. Following the attacks, air traffic ground to a halt and road access into and out of parts of New York and Washington, D.C. was sharply restricted. Had it not been for the availability of bus and rail service, many travelers would have been stranded.

In other cities across the U.S., including St. Louis, Dallas, Salt Lake City, and Denver, new light rail lines have opened in recent years. Denver's new line, completed in June 2000 at a cost of 178 million dollars, provides a fine example of the maxim, "Build it and they will come."[7] The five-stop Southwest line runs from Interstate 25 and Broadway south nine miles to Mineral Avenue in Jefferson County. There, it connects with the existing Central Corridor that runs from Broadway through the downtown to 30th Avenue. On an average weekday, as many as 14,000 people ride the line – 66 percent more than the original projections of 8,400. On the very first day of service, the Mineral Avenue and downtown Littleton station parking lots were filled to capacity before 8:00 a.m., with dozens of cars parked illegally nearby and others parking at an undeveloped overflow lot west of Mineral Avenue Station. To ease the overcrowding, the Denver Regional Transportation District (RTD) is adding parking lots, including a multi-level garage at Mineral Avenue, and is awaiting the delivery of 12 new light rail cars it has ordered at a cost of 30 million dollars. The Southwest line is successful not because it has lured riders from the bus, but because it has attracted new riders who did not take public transport in the past; fully 60 percent of riders surveyed admitted they had not used RTD's bus system.[8] Today, a new, 41 million dollar, two-mile extension of the system, that will connect to the Central and Southwest Corridor lines near Colfax Avenue and continue on to Denver Union Station.

Salt Lake City's new light rail line, TRAX, opened in December 1999, running 15 miles from Sandy to downtown Salt Lake City. Today, ridership averages over 20,000 passengers each day, 43 percent above projections. A 2.5-mile extension to the University of Utah campus is underway, and is expected to be completed by 2002 when Salt Lake City hosts the Winter Olympic Games.[9] In Dallas, an 860 million dollar, 20-mile light rail "starter system" opened in 1996. Ridership has outpaced forecasts by 30 percent, and the stations are serving as a magnet for new residential and commercial development. Over 1,100 apartments and lofts have been built around two light rail stations, with restaurants, shops, theaters, and a large entertainment complex planned or under construction. In 2000, the new line's popularity helped convince voters to pass a 2.9 billion dollar long-term financing bill. As a result, 53 more miles of light rail will be added to the system by 2013.[10]

On an average weekday, as many as 14,000 people ride Denver's new light rail line – 66 percent more than the original projections of 8,400.

In Des Moines, Iowa, traffic congestion and parking shortages prompted the City of Des Moines and the Des Moines Metropolitan Transit Authority to commission a new park-and-ride facility. The facility, which was built one-half mile north of the central business district on Center Street, includes parking for 1800 vehicles, retail stores, and a daycare center and playground in a park-like setting. LINK buses circulate through an attractive

[7] "Denver Ridership Hits Target," *Light Rail Progress*, July 2000.

[8] Cathy Proctor, "Light Rail Draws More Riders," *The Denver Business Journal*, 22 December 2000.

[9] Utah Transit Authority information and press releases, available at www.rideuta.com as of July 2001.

[10] Tony Hartzel, "Getting a Head Start on DART," *The Dallas Morning News*, 15 August 2000.

shuttle station inside the building at five to 10-minute intervals, taking commuters to the central business district. The Center Street Park-and-Ride's elegant design and high-quality construction have earned it a Design for Transportation National Award from the U.S. Department of Transportation in 2000.[11]

Offering non-motorized travel choices – whether for transportation or recreation – is just as important as offering motorized choices. Walking and bicycling can greatly improve both our health and our quality of life. According to the Centers for Disease Control and Prevention, nearly two-thirds of Americans are not regularly physically active, and more than half are overweight or obese. Each year, 300,000 Americans die from diseases associated with a sedentary lifestyle, including coronary heart disease, hypertension, colon cancer, diabetes, and depression. Yet as little as 30 minutes of moderate-intensity exercise, such as cycling or brisk walking, can reduce health risks dramatically.[12]

A 1996 study in Santa Barbara, for example, showed that the number of cyclists on streets where bike lanes were added increased by 47 percent, compared to just one percent of streets without bike lanes.

While many trips are too far to make non-motorized travel an option, a surprising number are not. In urban areas, two-thirds of trips are five miles or less – suitable for cycling – and nationwide one-quarter of all trips made are one mile or less – suitable for walking. But how many of us have driven across the street from the parking lot of one shopping plaza to the parking lot of another, simply because no sidewalks or crosswalks were available?

Transportation investment in a variety of design features can encourage non-motorized travel for short trips such as these. In recent years numerous street redesign projects across the country have been completed with one or more of the following "pedestrian-friendly" or "bicycle-friendly" improvements: 1) wide sidewalks that permit pedestrians to walk side by side and carry on a conversation; 2) traffic lights that give pedestrians a "WALK" signal or green light within requiring excessive waits; 3) clearly painted "zebra stripe" crosswalks at intersections make pedestrians more visible to motorists; 4) tight intersection curb radii that shorten crossing distances for pedestrians and encourage cars to slow down as they round the corner; 5) benches, bicycle racks, shade trees, good lighting, and other amenities that make non-motorized travel more pleasant; and 6) painted bicycle lanes between the travel lane and the parking lane.

Painted bicycle lanes legitimize the presence of cyclists on the road. They also make the actions of both cyclists and motorists more predictable, leading to higher comfort levels and an increased perception of safety. A 1996 study in Santa Barbara, for example,

[11] *Design for Transportation National Awards 2000* (Washington, D.C.: U.S. Department of Transportation, 2000), 34.

[12] U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, *Physical Activity and Health: A Report of the Surgeon General Executive Summary*, Washington, D.C., 1995.

showed that the number of cyclists on streets where bike lanes were added increased by 47 percent, compared to just one percent of streets without bike lanes.[13]

Boulder, Colorado, is an example of a city that has built an extensive network of pedestrian and bicycle facilities. The most critical part of the network is the popular Boulder Creek Path, a 10-foot-wide mixed-use trail that parallels Boulder Creek and provides direct access to the city center. Several miles of on-street bike lanes have been striped on major north-south and east-west roads in the downtown area, and barrier-protected bicycle boulevards connect to off-street bike paths. Signs inform cyclists which way to turn to find the best bicycle route, and at several intersections turns for motor vehicles are prohibited but allowed for bicycles. An aggressive traffic calming program has led to the installation of traffic circles, speed humps, narrowed streets, necked down intersections, brick crosswalks, and diverters, making walking safer and more inviting.[14]

"The serendipity of walking means that we interact with our friends and neighbors more often, thereby creating a sense of community that not only makes us feel good, but also helps motivate us to support schools, parks, and other public necessities and amenities. Without a sense of community, we retreat to our cocoons, and become less likely to unite against societal challenges. And our cocoons become breeding grounds for fear and suspicion."

– Dom Nozzi
Urban Planner, Boulder, Colorado

In Cleveland, Ohio, the Greater Cleveland Regional Transit Authority has improved walking conditions by building an elevated pedestrian walkway connecting Tower City Center, the main train station, with the Gateway Sports and Entertainment Complex. The Complex includes the 42,000 seat Jacobs Field, home of the Cleveland Indians, and the 21,000 seat Gund Area, home of the Cleveland Cavaliers. The 1,000-foot long structure is climate-controlled and offers scenic views of the Cuyahoga River. It provides convenient, safe access to buses and trains, making it possible for sports fans to leave their cars at home on game day. Over 60 percent of Gateway Stadium attendees use the walkway, and over 25 percent use the public transit system. Just 16 months after the walkway opened, it had attracted more than 940,000 users.[15]

Another example of a facility that enhances pedestrian/bicycle access to transit is the 10-mile Minuteman Commuter Bikeway northwest of Boston. The multi-use trail extends through the towns of Bedford through Lexington and Arlington to an important subway and bus terminal in Cambridge. The Bikeway was the 500th rails-to-trails conversion in the U.S. and after its first year of operation was one of the busiest. On weekdays, hundreds of

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[13] Rails-to-Trails Conservancy and the Association of Pedestrian and Bicycle Professionals, *Improving Conditions for Bicycling and Walking* (Washington, D.C.: Federal Highway Administration, 1998): 24.

[14] Dom Nozzi, "City of Boulder Planning," available at http://user.gru.net/domzbldr.htm as of September 2001.

[15] Federal Highway Administration, *Innovations in Transportation and Air Quality: Twelve Exemplary Projects* (Washington, D.C.: U.S. Department of Transportation, 1996): 12–13.

people use the trail for commuting, and on weekends more than 10,000 people use it for recreation.[16] Because rail-trails separate motorized and non-motorized traffic completely, they provide a more relaxing experience for their users while greatly reducing the risk of fatalities.

Outfitting trains, buses, and stations with bike racks and bike lockers reinforces the attractiveness of both transit and cycling. Lockers offer commuters the flexibility of riding a bike either from home to the station and back, or from the station to work and back, without fear that their machine will be stolen or vandalized in their absence. Racks on transit vehicles allow commuters to take their bicycles with them for use at both ends of their trip.

"The popularity of the Minuteman Commuter Bikeway is breathtaking – on some days it looks like the start of the Boston Marathon! People are literally voting with their feet – and their wheels – for a transportation infrastructure that welcomes bicyclists and pedestrians instead of intimidating them."

– Tom Fortmann
Vice President, BBN Technologies
and long-time bicycle commuter

Several transit agencies have installed bike racks on their vehicles in recent years. Caltrain, the 70-mile passenger rail line connecting San Francisco with Silicon Valley, has equipped its cars with onboard racks that accommodate 24 bicycles per train. Bikes are allowed on every train, every day, at no additional cost and without a permit. As a result, Caltrain carries almost 2,000 bikes each weekday. So popular is the program that on some days Caltrain must turn riders away for lack of rack space. Bike lockers can be rented at most Caltrain stations for a nominal fee. Caltrain even offers a "two-for-one" promotional that encourages bikers to rent two lockers, one at their origin and one at their destination station. This way, by buying a second bike, commuters do not need to bring their bikes with them on the train.[17]

3.0 Safety Benefits

In 1999, approximately 44,000 people died and another 3.3 million were injured in transportation-related accidents in the United States. The vast majority of fatalities (80 percent) were motor vehicle operators and passengers although a significant number (14 percent) were pedestrians and bicyclists struck by motor vehicles. The remaining six percent were various transport users, including recreational boaters, railway workers and passengers, airline passengers and crew, and passengers and pilots in small planes. Although

[16] "Commuting on the Minuteman Commuter Bikeway," Briefing by Tom Fortmann, 19 March 1997, Alewife MBTA Station. Available at www.tiac.net/users/bingham/lexbike/fortmann.htm as of July 2001.

[17] Caltrain bicycle information, available at the Caltrain web site, www.caltrain.com as of July 2001.

significantly lower than the 56,000 deaths recorded in 1970, the present figure is a grim reminder that much work is needed to improve transportation safety.

Generally speaking, infrastructure investments that result in grade separation, the reduction of intersection conflict points, and the elimination of intersections entirely reduce fatalities and injuries; the safest roads are those with limited access. In 1999, urban interstate highways averaged 0.61 fatalities per 100 million vehicle miles traveled, compared to 1.28 fatalities on urban local roads. Rural Interstates averaged 1.23 fatalities, compared to 3.7 on rural local roads. Shifts to other modes will also generally improve safety. In 1999, 40,000 deaths involved motor vehicle occupants, but just 58 involved bus occupants (school, intercity, and transit), and 14 involved passengers on trains.[18]

A study of 11 intersections in the U.S. where modern roundabouts have been constructed showed a 37 percent reduction in the number of crashes and a 51 percent reduction in the number of injuries.

In 1999, according to the National Highway Traffic Safety Administration, approximately 8,500 fatal crashes took place at or near intersections.[19] Many of these occur when a vehicle traveling in one direction does not yield the right-of-way to a vehicle traveling in another. Signalized intersections can be especially dangerous because traffic does not slow down through the intersection during the green phase and red light running is an all-too-common occurrence. One innovative solution that is becoming increasingly popular among traffic planners in the U.S. is the roundabout. Not to be confused with the older, often chaotic rotary found mainly on the East Coast, the modern roundabout originated in Europe in the 1960s, where today they are widely used. The safety of a modern roundabout resides in its ability to slow down traffic entering the circle by channeling it and deflecting it around a center island. This reduces both the probability and severity of a crash. Moreover, there are fewer conflict points within a roundabout compared to a four-way intersection where left turns across traffic are permitted, also reducing the chances of collision. Because traffic moves through a roundabout with fewer delays, drivers are less likely to become frustrated and aggressive, further reducing the likelihood of an accident. Statistics attest to the safety of roundabouts: a study of 11 intersections in the U.S. where modern roundabouts have been constructed showed a 37 percent reduction in the number of crashes and a 51 percent reduction in the number of injuries.[20] For example, in 1993, in Lisbon, Maryland, a roundabout replaced a conventional four-way intersection

In 1999, urban Interstate highways averaged 0.61 fatalities per 100 million vehicle miles traveled, compared to 1.28 fatalities on urban local roads. Rural Interstates averaged 1.23 fatalities, compared to 3.7 on rural local roads.

[18] Bureau of Transportation Statistics, *National Transportation Statistics 2000* (Washington, D.C.: U.S. Department of Transportation, 2001): 99, 108, 130.

[19] National Highway Traffic Safety Administration, *Traffic Safety Facts 1999* (Washington, D.C.: U.S. Department of Transportation, 2000): 66

[20] Georges Jacquemart, *Modern Roundabout Practice in the United States, National Cooperative Highway Research Program Synthesis of Highway Practice 264* (Washington, D.C.: National Academy Press): 25.

of two state highways that had been marked by a two-way blinking red beacon. The number of accidents fell from an average of 7.4 each year before the roundabout to just 1.4 each year after the roundabout was constructed.[21] For this reason, the Insurance Institute for Highway Safety and State Farm Insurance, the nation's largest auto insurer, encourage the widespread use of roundabouts.[22]

Safety can also be improved using Intelligent Transportation Systems (ITS). For example, loop detectors embedded in the roadway, together with surveillance cameras mounted on major traffic arteries, provide early warning of accidents, reducing response time of emergency vehicles. Such a system was deployed in San Antonio, Texas beginning in 1995. Called TransGuide, the system was developed by the Texas DOT with federal funding. TransGuide uses loop detectors, high-resolution color video cameras mounted on poles, variable message signs, lane control signals, and a digital communications network to transmit data to an operations control center. The loop detectors measure the speed and density of traffic on each highway lane and detect any disruptions in flow. This information is displayed graphically on color-coded maps. Incident managers in the control center use this data, coupled with the live video feed, to notify emergency response personnel, and also to adjust the variable message and lane control signals to notify travelers as soon as an incident occurs. Before TransGuide, an average of 100 accidents occurred each day on the city's highways, and emergency vehicles took an average of 18 minutes to reach the scene of an accident. With the new system in place on the first 26 miles of San Antonio's highway network, accidents fell by 15 percent and emergency response times fell by 20 percent. Eventually, TransGuide will cover 191 miles of highway around San Antonio.[23]

After the TransGuide vehicle detection system was implemented on the first 26 miles of San Antonio's highway network, accidents fell by 15 percent and emergency response times fell by 20 percent.

The Georgia DOT has also deployed an early detection system. Known as Navigator, the Atlanta-based system covers 220 highway miles, making it one of the largest ITS programs in the country. Hundreds of cameras and dozens of radar speed sensors provide real-time images of road conditions, plus information on average speed, traffic volume, and vehicle classification. The cameras not only detect many accidents as soon as they occur, they help prevent secondary accidents from occurring by directing motorists away from congested roadways or accident sites. Prior to the introduction of Navigator, emergency

[21] Ibid., 42-43.

[22] "Many Crashes Could Be Avoided With Low-Cost Improvements," article available at State Farm Insurance web site, www.statefarm.com/media/lowcost.htm as of July 2001.

[23] "ITS and Public Safety: How Technology and Collaboration Can Save Lives," *Public Management* 80 (September 1998). Using the Internet, motorists can check the TransGuide web site (www.transguide.dot.state.tx.us/index.php) before leaving for work in the morning or before leaving the office at the end of the day to learn of any delays due to accidents or congestion. A glance at the color-coded map of the highway network will show delays and average travel speed on any given segment of roadway covered by the system. Live camera images are also displayed. Much of this information is also disseminated over a local television station.

response times on Atlanta's highways averaged 15 to 35 minutes. In 1997, with the new system in place, response times averaged just 12 minutes.[24]

The Kansas Highway Patrol has recently equipped 60 of its patrol cars with an automatic location system that allows the vehicles' movements to be precisely tracked from a dispatch office. The global positioning system identifies the latitude and longitude of the cars to an accuracy of 100 meters, then relays this information via the existing two-way radio system. The positions of the vehicles are automatically updated every two minutes. The troopers can also activate a special "pursuit mode" that increases the accuracy of the positioning to 10 meters and the frequency of the updates to seven seconds. The automatic vehicle location system increases both the safety of Kansas state troopers and the precision of crash location information.[25]

To improve safety for pedestrians and cyclists, context-sensitive design is often the key. Even modest increases in spending will yield tangible results; nationwide, a little over five percent of all trips are made on foot, yet 13 percent of all traffic deaths are pedestrians. However, the states spend less than one percent of their federal transportation funds on pedestrian facilities.[26] The most important safety enhancement for pedestrians is the construction of wide, well-lighted sidewalks and crosswalks. Other recent efforts to improve pedestrian safety have focused on "traffic calming," that is, redesigning a street in a neighborhood where pedestrians and children are present to slow the speed of traffic. The investments in amenities discussed in Section 2.0 above – those that encourage people to walk or bike to work, to shops, and for exercise and relaxation – also tend to calm traffic. Narrowing or eliminating travel lanes, adding parallel parking on both sides of the road, installing pedestrian-friendly traffic signals at intersections, and building bulb-outs, refuge islands, mini-roundabouts, and textured crosswalks make walking and biking more attractive in part because they make these activities safer. Traffic calming enhances safety for motorists as well by obliging them to travel the posted speed limit.

In the early 1990s, traffic sped through the near-empty downtown of Lake Worth, Florida at speeds as fast as 55 mph. Pedestrians rarely walked the narrow sidewalks or mustered the courage to cross Lake and Lucerne Avenues, each three lanes wide. In 1994, in response to community requests for more pedestrian space, slower speeds, and more parking, the Florida DOT undertook an experiment. Using only paint, it narrowed both avenues to two lanes with a third lane for parallel parking. In just one year, accident rates fell by 44 percent. As a result, the changes were made permanent, and the two main streets of downtown Lake Worth were given narrower lanes with bulb-out intersections, curbside parking, wide sidewalks, decorative light fixtures, planters, benches, and trash

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[24] "ITS and Public Safety." Like TransGuide, Navigator can be accessed over the Internet at www.georgia-navigator.com.

[25] Federal Highway Administration, *Intelligent Transportation Systems in the Heartland* (Washington, D.C.: U.S. Department of Transportation, 2001), 7.

[26] Barbara McCann and Bianca DeLille, *Mean Streets: Pedestrian Safety, Health, and Federal Transportation Spending* (Washington, D.C.: Surface Transportation Policy Project, 2000): 19.

containers. A roundabout was also constructed to calm traffic and serve as a gateway to Lake Worth's center. Traffic moves more slowly on Lake and Lucerne Avenues, but the level of service remains unchanged. The number of accidents has fallen by half, and the downtown has been transformed into a thriving shopping district with virtually no commercial vacancy. The city with a population of just 30,000 now attracts more than 100,000 people to its annual downtown street painting festival.[27]

"Traffic moves more slowly, but hey, it's a downtown, not a highway."

– Gene Nowak
City Planner,
Lake Worth, Florida

Although the Lake Worth project cost between 25 and 30 million dollars, mostly in state and federal funds, not all traffic calming measures require significant capital outlays. In St. Petersburg, Florida, a simple experiment designed to improve pedestrian safety at three intersections yielded positive results. Pedestrians were given a three-second head start to engage the crosswalk before motor vehicles enter the intersection, in order to minimize conflicts with turning vehicles. This head start, called a "leading pedestrian interval" was programmed into the signal phasing at three St. Petersburg intersections at which the "WALK" signal had previously been concurrent with the green signal for turning vehicles. Careful monitoring of the intersections showed that prior to the reprogramming, the number of conflicts per 100 pedestrians averaged 3.0, 2.1, and 3.3 for the three intersections. After the three-second leading pedestrian interval was introduced, conflicts were virtually nonexistent. Once pedestrians had engaged the intersection, motorists were more likely to acknowledge their presence and yield the right-of-way.[28] While many signalized intersections in the U.S. already provide a three-second leading pedestrian interval, many do not, leaving considerable room for safety enhancement along these lines.

Better signal timing can also improve safety for cyclists. In Davis, California, one major intersection near the edge of the university campus had peak-hour flows of over 2,300 cars and 1,100 cyclists. During one two-year period, 16 car-bike accidents occurred. To reduce conflicts, the city installed traffic signals with special bicycle symbols and a 30-second "bikes only" phase in the signal timing. These allowed bicyclists to clear the intersection before the cars were given a green light, minimizing conflicts for everyone. One year after the new signals had been installed, no accidents were reported at the intersection. As a result, bicycle signals have been installed at six other intersections in Davis. Another means of providing cyclists with a head start at intersections involves restriping the intersection to make a separate stop line for cyclists ahead of the stop line for cars. This allows cyclists to engage the intersection first.

Offering pedestrians a three-second head-start at signalized intersections can virtually eliminate motorist-pedestrian conflicts.

[27] Project for Public Spaces, *Transportation and Community Partnerships*, 6-7.

[28] Rails-to-Trails, *Improving Conditions*, 30.

The most effective way to ensure a cyclist's safety is to build off-road trails that are completely separated from vehicular traffic. Often, these are constructed along abandoned rail rights-of-way. The Rails-to-Trails Conservancy estimates that a total of 1,000 rail-trails exist nationwide, with at least one in every state. Another 1,200 rail-trail projects are in progress, with new ones beginning every month. While many trails are primarily used by recreational cyclists, others attract commuters as well. The Minuteman Commuter Bikeway, described above, is one such example. Another is the 11-mile Capital Crescent Trail that connects downtown Washington, D.C. with the suburbs of Bethesda and Silver Spring, Maryland. Since it opened to the public in 1993, it has become a popular route into the nation's capital, heavily used by commuters in the morning and the evening and by recreational riders on weekends. The 35-mile Pinellas Trail in St. Petersburg, Florida is used by 90,000 people each month, nearly a third of whom are commuters. The Cedar Lake Trail in Minneapolis is also heavily used by commuters, as it gives suburban cyclists an easy commuting link with downtown. The Cedar Lake Trail has been called the nation's first "divided-lane bicycle freeway" because users enjoy two 10-foot-wide asphalt lanes, one inbound and one outbound. Pedestrians have a choice of a six-foot-wide asphalt path or an adjoining three-foot-wide strip of crushed limestone designed to give runners a softer cushion. Well over a thousand riders use the trail on an average weekday.[29]

The Rails-to-Trails Conservancy estimates that a total of 1,000 rail-trails exist nationwide, with at least one in every state.

When accidents do occur, transportation investment – particularly investment in ITS – can help reduce emergency vehicle response times. Today, an average of 5.2 minutes elapses between the time an accident occurs and the time it is first reported. The Fatal Accident Reporting System estimates that if this time could be reduced to just two minutes, fatalities on urban Interstates would fall by 15 percent, saving an average of one life each day.[30] In Albuquerque, New Mexico, ambulances are guided by a map-based computer-aided dispatch system that pinpoints the exact location of an accident. Since the new system has been installed, emergency response times have declined by 10 to 15 percent. In Palm Beach County, Florida, a new Priority One traffic preemption system is being installed that overrides the normal traffic light sequence and allows emergency response vehicles to go through intersections without stopping. Priority One relies on the global positioning system and vehicle transponders that automatically interrupt the normal light cycle, changing red lights to green or preventing green lights from changing to red. When system installation is complete, emergency response times in Palm Beach

Reducing average accident response time on urban Interstates from its present 5.2 minutes to two minutes would reduce fatalities by 15 percent, saving an average of one life each day.

[29] Rails-to-Trails Conservancy web site, www.railtrails.org.

[30] Federal Highway Administration, *Intelligent Transportation Systems: Real World Benefits* (Washington, D.C.: U.S. Department of Transportation, 1998), 7.

County are expected to fall by as much as 20 percent. Other traffic preemption systems are being installed in cities from coast to coast.[31]

4.0 Aesthetic Benefits

Transportation investment can improve the visual appearance of a neighborhood. Some projects, like the Golden Gate Bridge, are so spectacular that they can rightfully be called works of beauty. They become the symbols of a community or a city. Most projects are more modest in scale and ambition, and seek only to improve the appearance of a city block or short stretch of roadway. Collectively, however, they contribute to the overall visual impression one has of a city, a state, and ultimately the entire country. Across the nation, new and rehabilitated infrastructure is being designed with aesthetics as well as function in mind.

East Main Street in Westminster, Maryland retains much of its 19th-century charm, with white-painted brick and wood houses set close to the narrow street. By the early 1990s, however, the very qualities that had led to the downtown's designation as a National Register Historic District were threatening to erode its attractiveness as a tourist and shopping venue. Successive road repavings had raised the street's center, resulting in sloping parking spaces that caught car doors on curbs. The lack of storm drainage caused puddles to linger in the street after each rainfall. The sidewalks – where they existed – were narrow, cracked, and caving in. Utility poles and lines had displaced most of the stately old trees. As a result, many retail and office spaces were vacant. In response to local requests, Maryland DOT agreed to double the sidewalk width and narrow the travel lanes slightly. Some 34 of the 42 mature trees were saved and 104 new trees were planted. New concrete sidewalks were given a brick-like texture and color, and 11 pedestrian-friendly areas with landscaping were created. Concrete curbing provided a continuity of texture and helped define the edge of the roadway. Westminster's historic "street furniture," such as boot scrapers and hitching posts were preserved. Work on the one-mile stretch of East Main Street was completed by the end of 1994 at a cost of three million dollars. Today, business in the downtown is again thriving.[32]

Not far from Westminster, another Maryland neighborhood suffering from visual blight has been given a dramatic makeover. Before 1998, motorists entering the Baltimore suburb of Towson were greeted by long lines of cars waiting at a noisy, congested, five-way intersection regulated by a messy array of traffic signals. Today, in its place, is a

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[31] Federal Highway Administration, *Intelligent Transportation Systems Benefits: 1999 Update* (Washington, D.C.: U.S. Department of Transportation, 1999), 40; Federal Highway Administration, *Enhancing Public Safety, Saving Lives: Emergency Vehicle Preemption* (Washington, D.C.: U.S. Department of Transportation, 1999).

[32] Federal Highway Administration, *Flexibility in Highway Design* (Washington, D.C.: U.S. Department of Transportation, 1997): 175-81.

large, neatly-landscaped roundabout. The traffic signals are gone, and so too are the noise and pollution that resulted from the lines of waiting cars. Nearby merchants are pleased because traffic tie-ups have been virtually eliminated, and traffic planners are pleased that the new roundabout handles 400 more cars each hour at peak period than did the previous signalized intersection, while lowering the number of severe accidents. What was once just another unsightly streetscape is now the new gateway to Towson. On the large center island trees and shrubs have been planted, while around the periphery new sidewalks and crosswalks have been built. Streetscape revitalization has continued westward into the center of town. At the same time, the 4.25 million dollar improvement project has become a magnet for private development, and businesses are starting to gravitate toward the newly-created "downtown" roundabout area to take advantage of increasing foot traffic.[33]

"The [Vermont Avenue Metro rail station] design is an exemplary demonstration of the value of collaboration between art and architecture. The sculptural entrance canopy and lighting create a strong, clear image in the midst of urban clutter. This design pushes the limits and creates a memorable public place."

– U.S. Department of Transportation
Design for Transportation National Awards 2000

New transit stations that result from the collaboration of engineers, artists, and architects can be visually appealing. In Los Angeles, California, the newly completed Vermont Avenue metro rail station has won a 2000 Transportation Design National Award from the U.S. DOT for its visually arresting appearance. The station, which serves Los Angeles City College, the Braille Institute, and numerous local businesses and residences, consists of an urban transit plaza and an underground station. A large elliptical metal canopy appears to float above one of the two entrances, while nearby a trapezoidal glass box contains an elevator. Custom-designed light poles painted bright red tower over the plaza, illuminating it at night and providing a sense of tremendous scale during the daytime. A glass block skylight is positioned over the escalator to ease the transition from bright daylight to the relative darkness of the station. The station interior is paneled in stainless steel, and a series of stainless steel elliptical louvers echo the shape of the entry canopy.[34]

Many new bridges are being designed with aesthetics as well as function in mind. For example, the handsome new Portland Avenue Bridge in Beloit, Wisconsin is credited with helping to revitalize the town's once-dingy riverfront. A recipient of the Federal Highway Administration's 1998 Excellence in Highway Design Award, the bridge was completed in 1996 at a cost of 2.5 million dollars. It has four driving lanes, two bicycling lanes, and two sidewalks. Flared overlooks allow pedestrians to view the riverfront and circular stairways wrap around the wingwalls leading to the river. Ornamental railings, distinctive lights, limestone surfaces, and exterior girder staining add to its attractiveness.

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[33] Project for Public Spaces, *How Transportation and Community Partnerships Are Shaping America, Part II: Streets and Roads* (Washington, D.C.: AASHTO, 2000): 14-15.

[34] *Design for Transportation National Awards 2000*, 47.

The Portland Avenue Bridge is part of Beloit's three-mile RiverWalk, which attracts walkers, joggers, skaters, cyclists, and stroller-pushers.[35]

Two recently-constructed bridges near Columbus, Indiana are attractive structures designed as part of the 48 million dollar Front Door Project. The project was a community-initiated effort to create a striking entryway for motorists as they approached the city's historic downtown from the west. Since a number of unique architectural structures are already found in the city center and its neighborhoods, the goal was to extend the character and feel of Columbus to the Interstate 65/ Route 46 interchange. The first phase, which involved the construction of the Columbus Gateway Arch Bridge, was completed in 1997. The bridge, which forms the western anchor point of the corridor, is a unique, twin-ribbed steel arch structure that carries four lanes of I-65 traffic over Route 46.[36] The final phase of the Front Door Project was completed in 1998. It entailed the construction of the Tipton Bridge, a cable-stayed bridge across the East Fork of the White River and into downtown Columbus. As motorists cross the bridge, they see the towers of the historic County Courthouse and the First Christian Church framed within the bridge's triangular shape. The effect is deliberate; the axis of the bridge was aligned with the courthouse to make a dramatic statement.[37]

"Building architecturally significant structures adds value to this community [Columbus, Indiana]. This is a community with a vision that wants something beautiful."

– Pat Cassity
Principal Bridge Engineer,
J. Muller International

In some cases, transportation investment designed to make a project less, rather than more, conspicuous is desirable. Using flexible design methods, highways in need of improvement or restoration can be integrated into the natural landscape to reduce their visual impact. One such example is the recent reconstruction of South Broadway (Route 9) in Saratoga Springs, New York. The approximately one-mile stretch of four-lane highway is bounded on both sides by state park land, and is the southern gateway to a town famous for its historic, recreational, and cultural attractions. Originally an undivided highway without left turn lanes, South Broadway was rebuilt as a divided highway with left turn lanes and a raised grass median featuring landscaping, flower beds, and granite curbing. Decorative Victorian-style black fluted lamp posts were installed on the median and along both sides of the road, replacing the conventional – and decidedly less attractive – "cobra head" streetlights. New traffic signals with fluted, pole-mounted pedestrian-activated "WALK" lights and high-visibility crosswalks were added. All overhead utilities were relocated

[35] *Excellence in Highway Design 1998 Biennial Awards* (Washington, D.C.: Federal Highway Administration, 1998).

[36] "Columbus Gateway Arch Bridge," *Modern Steel Construction*, September 1998.

[37] "East Fork Cable-Stayed Bridge," Columbus, Ind.," article available at Construction.com web site as of July 2001.

underground. A full-length sidewalk on the east side of South Broadway was constructed, with a mixed use path on the west side. Finally, benches, bollards, flower beds, and trees were located behind the sidewalk to create a boulevard setting. The result is a highway that is far more aesthetically pleasing than the one it replaced, and a boon to the local tourist economy.[38]

5.0 Community Cohesion Benefits

Transportation investment can increase community cohesion and inspire a sense of togetherness. That is, it can stimulate social interaction among members of the community, increase civic participation, foster closeness among neighbors, and increase people's sense of safety. Any project that relies on extensive public participation and context-sensitive design principles, from a highway in Appalachia to a transit stop in Los Angeles, will also bring people together. Community cohesion is an extra benefit, a reward for respecting community needs.

State and local transportation partners are working to ensure that community impacts are consistently examined in transportation planning. This involves examining the distribution of benefits as well as the manner in which all population groups and communities may be burdened. Transportation investment can promote greater respect for communities in two ways. First, it can provide infrastructure and services that meet the needs of minority, low-income, and other populations as well as the entire public. These include access to employment opportunities and other activities, ensuring high levels of accessibility to a range of transportation services and choices, and maintaining existing roadway and public transportation investments. Second, it can ensure that adverse health and environmental impacts that might be associated with project construction do not strike particular communities disproportionately. For example, if a neighborhood will be adversely affected by transportation construction, a vigorous plan can be carried out that minimizes these potential adverse effects and also provides benefits to the affected community. A key to effectively and practically accomplishing these community design objectives is engaging potentially affected communities in a dialog throughout the planning and design process that is designed to provide community as well as regional benefits.[39]

The South Park Avenue improvement project in Tucson, Arizona resulted from a decade-long planning process that began in 1989. The objective was to improve the struggling South Park neighborhood, a low-income minority community originally settled by African Americans in the 1940s. The planning process involved extensive community outreach and involvement, including town hall meetings, neighborhood "walkabouts," and in-home

[38] *Regional Submissions for the Context Sensitive Design Award Excellence in Engineering 2001* (New York: New York State Department of Transportation, 2001).

[39] *Transportation and Environmental Justice Case Studies* (Washington, D.C.: U.S. Department of Transportation, 2000).

interviews with several respected elders in the South Park community. One of the more creative aspects of the South Park improvement project was the use of public art to enhance the streetscape along South Park Avenue and draw attention to the South Park area's history and identity as a community. For example, a number of new bus shelters featured colorful figures at each corner, their upraised arms holding up the roof of the shelter – a symbol of community spirit and willingness to help others during difficult times. In the end, the project resulted in the construction of six artistic bus shelters and one standard shelter, walls that doubled as a public art canvas, and new traffic signals, sidewalks, street lighting, and landscaping. Various other forms of public artwork became part of the streetscape, including decorative totems, bridge mosaic insets, sidewalk epoxy with random stenciled designs, and plaques with site-specific or historic information and graphics. The project was completed in 1999 at a cost of 1.5 million dollars.[40]

San Diego's mid-city neighborhood remained split for several years by 2.2-mile right-of-way, cleared to permit construction of a segment of Interstate 15. Property values fell, and with adjacent sections of I-15 to the north and south of the community already completed, traffic increased. In 1996, ground was at last broken on the remaining section, and the multi-ethnic, primarily low-income neighborhood began to recover. Enhancements to the design of the new highway segment brought many benefits including sound walls, dedicated bus lanes, transit stations, and a 25-foot below grade depression. Most importantly, an entire block was covered with a park, once again connecting the two halves of the neighborhood. Today, the high volume of traffic has been removed from local streets and placed below-grade. The neighborhood enjoys direct transit access via bus ramps and lanes, which have been designed to allow for conversion to light rail in the future. As a result, real estate values are rising and economic development opportunities are multiplying.[41]

Integrating transportation and land use planning can also increase community cohesion. This is one of the principles behind the Federal Highway Administration's Transportation and Community and System Preservation Pilot Program (TCSP), established under the Transportation Equity Act for the 21st Century. In Connecticut, a TCSP project has helped residents of Hartford's Parkville

"Because of the TCSP project, we have a better understanding of transportation issues and how they relate to the neighborhood. We are also gaining a better understanding of what to look for in the design of new development."

– Joe Langlais
Chair, Parkville Community Association,
Hartford, Connecticut

[40] Ibid.

[41] Federal Highway Administration, "San Diego, California: The PLACE^{3}S Analysis Method," Transportation and Community and System Preservation Pilot Program, Case Study #4, May 2001.

neighborhood identify pedestrian and traffic linkages, urban design strategies, and zoning changes that will better integrate planned transportation improvements and development projects with the neighborhood. It has also helped the small town of Suffield, Connecticut, plan for new transportation improvements while preserving the town's rural character and the strength of its old town center. Finally, a regionwide outreach and education effort is helping Connecticut residents understand how investing in transportation infrastructure in urban neighborhoods can reduce sprawl and congestion, preserve rural communities, and revitalize existing neighborhoods.

The Cypress Freeway replacement project in West Oakland, California is an example of a transportation investment that improved community cohesion. In 1989, a powerful earthquake struck the Bay Area, causing the double-deck Cypress Freeway in West Oakland to buckle and collapse. The local community immediately sensed an opportunity. The highway, built in the 1950s, had been a controversial project, bisecting the predominantly African American community in West Oakland, uprooting 600 families and dozens of businesses, and isolating a four-square-mile area of the very poorest part of the city from the more prosperous downtown. Over the next three decades, the area to the west of the highway withered, pressed against metalworking shops, rail yards, and the Port of Oakland. Throughout West Oakland, the noise and fumes from automobiles passing overhead degraded the quality of life for thousands. With the Cypress Freeway reduced to rubble, the opportunity arose to build a replacement farther to the west that would unite most of the neighborhood. The new highway opened in 1998. Caltrans also built an exit ramp at Market Street to provide access to local businesses and to erect landscaped sound barriers along the highway to reduce noise levels. Now attention has turned to converting the old right-of-way into a linear park that will reunite a city once cut in two.[42]

The East-West Expressway, a 10-mile limited-access highway near the central business district of Durham, North Carolina, was first planned in 1959. Nearly 40 years would pass, however, before the final section would be completed. The Crescent Street neighborhood, a poor African American community that included more than 200 households, stood squarely in the path of the proposed alignment. The North Carolina DOT put in place a plan that would keep the neighborhood intact. The Crescent Street neighborhood was rebuilt a short distance away, thereby reducing the social dislocations resulting from a move but also permitting residents without cars to continue to walk to their jobs at the nearby Veteran's Hospital and Duke University Medical Center. In the early 1990s, 65 houses were moved from the old site to the new, where they were renovated with modern conveniences. Over 100 new single-family homes were built, together with 66 multi-family units. A former school located on the new site was renovated for elderly housing. Two new parks and a community center were built, as well as new infrastructure. Today, a walk down Crescent Street reveals modern streets, sidewalks, and homes, with neatly

[42] *Transportation and Environmental Justice Case Studies*.

tended lawns and gardens. Most importantly, the neighborhood has remained whole and has not lost its cohesiveness.[43]

Conclusion

By improving our transportation infrastructure and services, our quality of life is improved in many ways, large and small. Greater ease and speed of mobility allows us to visit distant friends and relatives, and to choose between a greater number of jobs, shops, schools, and hospitals. Greater choice of travel modes and improved access provides flexibility, improved access, and opportunities for pleasure and relaxation.

Transportation investment can improve safety. When we face an emergency at home, we rely on well-maintained roads free of congestion and bottlenecks to speed the arrival of an ambulance, police car, or fire engine. Whether traveling by car, bus, train, bicycle, or foot, we benefit, sometimes unknowingly, from thoughtful road design, proper maintenance, and a variety of intelligent transportation systems.

The aesthetic benefits of transportation investment are perhaps the hardest to quantify, and yet they are among the most important when it comes to public acceptance of new projects. The most memorable projects are those that are not merely functional but attractive as well. Eye-catching streetscapes, bridges, and transit stops not only add to our enjoyment when we travel, they increase pride in community and nation. Conversely, by applying the principles of context-sensitive design, we can minimize the visual intrusion of roadways in nature, thereby better preserving the beauty of the landscape for future generations.

As a result of all of these transportation-related improvements, communities can become more cohesive. Streets that are attractive and safe for all users encourage social interaction. They encourage children to ride bicycles to their friends' houses and adults to cross the street to talk to neighbors. Efficient public transit systems allow those without cars – the young, the poor, the elderly, and the handicapped – to participate more fully in civic life, giving them a degree of independence they would not otherwise have. By understanding and addressing the unique needs of many different socioeconomic groups through early, inclusive, and meaningful public involvement, transportation facilities can be designed that fit more harmoniously in communities.

[43] Ibid.

The Benefits of Reducing Congestion

Working Paper #4

Working Paper #4: The Benefits of Reducing Congestion

Introduction

Traffic congestion has a direct impact on quality of life in urban areas and on the nation's economy. In a 2001 report examining the 68 largest metropolitan areas in the U.S., researchers at the Texas Transportation Institute found that highway congestion – defined as travel at speeds below free-flow or "posted" speed limits – causes an estimated 4.5 billion hours of delays per year in these metropolitan areas. Motorists in the most congested cities, such as Los Angeles, Atlanta, and Houston, experience over 50 hours of excess travel time per year. Furthermore, congestion has grown throughout the 1990s (Figure 1). In 1999, 65 percent of peak-period travel on metropolitan highways was estimated to occur under congested conditions, compared to only 53 percent in 1990.[1]

The percent of peak-period metropolitan highway travel occurring under congested conditions has increased from 53 percent in 1990 to 65 percent in 1999.

Mobility is especially difficult during the peak "hour," which has become as long as three hours in some metropolitan areas. Los Angeles, the most congested urban area in the U.S., has a "travel rate index" (TRI) of 1.51, which means that it would take 51 percent more time to travel during peak periods than it would during off-peak periods. The 10 U.S. metropolitan areas with the greatest levels of congestion all have TRIs higher than 1.31.[2]

Congestion specifically affects the nation in the following ways:

- **Congestion wastes time and affects peoples' quality of life**. Time spent in traffic is time that cannot be spent working or with families. Congestion also leads to frustration and stress, reduces access to jobs and other activities, and causes people to rearrange schedules or even change their residence location.

- **Congestion has safety and environmental impacts**, since accident rates, fuel consumption, and air pollution all increase under congested driving conditions.

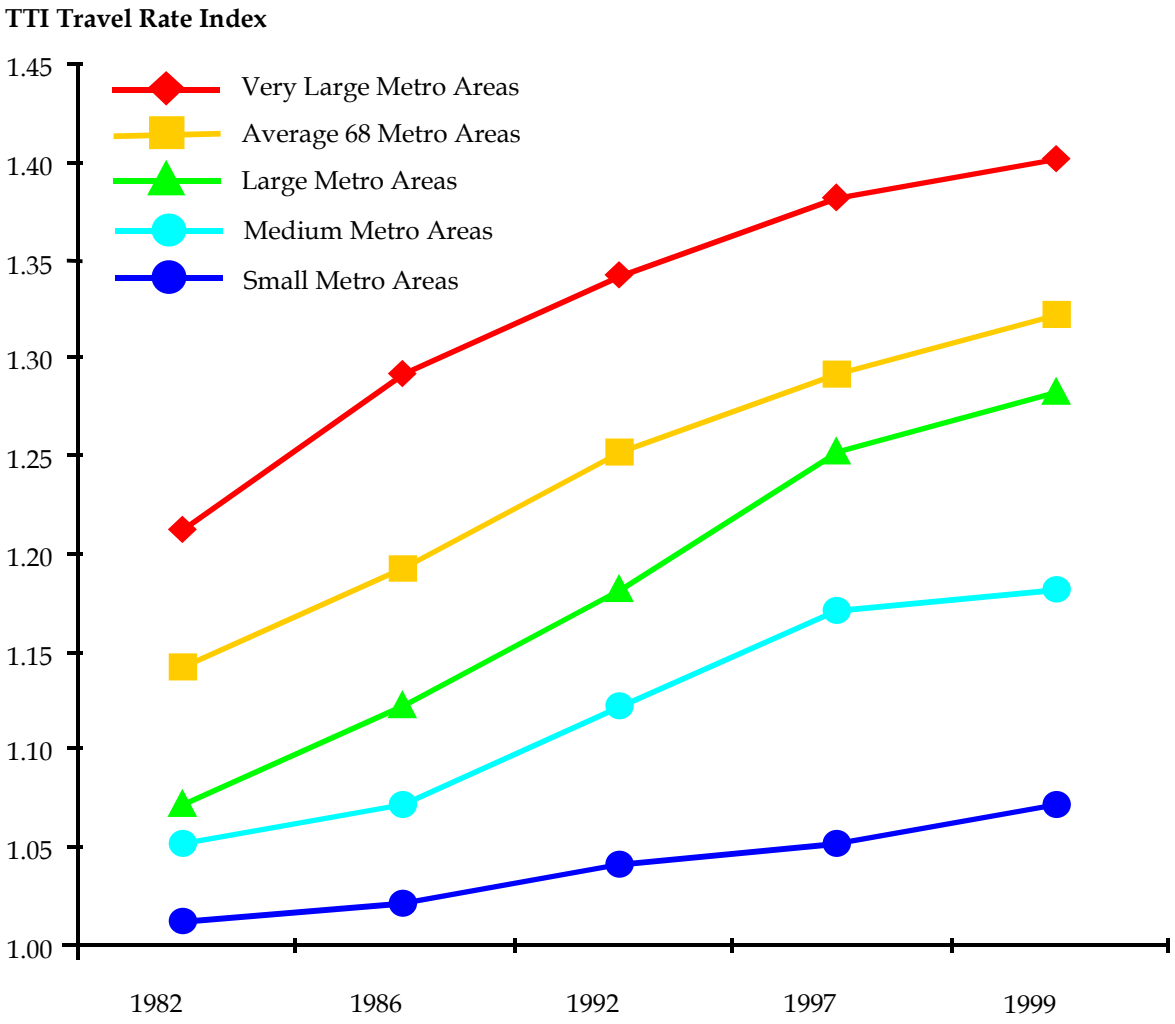
[1] David Schrank and Tim Lomax, *The 2001 Urban Mobility Report* (College Station, Texas: Texas Transportation Institute, May 2001).

[2] Schrank and Lomax, *Urban Mobility*.

- **Congestion affects the economy**, increasing the costs of shipping goods and disrupting production schedules.

- **Travel time reliability is especially important.** Roughly 60 percent of all vehicle-hours lost in congestion are due to non-recurring congestion, which is particularly onerous because drivers cannot fully anticipate or plan for it.

Figure 1. Metropolitan Congestion



Fortunately, reducing congestion is both feasible and beneficial. A wide range of effective strategies are available to address congestion. These are not limited to traditional capacity expansion and bottleneck removal projects. System operational improvements such as traffic signal timing can cost-effectively improve traffic flow. Incident management and traveler information programs can reduce delays due to unexpected congestion.

Workplace strategies such as telecommuting and flexible work hours can provide employees with alternatives to driving during peak travel periods.

Furthermore, the benefits of increasing road capacity and improving traffic flow are not simply eaten up with more traffic. Congestion relief projects provide an immediate benefit to existing travelers and also provide people with greater flexibility in determining when and where they wish to travel.

Fixing the 166 worst highway bottlenecks in the country would reduce average peak-period delays at these locations by 19 minutes per vehicle trip.

A study prepared for the American Highway Users Alliance highlights the potential benefits of reducing congestion. This study estimates the benefits of improvements to the 166 worst bottlenecks throughout the country, including major highway interchanges in cities such as Los Angeles, Seattle, Denver, and Atlanta. Improvements at these locations could reduce average peak-period delays from 25.2 to 6.2 minutes per vehicle trip, a 75 percent decrease. Furthermore, fixing these bottlenecks would greatly reduce crashes, emissions of smog-forming hydrocarbons, and greenhouse gas emissions at each location.[3]

1.0 Congestion Wastes Time and Affects Peoples' Quality of Life

Congestion is a growing concern and annoyance for many residents of urban and suburban areas. It affects people psychologically and physiologically; reduces access to jobs, health care, education, recreation, and other essential services and activities; and imposes monetary costs on travelers.

Psychological and physiological effects. Congestion affects peoples' mental and physical states. Dissatisfaction with the daily commute has been found to produce undesirable psychological and physiological responses, including elevated blood pressure, increased negative mood states, lowered tolerance for frustration, increased irritability, and more impatient driving behavior.[4] Travelers driving in congestion experience increased levels of stress and aggression, especially if they are late or the congestion is unpredictable.[5]

[3] Cambridge Systematics, Inc. *Unclogging America's Arteries* (Washington, D.C.: American Highway Users Alliance, 1999).

[4] Raymond W. Novaco, Daniel Stokols, and Louis Milanesi, "Objective and Subjective Dimensions of Travel Impedance as Determinants of Commuting Stress," *American Journal of Community Psychology* 18 (1980).

[5] D.A. Hennessy and D.L. Wiesenthal, "Traffic Congestion, Driver Stress, and Driver Aggression," *Aggressive Behavior* 25 (1999).

Access to jobs and other activities. Work is a central and economically sustaining part of life for most people. Yet research has shown that congestion may constrain the range of job opportunities available.[6] Some employers favor hiring people living closer to the firm than people living further, their reasoning being that an employee living further will have a work attendance that would be less reliable than that of an employee who lives closer to the firm. Interviews show that some employers are even having difficulty recruiting employees in congested areas.[7]

Other activities are also affected. In workplace surveys, employees have reported shifting their schedules and residence locations to prevent commuting from cutting into work, personal, family, and recreational time. Strategies to avoid peak-period congestion that spreads over two and sometimes three hours include alteration of work schedules, shorter work weeks, telecommuting, and reliance on telecommunications to reduce business trips. People may reschedule or forego non-work activities because they are too difficult to get to during congested times. At the extreme, people may change their residence or business location to avoid congestion.[8]

Some coping strategies, such as flexible work schedules and telecommuting, may benefit businesses as well as workers. Such coping strategies are not always convenient, however, nor are they available to everyone. It is primarily professional, white-collar, service-sector workers who are able to take advantage of flexible work arrangements; other workers such as those in manufacturing jobs or administrative support staff have much less flexibility. Even people with work-schedule flexibility may be constrained by other activities, such as the need to pick a child up from daycare. Overall, findings suggest that while difficult to measure, the business and personal costs of congestion avoidance strategies may be considerable.[9]

The value of time lost to congestion. The costs of congestion go beyond increased stress and disruption to peoples' daily schedules. The time that people lose in congestion has a monetary value. For motorists driving to work or on business, the opportunity cost includes the work time that may be lost due to delays in the daily commute.

The value of extra time spent in travel is usually estimated by multiplying the number of hours lost by some fraction of the gross hourly wage, which includes workers' compensation and other fringe benefits paid by the employer. This average value has most recently been estimated at $12.40 per hour, in 1999 dollars. Considering the hours

Valuing lost time in congestion at $12.40 an hour, the total cost of congestion in the 68 largest U.S. metropolitan areas is estimated at $69 billion a year.

[6] Cambridge Systematics, Inc. *Impact of Urban Congestion on Business*, National Cooperative Highway Research Program Project 2-17(5) (Washington, D.C., Transportation Research Board, 1994).

[7] Cambridge Systematics, *Unclogging America's Arteries*.

[8] Ibid.

[9] Ibid.

lost to congestion annually in the 68 largest U.S. metropolitan areas, the total cost of lost time is estimated at $69 billion nationwide.[10]

2.0 Congestion Increases Crashes and Harms the Environment

In addition to causing stress, wasting time, and decreasing mobility, congestion increases highway crashes, vehicle operating costs, fuel consumption, and air pollution.

Crashes. Traffic congestion contributes to highway crashes. As highway crowding increases and motorists jockey for position at exits and entryways, the potential for crashes increases (Figure 2). While accidents are more likely to be fatal at higher speeds, fixing bottlenecks can nevertheless reduce the number of all types of crashes, thereby saving lives and preventing injuries. A study prepared for the American Highway Users Alliance estimated that improvements to the 166 most serious bottlenecks nationwide would prevent 287,200 crashes over a 20-year period, including 1,150 fatalities and 141,000 injuries.[11] Increased crash costs also affect business costs such as insurance, driver replacement, and workers' compensation.

Improvements to the 166 most serious bottlenecks nationwide would prevent 287,200 crashes over a 20-year period, including 1,150 fatalities and 141,000 injuries.

Vehicle operating costs and fuel consumption. The cost of gasoline and other operating and maintenance requirements attributable to congestion can also be relatively high. Fluctuating speeds resulting from congestion can add considerably to vehicle operating costs, to the point where a "stop-and-go" speed of 30 mph can result in higher costs than an average 'steady' 50 mph.[12] Researchers at the Texas Transportation Institute estimated that 6.8 billion gallons of fuel are wasted each year because of metropolitan congestion. When dollar values are assigned to the value of excess fuel consumed, the cost is estimated to be $9 billion annually.

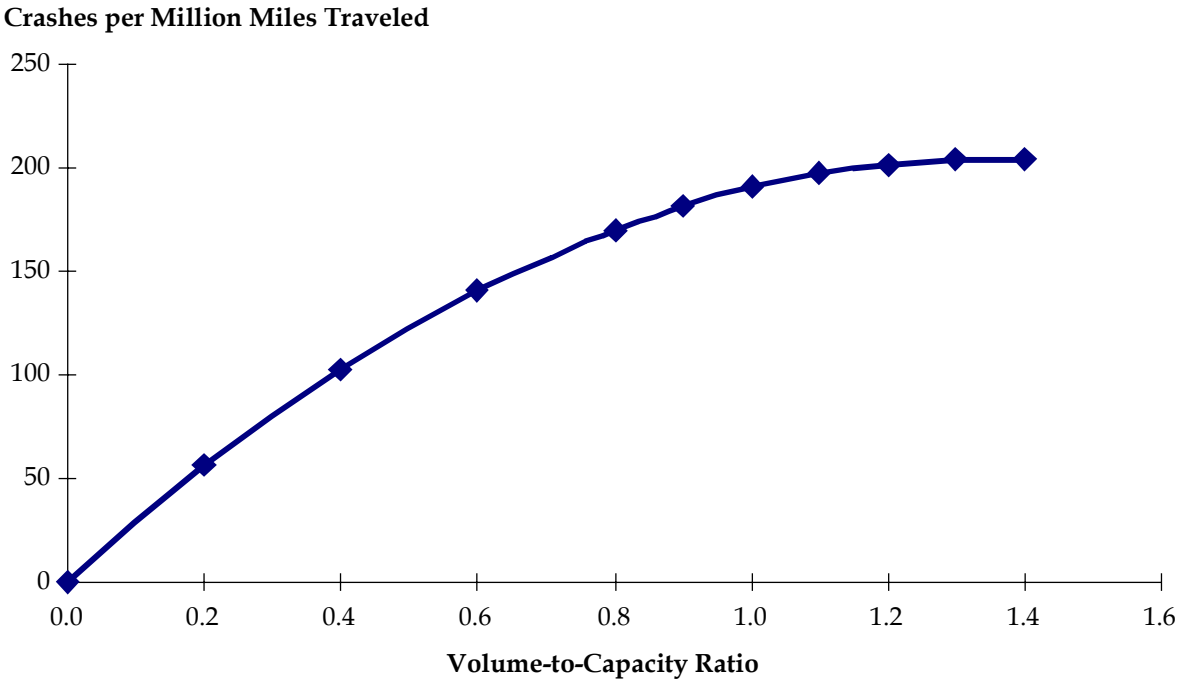
Emissions and air quality. Efforts to reduce congestion can have a positive effect on air quality. Idling, low-speed travel, and especially hard acceleration – which characterize congested conditions – all result in higher emissions than does travel at consistent, moderate speeds. Strategies to reduce congestion, including coordinating traffic signals, expanding intersection capacity, and responding to incidents more quickly, therefore can help to reduce emissions from motor vehicles.

[10]Schrank and Lomax , *2001 Urban Mobility Report*.

[11]Cambridge Systematics, *Unclogging America's Arteries*.

[12]Ibid.

Figure 2. Relationship of Congestion and Accident Rates on Urban Highways[13]



This figure illustrates the relationship between traffic volumes and crash rates. Congestion increases as the volume-to-capacity ratio approaches or exceeds 1.0. A greater level of traffic volume relative to the capacity of the highway increases the risk of a crash.

Recent research to update the U.S. Environmental Protection Agency's MOBILE emission factor model has produced new "speed correction factors" that show how emissions vary according to the level of congestion on highways and arterial roads. These factors suggest that the greatest emission reduction benefits come from reducing extreme congestion and smoothing traffic flow on arterials. Increasing average arterial speeds from 10 to 20 mph, for example, reduces hydrocarbon (HC) emissions by roughly 40 percent and emissions of oxides of nitrogen (NOx) by roughly 20 percent. Under most conditions, emissions continue to decline until 30 to 40 mph, although they

When the EZ-Pas toll collection system was introduced on the New Jersey Turnpike in 2000, emissions of VOC and NOx on a typical weekday declined by 0.35 tons and 0.056 tons, respectively, as a result of reduced queuing and increased speeds.

[13]Shelby Tedesco, Vassili Alexiadis, William Loudon, Richard Margiotta, and David Skinner, *Development of a Model to Assess the Safety Impacts of Implementing IVHS User Services*, Proceedings, IVHS America, 1994.

increase somewhat as average speeds approach 50 to 60 mph or more. When the EZ-Pass toll collection system was introduced on the New Jersey Turnpike in 2000, emissions of VOC and NOx on a typical weekday declined by 0.35 tons and 0.056 tons, respectively, as a result of reduced queuing and increased speeds. In addition, toll plaza delays were shortened by 85 percent and fuel consumption reduced by 1.2 million gallons annually.[14]

Research has also shown that emissions are sharply higher under conditions of hard acceleration and deceleration.[15] As a result, measures that smooth traffic flow, reducing starts, stops, and hard accelerations, can have disproportionate benefits for emission reduction. A study in Atlanta estimated that coordinating traffic signals along an arterial would result in a reduction in emissions of nine percent.[16] This study considered not only changes in average speed, but also changes in the amount of acceleration, deceleration, and idling required of vehicles along this roadway.

3.0 Congestion Affects the Economy

Congestion in metropolitan areas affects business transportation costs and productivity, and hence the "bottom-line" cost of doing business. Transportation costs are now taking on even greater importance as the pressures and opportunities of the global marketplace force U.S. firms to change the way they do business. Congestion affects businesses in three specific ways: by increasing costs for the delivery of goods and services; by affecting production and sales operations that rely on the timely delivery of goods and services; and by restricting workers' access to jobs.

Delivery of goods and services. Congestion increases the cost of delivering products and services to customers and limits the effective size of the area which a business can serve on a competitive basis.[17] The cost of congestion to firms delivering goods and services are grouped into two broad categories:

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[14]Wilbur Smith Associates, *Operational and Traffic Benefits of EZ-Pass to the New Jersey Turnpike, Executive Summary*, 20 August 20 2001, available at the New Jersey Turnpike Authority web site, http://www.state.nj.us/turnpike.

[15]H.Y. Tong, W.T. Hung, and C.S. Cheung, "On-Road Motor Vehicle Emissions and Fuel Consumption in Urban Driving Conditions," *Journal of the Air and Waste Management Association* 50 (April 2000).

[16]Shauna L. Hallmark, Ignatius Fomunung, Randall Guensler, and William Bachman, "Assessing the Impacts of Improved Signal Timing as a Transportation Control Measure Using an Activity-Specific Modeling Approach," *Transportation Research Record* No. 1738 (2000).

[17]Glen Weisbrod, Donald Vary, and George Treyz, *Economic Implications of Congestion*, National Cooperative Highway Research Program Project 2-21 (Washington, D.C.: Transportation Research Board, February 2001).

1. **Direct costs.** These include increased in-vehicle travel time, increased allotted travel time because of the risks of worst-case congestion, and increased fuel consumption and other vehicle operating costs. A study using data from Chicago and Philadelphia compared the benefits to businesses of reducing truck travel costs by 2.5 percent regionwide. These benefits were as high as $980 million per year in the Chicago region and $240 million per year in the Philadelphia region.18

2. **Congestion avoidance costs.** A range of strategies are available to avoid congestion, such as shifting to off-peak and night travel, adding inventory and storage, using alternative modes and routes, changing facility locations, changing buying patterns, or hiring additional staff and vehicles. These strategies, however, may be costly or disruptive to business operations.[19]

The trucking industry is especially affected by metropolitan congestion. A recent survey of 1,200 managers of trucking companies operating in California found that more than 80 percent consider traffic congestion to be a "somewhat serious" or "critically serious" problem for their business.[20] Specific concerns included unreliable travel times, driver frustration and morale, slow average speeds, increased fuel and maintenance costs, and higher numbers of accidents and insurance costs. Costs to the motor carrier industry may also be passed on to shippers and receivers, increasing the cost of transporting goods. These costs, in turn, may be passed on to consumers in the form of higher costs for food, clothing, housing, and other items. The impact is sizeable because the U.S. economy is highly dependent on trucking. Logistics costs account for roughly 10 percent of gross domestic product – four percent for inventory and six percent for transportation.[21] Within the transportation sector, trucking is responsible for 81 percent of all freight revenues.[22]

A recent survey of trucking company managers in California found that more than 80 percent consider traffic congestion to be a "somewhat serious" or "critically serious" problem for their business.

Most of the nation's growth is forecast in services, high-technology industries, and foreign trade. As a result, there is likely to be less bulk freight, more small shipments, and more demand for individualized services in the future (Figure 3). At the same time, the consumer market is evolving into one in which customers place orders immediately and expect delivery within days of the order. The total number of truck shipments will increase, as will the value and time sensitivity of these shipments. The impacts of congestion on business operations will increase proportionately.

[18] Ibid.

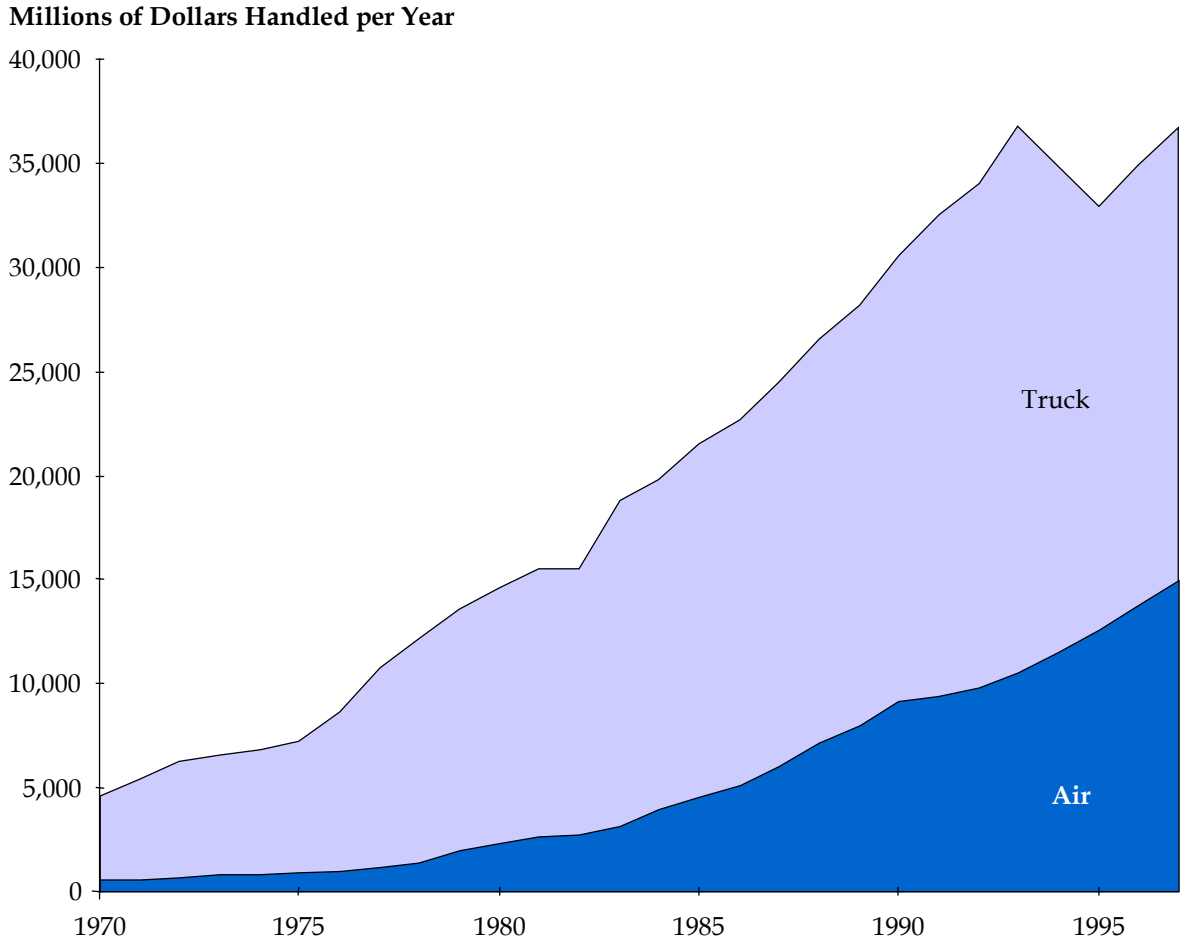
[19] Ibid.

[20] Thomas F. Golob and Amelia C. Regan, "Impacts of Highway Congestion on Freight Operations: Perceptions of Trucking Industry Managers," *Transportation Research* 35 (Part A, 2001).

[21] Cass/ProLogis, Tenth Annual State of Logistics Report, 1998.

[22] *U.S. Transportation Freight Forecast to 2007*, Standard & Poor's DRI (1998).

Figure 3. Growth in Small Package Freight[23]



Impacts on production and sales. Congestion delays product deliveries, inhibiting productivity and raising costs. The cost of delays for businesses can be substantially greater than the cost of driver time and vehicle operating time alone. There are significant transportation-related costs associated with inventory and logistics for some types of business. Much of these costs are due to either perishability of the goods or "just-in-time" needs for stocking and manufacturing processes. Costs are especially high when there is travel time *variability* – i.e., non-predictable delays caused by traffic incidents, which increase under congested conditions.[24]

[23] Bureau of Transportation Statistics, *National Transportation Statistics 1999* (Washington, D.C.: U.S. Department of Transportation, 2000).

[24] Weisbrod, Vary, and Treyz, *Economic Implications*.

An additional cost of congestion relates to the location and patronage of local retail stores. Firms may establish new outlets for their goods and services in order to maintain market share that might be lost because of worsening traffic congestion. Firms also may accept higher prices from local vendors as a tradeoff for not bearing a higher risk of disruption from more distant vendors who might get caught in traffic delays.[25] Both of these situations may lead to higher costs of goods for the consumer as well as to the affected businesses.

Worker access to jobs. Congestion serves to increases the business cost of obtaining employees and limits the effective size of the labor market. Although employees bear the immediate cost of commuting, most businesses absorb some portion of those costs indirectly through personnel-related issues such as:[26]

- Recruitment and retention: higher wages, less qualified applicants, and increased turnover;
- Decreased productivity: stress; tardiness; and costs for alternative work schedules and telecommuting; and
- Cost of employer-provided transportation benefits.

Findings strongly confirm that employers pay higher wages to compensate for higher commuting travel times.[27] Furthermore, if the employee leaves, the firm faces the cost of recruiting and training a replacement worker. If the firm cannot afford adequate wages to compensate for commuting costs or if the labor pool in the area does not match the firms' need, then the firm may consider relocating.[28] Evidence also confirms the benefits of improved access to workers as a result of reduced congestion. A recent study estimated that doubling the effective labor market available to a business leads to an average 6.5 percent increase in business productivity.[29]

4.0 Travel Time Reliability Is Important

According to FHWA estimates, 60 percent of all vehicle-hours lost in congestion are due to non-recurring congestion – congestion that happens unexpectedly due to crashes or other incidents. The greatest effect of incidents on delay is during peak hours: when traffic volumes are high, the presence of a stalled car or a driver changing a flat tire in the

[25] Ibid.

[26] Ibid.

[27] J.S. Zax, "Compensation for Commutes in Labor and Housing Markets," *Journal of Urban Economics* 30 (1991).

[28] Cambridge Systematics, *Impact of Urban Congestion*.

[29] Weisbrod, Vary, and Treyz, *Economic Implications*.

breakdown lane can slow traffic in the adjacent traffic lane, causing 100 to 200 vehicle-hours of delay to other motorists. Crashes (often involving injuries or spills) cause even more chaos. Forty percent of crashes block one or more lanes of traffic. Each crash incident typically lasts 45 to 90 minutes, causing 1,200 to 2,500 vehicle-hours of delay.[30]

Sixty percent of all vehicle-hours lost in congestion are due to non-recurring congestion – congestion that happens unexpectedly due to crashes or other incidents.

Non-recurring congestion is particularly onerous because drivers cannot fully anticipate or plan for it. As a result, it imposes costs well beyond the normal value of time lost. Unreliable travel times create additional costs for both personal travel and freight movement.

Personal travel. Studies suggest that congested travel time is valued more than uncongested travel time (i.e., there is a greater disutility or discomfort associated with congested travel conditions). Unexpected delay is particularly burdensome because people cannot easily plan for it. While people can factor in "normal" congestion as part of their commute, unexpected congestion can make people late for work, meetings, appointments, or other activities. Alternatively, people may choose to leave early in case they run into unexpected traffic, meaning they also may arrive earlier than necessary. Both options lead to lost time or time used in a less than optimal fashion.

A number of empirical studies have demonstrated the importance of considering travel time variability when estimating the benefits to travelers of time savings. One recent study showed that a reduction of one minute of travel time under unexpectedly congested conditions was valued at over 2.5 times the value of one minute of time under normal conditions.[31] The effects of improving travel time reliability, however, are rarely accounted for in project assessments. As a result, proposed transportation projects that have a significant effect on travel time reliability may be undervalued.

Travelers value one minute of travel time under unexpectedly congested conditions at over 2.5 times the value of one minute of time under normal conditions.

Freight movement. Congestion also contributes to longer and more unpredictable travel times for freight shippers. Delays in receiving goods and services can result in lost time

[30] Lance, Grenzeback and Clyde E. Woodle, *The True Costs of Highway Congestion*, ITE Journal, March 1992. Note that these statistics are based on research dating to the 1970s and early 1980s. Research on incident delay is currently underway through the "Temporary Losses of Capacity Study" by the Oak Ridge National Laboratory for the U.S. DOT Operations Core Business Unit. Preliminary findings suggest that the statistics for incident duration and vehicle-hours of delay per incident are slightly lower than cited here, but nonetheless of the same order of magnitude.

[31] Kenneth Small, Robert Noland, Xuehao Chu, and David Lewis, *Valuation of Travel Time Savings and Predictability in Congested Conditions for Highway User-Cost Estimation*, National Cooperative Highway Research Program Report 431 (Washington, D.C.: Transportation Research Board, 1999).

and wages; any unproductive time for people on the assembly line, in the meeting room, or at the warehouse; and possibly the opportunity cost of lost sales. In addition, production operations may be disrupted, and firms may need to add inventory as a buffer against unpredictable delays.[32]

The importance of travel-time reliability is becoming especially pronounced as many manufacturers adopt just-in-time (JIT) manufacturing processes and other schedule-dependent inventory, assembly, and distribution logistics. Time-sensitive manufacturing and delivery systems such as JIT systems are designed to improve productivity and increase profits. JIT systems rely on tightly scheduled and frequent deliveries of supplies and parts to reduce warehousing and inventory needs. While many firms have embraced JIT techniques and have benefited from them, unreliability in the transportation network can impose significant costs if severe enough. Congestion increases transport times and costs; perhaps more important, it also introduces a measure of uncertainty in pick-up and delivery operations. At a minimum, non-recurring congestion imposes opportunity costs on producers as they take measures to protect themselves from the possibilities of missed deliveries and production deadlines.[33]

Studies have shown that reliability is one of the most important factors influencing choices in freight transportation. A recent study estimated that carriers on average value savings in transit time at $144 to $193 an hour and savings in schedule delay at $371 an hour.[34] As in the case of automobile travelers, truckers value time savings in congested conditions more than twice as highly as overall travel time savings.

5.0 Reducing Congestion Is Feasible and Beneficial

It is increasingly being said that we "do not have the resources to build our way out of congestion." Some argue that efforts to increase road capacity or speed traffic flow simply allow more people to drive longer distances – creating more traffic and leading to more congestion. In extreme cases, people argue that this "induced" traffic will fill up the roadway near its previous congestion levels, providing little or no benefit as measured in terms of congestion relief.

It is indeed true that vehicle-miles of travel (VMT) have increased dramatically in recent decades. Evidence suggests, however, that the growth of the highway system is just one of many factors that have influenced the overall growth in vehicle travel. Furthermore, society has experienced significant benefits from past efforts to provide transportation

[32]Cambridge Systematics, *Impact of Urban Congestion*.

[33]Weisbrod, Vary, and Treyz, *Economic Implications*.

[34]Small and others, *Valuation of Travel Time*.

capacity and enhance mobility, and similar benefits will continue to accrue from congestion relief strategies in the future.

Many factors have led to recent growth in vehicle-travel. These factors include population and employment growth, especially in metropolitan areas; more widespread vehicle availability; greater labor force participation by women, meaning more commute trips; a decrease in the average number of persons per household, leading to more trips per capita for household-serving purposes; and the greater ease of vehicle travel enabled by expansion of the highway and road system.[35] A number of studies in recent years have attempted to measure the "induced travel" effect, or the extent to which growth in transportation capacity results in additional travel. Studies that fully account for the range of factors influencing travel growth estimate that highway expansion may be responsible for only a small fraction of recent VMT growth.[36] A recent analysis of induced travel suggests that a highway improvement resulting in a 10 percent decrease in travel time might result in only a one to four percent increase in VMT – not nearly enough to offset the travel time savings from the improvement.[37]

In addition, urban congestion, if severe enough, can push people and businesses toward the periphery of a metropolitan area as they seek uncongested areas. As a result, not addressing issues of urban congestion may lead to additional urban sprawl and associated land use impacts.

Congestion relief strategies are effective. Because of the notion of induced demand, some have come to believe that strategies to relieve congestion are broadly ineffective or unaffordable. In reality, a range of strategies are available and have been effectively used throughout the U.S. to address congestion. These include operational strategies to improve traffic flow on existing facilities and reduce incident-related delays, demand management strategies that provide alternatives to highway travel during congested periods, and strategies to increase capacity by expanding roadways and eliminating bottlenecks.

Strategies to improve traffic flow, such as traffic signal timing, ramp metering, and incident management, have proven effective in many cities at reducing congestion. The Institute of Transportation Engineers estimates that reductions in travel time from traffic signal improvements range from eight to 25 percent.[38] An example of such a traffic management system is the Automated Traffic Surveillance and Control Program in Los Angeles,

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[35] Mark Kiefer and Shomik Raj Mehndiratta, *If We Build It, Will They Really Keep Coming? A Critical Analysis of the Induced Demand Hypothesis*, presented at the 77th Annual Meeting of the Transportation Research Board, Paper No. 980937 (January 1999).

[36] Kevin Heanue, *Highway Capacity and Induced Travel: Issues, Evidence, and Implications*, Transportation Research Circular No. 481 (1998).

[37] Harry Cohen, "The Induced Demand Effect: Evidence from National Data," in *Working Together to Address Induced Demand* (Washington, D.C.: Eno Transportation Foundation, forthcoming).

[38] M. Meyer, ed., *A Toolbox for Alleviating Traffic Congestion* (Washington, D.C.: Institute of Transportation Engineers, Publication No. IR-054B, 1997).

California. In operation since 1984, this system has reported an 18 percent reduction in travel time and a 16 percent increase in average travel speed.[39] A highway ramp metering system implemented in the Twin Cities in the early 1970s provides another example of operational benefits. Fourteen years after implementation, average peak-hour speeds on area highways remained 16 percent higher than before implementation, despite a 25 percent increase in traffic volumes over the same period.[40] The value of ramp metering in the Twin Cities was reconfirmed when travel times increased and travel speeds decreased in a recent experiment in which the ramp meters were turned off.[41] Such strategies have been deployed in a number of metropolitan areas, but could be introduced on a more widespread basis. Further improvements in traffic operations made possible by intelligent transportation systems (ITS) technology will make possible additional congestion relief without physically expanding the capacity of existing roads.

Fourteen years after implementation of a ramp metering system in the Twin Cities, average peak hour speeds on area highways remained 16 percent higher than before implementation, despite a 25 percent increase in traffic volumes over the same period.

Non-recurring congestion – the source of unpredictable delays – can be addressed in a variety of ways. These include incident management to identify and clear incidents more quickly; traveler information to inform people about traffic conditions and alternate routes; "work zone" management programs to ease the flow of traffic through or around work zones; and capacity expansion so that lane blockages are not as severe. ITS that provide real-time information about incidents and traffic delays are one key to reducing non-recurring congestion. For example, adaptive signal controls, which change traffic signal timing to reroute traffic in response to localized congestion, have been shown to reduce delay in a variety of situations by 14 to 44 percent. Incident management programs in Denver, San Antonio, Houston, and Atlanta have shown significant and cost-effective congestion relief benefits ranging from 95,000 to 2 million hours saved per year.[42]

Incident management programs in Denver, San Antonio, Houston, and Atlanta have shown significant and cost-effective congestion relief benefits ranging from 95,000 to 2 million hours saved per year.

Recent studies have confirmed that expanding roadway capacity can also be an effective congestion reduction measure. An analysis by The Road Information Program, using data compiled by the Texas Transportation Institute, compared increases in congestion levels

[39] City of Los Angeles Department of Transportation, *Automated Traffic Surveillance and Control (ATSAC) Evaluation Study*, June 1994.

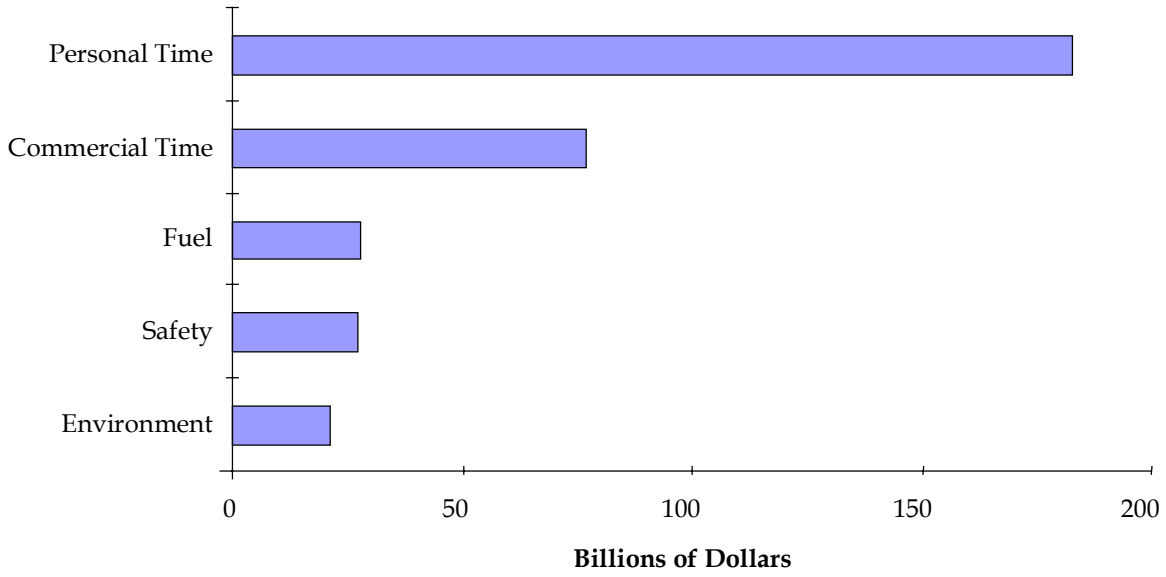
[40] Federal Highway Administration, *Ramp Metering Status in North America* (Washington, D.C..: U.S. Department of Transportation, 1989).

[41] Cambridge Systematics and others, *Twin Cities Ramp Meter Evaluation* (St Paul: Minnesota Department of Transportation, February 2001).

[42] Federal Highway Administration, *Intelligent Transportation Systems Benefits: 1999 Update* (Washington, D.C.: U.S. Department of Transportation, 1999).

and travel delays with increases in road capacity in 68 cities nationwide. The analysis found that areas that were more aggressive in increasing road capacity experienced congestion increases that were 40 percent less than in areas that were less aggressive in adding lane mileage. The study also found that congestion increases as the amount of available lane mileage of roads per driver decreases. Cities with the highest level of congestion had, on average, 18 percent fewer lane miles per driver than the cities with the lowest levels of congestion.[43] A study prepared for the American Highway Users Alliance estimated that improvements to the 166 most serious bottlenecks nationwide including traffic operations, demand management, and capacity expansion could significantly reduce delays, crashes, and air pollution and result in significant cost savings (Figure 4).[44]

Figure 4. Savings From Fixing Bottlenecks



Estimated 20-year savings, in $2000, associated with fixing the nation's 166 worst highway bottlenecks.

Induced traffic represents a benefit. Growth in traffic made possible by transportation system improvements can represent a benefit in and of itself, even if it reduces some of the congestion benefits of congestion relief strategies. The very fact that more people are traveling shows that there is a benefit, because some people are making trips they previously would not have made. This growth in travel may come from a variety of sources. For example, people may choose to make a trip at a more convenient time; they may take

[43] Frank Moretti, *The Best Solutions to Highway Congestion: Dispelling the Myths About the Impact of Expanding Roads* (Washington, D.C.: The Road Information Program, 1999).

[44] Cambridge Systematics, *Unclogging America's Arteries*.

a new trip to a new social activity; or they may find a job that pays better but is farther from their home. In each of these cases, the person making the new or longer trip obviously benefits from the opportunity – otherwise they would not have made the new trip in the first place.

Thus, the benefits of strategies to relieve congestion may not show up entirely as congestion relief: they may also appear in the form of greater traveler convenience, greater access to opportunities, or increased economic development. Economic studies that measure traveler benefits comprehensively – not just in terms of travel time saved – show that there is indeed a positive benefit to road users resulting from congestion relief, even when traffic increases as a result of the project.[45]

Conclusion

Congestion is clearly on the rise in the U.S. It is having an increasing impact on peoples' lives, including their ability to get to work, school, health care, recreation, and other activities; their choice of a residence; and the scheduling of activities in which they participate. It is leading to more crashes, air pollution, and wasted fuel. It is increasing the costs of doing business, as truck drivers waste hours in traffic and production schedules are disrupted. Congestion is ultimately resulting in a less productive economy and reduced quality of life for many people.

Congestion may not be completely curable, but it can be relieved through targeted infrastructure investment. Metropolitan areas that have invested in road capacity in recent years have managed to stem the growth of congestion. Traffic operational improvements, such as signal timing programs, have demonstrated cost-effective and lasting benefits. Incident management programs, utilizing new information technologies, are helping to reduce unexpected congestion – congestion which is particularly onerous because people cannot plan for it.

Reducing congestion, because it is both feasible and beneficial, makes sense.

[45] Patrick DeCorla-Souza and Harry Cohen, *Accounting for Induced Travel in Evaluation of Metropolitan Highway Expansion*, presented at the 77th Annual Meeting of the Transportation Research Board, January 1998, Paper No. 980132 (1997).

Appendix A

Compendium of Facts

Table A.1 Compendium of Facts

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Economic		
Production costs	⇩	A 1988 FHWA study of 35 industry sectors showed that a $1.00 increase in highway capital historically generates about 30 cents of production cost savings over the lifetime of the road improvement.
Production costs	⇩	A 10 percent reduction in travel times for all trips made throughout the Chicago and Philadelphia areas would save the respective business communities an estimated $350 million and $200 million in labor costs each year.
Distribution costs	⇩	Transportation investment provides timely, reliable, low-cost access to domestic and foreign markets.
Distribution costs	⇩	In 1997, the country's roadways, rail lines, airways, waterways, and pipelines shipped 11.1 billion tons of freight valued at nearly $7 trillion.
Distribution costs	⇩	The volume of U.S. merchandise trade (imports and exports) more than doubled from $976 billion in 1992 to nearly $2 trillion in 2000. These increases would not have been possible without a robust transport network.
Access to jobs, schools, and hospitals	⇧	In the state of Washington, the placement of health facilities and roadways permits 98 percent of the population to reach an acute care hospital within 30 minutes.
Access to jobs, schools, and hospitals	⇧	The National Highway System serves 90 percent of the counties in the U.S. and connects all state capitals and urban areas with populations of 50,000 or more.
Access to jobs, schools, and hospitals	⇧	Each year, Americans take over 600 million airplane trips, nine billion transit trips, and drive over two trillion miles.
Personal travel costs	⇩	In 1999, the average U.S. household owned 1.9 motor vehicles and spent $6,614 - or $3,481 per vehicle - to purchase, maintain, and insure them. Households with access to transit can often make do with one fewer vehicle than they would otherwise need.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Economic (continued)		
Personal travel costs	⇩	Investing in roadway maintenance, preservation, and rehabilitation reduces motor vehicle operating costs. Average operating costs per vehicle-mile fall from 30.1 cents per mile for poor pavement to 24.2 cents per mile for good pavement.
Home values	⇧	Efficient highway and transit networks boost home values because commuters value their time very highly - about $20 per hour according to a recent study. Access to a commuter rail, subway, or light rail station can place an additional premium on the value of residential property.
Home values	⇧	In Alameda County, California, statistical models developed to analyze the impact of rail transit on property values showed that a house within a short walk of a BART station would sell for close to 38 percent more than an identical house several miles away.
Home values	⇧	In suburban New Jersey, a study found the median price for homes in proximity to the rail lines operated by the Port Authority Transportation Corporation was 10 percent higher than the price for homes farther away from the rail line.
Home values	⇧	In Philadelphia, a study found the price of homes served by SEPTA commuter service average 3.8 percent more than the price of homes not directly served by commuter rail.
Home values	⇧	In Portland, Oregon, just two years after the completion of the Eastside Metropolitan Express (MAX) light rail line, residential properties within 500 meters of stations in the East Burnside area were worth 10.6 percent more than properties located beyond 500 meters.
Strength of local, regional, and state economies	⇧	The Appalachian Development Highway System is providing portions of 13 southern and mid-Atlantic states with improved access to national markets as well as better intraregional linkages between key economic centers within the region.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Economic (continued)		
Strength of local, regional, and state economies	⇧	Between 1969 and 1991, 110 Appalachian counties with development highways grew 49 percent faster in earnings, 69 percent faster in income, and 6.0 percent faster in population than their statistical "twins."
Strength of local, regional, and state economies	⇧	Commercial and office space in the Rosslyn-Ballston Corridor in Arlington, Virginia has more than tripled since a Metro station opened in 1979.
Strength of local, regional, and state economies	⇧	All but one of 13 counties touching I-40 in Arkansas grew in population in the 1990s, and four doubled in population since 1960, when the interstate began opening in segments.
Strength of local, regional, and state economies	⇧	In Oregon, a recent study showed that each $1 million in highway construction spending generates, directly and indirectly, an additional $531,000 in personal income, $2.0 million in economic output, and $59,000 in general revenue taxes.
Strength of the business travel industry	⇧	Despite the increasing popularity of teleconferencing and videoconferencing as alternatives to face-to-face meetings, business travel boomed during the 1990s. In 1998, nearly 44 million adults in the U.S. took some 272 million business trips.
Strength of the leisure travel industry	⇧	Traffic congestion, construction delays, poor road conditions, absent or confusing signage, inadequate parking facilities and scenic turnouts, barriers to people with disabilities, and lack of public transport options all diminish the drawing power of a tourist attraction.
Strength of the leisure travel industry	⇧	Acadia National Park's Island Explorer shuttle bus carried 240,000 riders during the summer of 2001, a 75 percent increase over 1999, its first year of operation.
Economic losses associated with accidents	⇩	In 1994, the most recent year for which government data is available, the costs associated with accidents were estimated at $150 billion.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Economic (continued)		
Economic losses associated with accidents	⇩	Following the installation of rumble strips along 457 kilometers or rural and urban highways in Illinois between 1990 and 1993, single-vehicle run-off-the-road accidents declined by approximately 18 percent.
Economic losses associated with accidents	⇩	A study of crash rates in four states - California, Michigan, North Carolina, and Washington - showed that the conversion from a two-lane to a four-lane divided road results in a crash per kilometer reduction of roughly 40 to 60 percent.
Economic losses associated with accidents	⇩	In Seattle, Washington, widespread use of small traffic circles on residential streets prevented 273 accidents over a four-year period, saving $1.7 billion in property and casualty losses.
Economic losses associated with accidents	⇩	A study of 11 intersections in the U.S. where modern roundabouts have been constructed showed a 37 percent reduction in the number of crashes and a 51 percent reduction in the number of injuries.
Economic losses associated with congestion	⇩	In 1999, the total cost of congestion in 68 metropolitan areas (those that were the subject of a recent Texas Transportation Institute Study) was a staggering $78 billion. This reflects the economic drain of 4.5 billion hours of delay and 6.8 billion gallons of wasted fuel.
Economic losses associated with congestion	⇩	On average, it takes just five minutes for the Los Angeles County Metro Freeway Service Patrol to reach a vehicle stalled on the highway, compared to more than 20 minutes for a private towing company. The Service Patrol prevents 22 million vehicle-hours of traffic delays each year.
Transportation-related employment opportunities	⇧	In 1999, some 4.4 million individuals were employed in the transport service sector, nearly two million were employed in transport equipment manufacturing, and nearly 4.4 million were employed in related transport industries.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Environmental		
Air pollution	⇩	Although vehicle miles traveled have increased 140 percent since 1970, CO emissions from on-road vehicles have fallen 43 percent, VOC emissions have fallen 59 percent, and lead emissions have fallen nearly 100 percent. Only NOx emissions have increased, by a modest 16 percent.
Air pollution	⇩	With over 1,000 CNG buses in operation and another 1,000 to be delivered by 2004, the Los Angeles County Metropolitan Transit Authority boasts the nation's largest CNG bus fleet. Placing one CNG bus into service is the equivalent of removing the exhaust of 7.2 automobiles.
Air pollution	⇩	In New York City, where taxis account for 10 percent of all vehicle miles traveled, a new Alternative Fuels Taxicab Program provides financial incentives for taxi owners to adapt their vehicles to run on CNG or to purchase new CNG vehicles.
Air pollution	⇩	Increasing average arterial speeds from 10 to 20 mph reduces VOC emissions by roughly 40 percent and NOx emissions by roughly 20 percent.
Air pollution	⇩	Implementation of the EZ-pass electronic toll collection system on the New Jersey Turnpike in 2000 was estimated to reduce VOC and NOx emissions on a typical weekday by 0.35 tons and 0.056 tons, respectively, as a result of reduced queuing and increased, steady speeds.
Air pollution	⇩	In St. Louis, the construction of a new light rail line in 1993 has reduced vehicle miles traveled by as much as 139,100 miles per day, for a daily savings of 7,130 gallons of fuel. During its first year of operation, the new line reduced carbon emissions by 4,500 to 9,600 metric tons.
Air pollution	⇩	Since New York City began work on a 900-mile city-wide bike network in 1994, cycling in Manhattan has increased 15 to 20 percent, translating into an annual emissions reduction of 45 tons of VOC and nearly 50 tons of NOx.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Environmental (continued)		
Noise pollution	⇩	Since 1970, 44 states and the Commonwealth of Puerto Rico have constructed over 1,600 miles of noise barriers at a cost of over 1.9 billion 1998 dollars.
Noise pollution	⇩	Noise barriers reduce noise levels by five to 10 decibels, cutting the loudness of traffic noise by as much as 50 percent. A 10-decibel reduction makes the sound of a passing tractor trailer truck no louder than that of a passing automobile.
Wetlands protection	⇧	The Federal-Aid Highway Program is creating 2.5 acres of wetlands for every acre it takes for road construction. This has resulted in a net gain of 11,628 acres of wetlands nationwide since 1996.
Water pollution	⇩	Constructing or planting natural drainage systems along the side of highways channels and filters rainwater as it runs off the pavement, thereby removing significant amounts of suspended solids, lead, zinc, phosphorous, and nitrogen before it contaminates underground reservoirs.
Light pollution	⇩	To reduce unwanted glare, light trespass, and uplight while saving money and energy, some transportation agencies have invested in fully shielded lighting fixtures that achieve a higher degree of lighting control.
Light pollution	⇩	The city of Tucson, Arizona, 55 miles northeast of Kitt Peak National Observatory, converted from mercury vapor to sodium lights and installed downward-facing fixtures on 40,000 streetlights. Fifty other communities surrounding Kitt Peak have taken similar measures.
Brownfields reclamation	⇧	Across the country, transportation funding is being used to clean up and rehabilitate polluted and abandoned industrial sites for use as intermodal centers and other transportation related-facilities.
Recycling	⇧	Eighty percent of the asphalt removed during road widening and resurfacing projects is recycled for use in other projects.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Environmental (continued)		
Archaeological preservation	⇧	Departments of transportation employ thousands of archaeologists to survey proposed sites, determine their historical significance, and remove artifacts from the ground for safe keeping in museums.
Historic preservation	⇧	To date, the Transportation Enhancements program has funded over 2000 transportation-related historic restoration projects at a cost of $721 million.
Roadkill	⇩	The construction of wildlife overpasses and underpasses (commonly known as ecoducts or "critter crossings") has reduced roadkill and guarded against habitat loss and fragmentation resulting from roadway construction.
Community and Social		
Mobility and access	⇧	In the state of Washington, the placement of health facilities and roadways permits 98 percent of the population to reach an acute care hospital within 30 minutes.
Travel mode choice	⇧	Between 1977 and 1995, the number of person trips made by bicycle increased 30 percent. According to a Harris survey, 20 percent of adults would sometimes bicycle commute to work if they could ride on safe bike lanes.
Travel mode choice	⇧	One of the most ambitious programs in the nation designed to increase bicycle mode share is New York City's Bicycle Network Development project. The 900-mile city-wide network includes on-street bike lanes as well as off-street dedicated bike paths.
Travel mode choice	⇧	Denver's new Southwest light rail line is successful not because it has lured riders from the bus, but because it has attracted new riders who did not take public transit in the past; fully 60 percent of riders surveyed did not use the local bus system prior to using the streetcar.
Safety	⇧	A study of 11 intersections in the U.S. where modern roundabouts have been constructed showed a 37 percent reduction in the number of crashes and a 51 percent reduction in the number of injuries.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Community and Social (continued)		
Safety	⇧	On the 26 miles of highway on which San Antonio's new TransGuide early detection system has been deployed, accidents have fallen by 15 percent and emergency response times have fallen by 20 percent.
Safety	⇧	Thanks to the introduction of the Navigator early detection system on Atlanta highways, emergency response times have averaged just 12 minutes, compared to 15 to 35 minutes before the introduction of Navigator
Safety	⇧	Traffic calming in downtown Lake Worth, Florida caused accident rates to fall by 44 percent in just one year.
Visual blight	⇩	Across the nation, new and rehabilitated infrastructure is being designed with aesthetics as well as function in mind.
Community cohesion	⇧	Transportation investment can stimulate social interaction among members of a community, increase participation in social events, foster closeness among neighbors, and increase people's sense of safety.
Community cohesion	⇧	Over the first three years of the Transportation and Community System Preservation (TCSP) Pilot Program, nearly 200 grants have been awarded to all 50 states to help build livable communities through transportation investment.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Congestion Relief		
Delays	⇩	A 2001 report examining the 68 largest metropolitan areas in the U.S. found that highway congestion causes an estimated 4.5 billion hours of annual delays in these metropolitan areas.
Delays	⇩	The Institute of Transportation Engineers estimates that reductions in travel time from traffic signal improvements range from 8 to 25 percent.
Delays	⇩	The Automated Traffic Surveillance and Control Program in Los Angeles, in operation since 1984, has reported an 18 percent reduction in travel time and a 16 percent increase in average travel speed.
Delays	⇩	A modern roundabout built in Towson, Maryland handles 400 more cars each hour at peak period than did the previous signalized intersection, virtually eliminating traffic tie-ups.
Stress and aggression	⇩	Travelers driving in congestion experience increased levels of stress and aggression, especially if they are late or if the congestion is unexpected. A recent study suggested that a reduction of one minute of "unexpected" travel time was worth 2.5 minutes of travel under normal conditions.
Job access	⇧	Research has shown that congestion may constrain the range of job opportunities available to people.
Costs	⇩	The total annual cost of congestion in the 68 largest metropolitan areas is $78 billion. This reflects the economic drain of lost worker productivity and wasted fuel. More than half of the $78 billion can be attributed to the 10 metropolitan areas with the highest congestion costs.

Table A.1 Compendium of Facts (continued)

The Positive Impacts of Transportation Investment

Issue	Potential Impact of Investment	Comments
Congestion Relief (continued)		
Costs	⇩	Freight carriers on average value savings in transit time at $144 to $193 an hour and savings in schedule delay at $371 an hour. As in the case with automobile travelers, truckers value time savings in congested conditions more than twice as highly as overall travel time savings.
Accident rates	⇩	A 1999 study estimated that, over a 20-year period, improvements to the 167 most serious bottlenecks nationwide would prevent 287,200 crashes, save 1,150 lives, and prevent 141,000 injuries.
Fuel consumption	⇩	In the 68 largest metropolitan areas in the U.S. an estimated 6.8 billion gallons of fuel are wasted each year because of congestion.
Air quality	⇧	Increasing average arterial speeds from 10 to 20 mph reduces VOC emissions by roughly 40 percent and NOx emissions by roughly 20 percent.