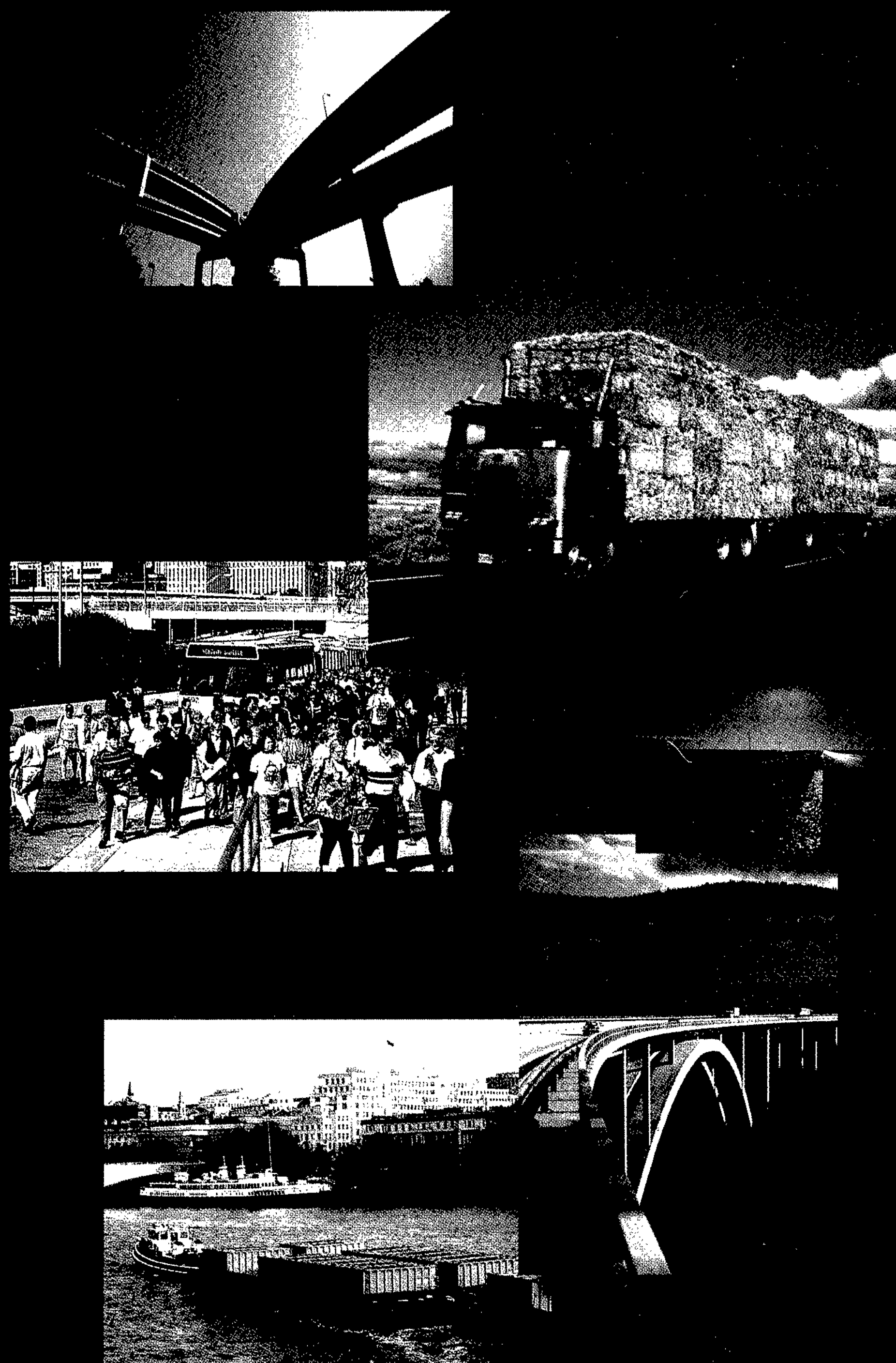
1997 Status of the Nation's Surface Transportation System

Report to Congress



U.S. Department of Transportation

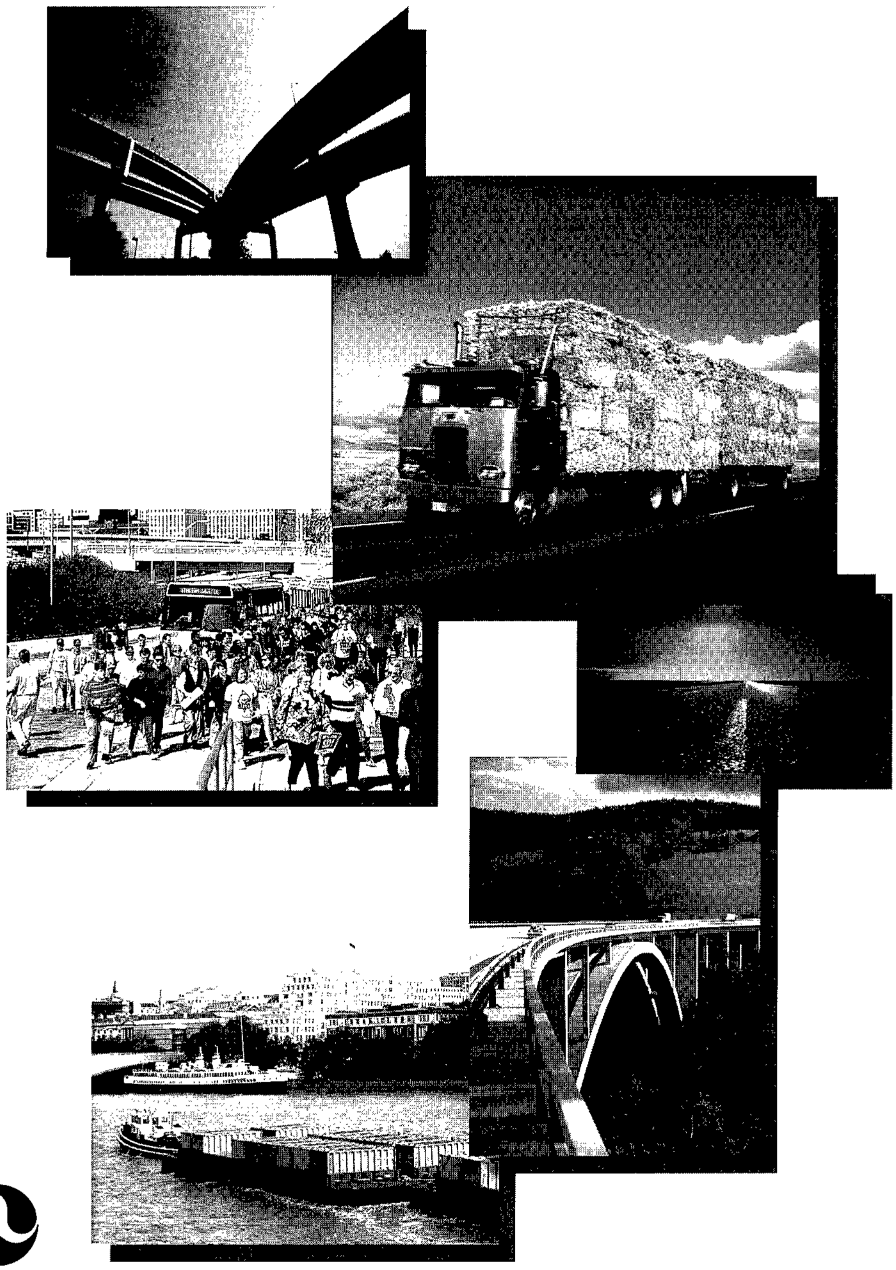
Federal Highway Administration

Federal Transit Administration

FTA-TBP-10-98-2

1997 Status of the Nation's Surface Transportation System

Condition and Performance



U.S. Department of Transportation
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Acknowledgments

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EXHIBITS

SECTION 1

Introduction

This is the 1997 edition of a series of reports required by Congress on America's surface transportation system. The report provides information on the physical and operating characteristics of the highway, bridge, and transit portions of our Nation's intermodal transportation system. It also discusses the current financing of those transportation modes and the future investment that will be required to achieve benchmarks of system performance. The investment analysis employs subjective assumptions about travel growth, land use, vehicle use patterns, and other factors that can be expected to influence future funding requirements.

The analysis in this report is based on data submitted by State and local transportation agencies. Modal administrations of the U.S. Department of Transportation have checked the quality and consistency of the data and ensured that it is systematic, statistically valid, and verifiable.

Highway data are derived from the Highway Performance Monitoring System (HPMS), a cooperative data/analytical effort dating from the mid-1970s that involves the Federal Highway Administration (FHWA) and State and local governments. All HPMS data and estimates of future travel demand are provided to the FHWA through State departments of transportation from existing State or local government data bases or transportation plans and programs, including those of Metropolitan Planning Organizations (MPOs). The State and MPO programs, developed in accordance with good planning practices as outlined in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), are fiscally constrained and reflect public policies that are consistent with environmental concerns and local land use objectives.

HPMS data are collected in accordance with the Highway Performance Monitoring System Field Manual for the Continuing Analytical and Statistical Data Base. This document is designed to create a uniform and consistent data base by providing standardized collection, coding, and reporting instructions for the various data items. State-reported HPMS data are reviewed by FHWA for completeness, consistency, and adherence to reporting guidelines. Where necessary, and with close State cooperation, data may be adjusted to improve completeness, consistency, and uniformity.

Bridge data are derived from the National Bridge Inventory which encompasses all bridges, that are covered by the National Bridge Inspection Standards and are located on a public road. Generally, each bridge is inspected at least once every two years, although bridges with higher risks of engineering problems are inspected more frequently and certain low-risk bridges get less frequent inspections. Special inspection emphasis is given to bridges with: members in which fractures would be critical; underwater members that are difficult to assess for condition, integrity, and safe load capacity because of excessive water depth or turbidity; and unique and special features requiring additional attention. All bridge information is verified for completeness, consistency, and adherence to reporting guidelines.

Transit data are derived from the National Transit Database (NTD) (formerly known as Section 15 data). The NTD includes detailed summaries of financial and operating information provided to the Federal Transit Administration (FTA) by the Nation's transit agencies. The NTD program provides information needed for planning public transportation services and investment strategies. Supplementing this information on transit facilities and fleets with information collected directly from transit operators provides a complete picture of the Nation's transit facilities and equipment.

Report Purpose

This document, submitted by the Secretary of Transportation and published by Congress, provides updated information on highway, bridge, and transit conditions, performance, and investment requirements. It provides informational support to the Nation's transportation policymakers, users, and stakeholders. The report includes information and analysis on the major elements of our intermodal transportation system without regard to jurisdictional responsibility. It offers a comprehensive, factual background to support development and evaluation of legislative, program, and budget options at all levels of government and also serves as a primary source of information for National and international news media, transportation associations, and industry.

Most data in this report are provided at the National level, although as part of the Department's annual statistics publication cycle, selected data are reported by State and/or metropolitan area as submitted by these jurisdictions. Investment analysis is performed and presented only at the National level because of significant variations among States and metropolitan areas in transportation objectives and internal administrative policies, unit costs, weathering, and related variables that influence either infrastructure deterioration rates or investment strategies.

Report Changes

This series of reports, dating from the mid-1960s, has evolved in content and coverage to meet the needs of the Department's partners, customers, and stakeholders. The content of this edition is similar to that of the 1995 edition, but it is presented in a much more condensed and accessible format. It will be available in an electronic version that can be found on the FHWA and FTA home pages (www.fhwa.dot.gov and www.fta.dot.gov). The electronic version will contain hypertext links to other sources of highway, bridge, and transit information as well as to comprehensive source documents that describe in greater detail the data systems and simulation procedures that were used and provide technical notes on methodology changes. Users who access the electronic version can submit questions and comments that will assist in the continuous improvement of this report series.

Data and Methodological Improvements

In addition to being more condensed, this edition incorporates enhancements to data systems and analysis procedures based on peer review recommendations. Where appropriate, the report notes the effect of these changes on estimates of current performance or future investment requirements. Among these changes:

- Highway capacity modifications based on the third edition of the *Highway Capacity Manual* (Transportation Research Board 1994) have been incorporated for all road systems. This modification affects the definition of current congestion levels and the evaluation of future highway capacity requirements.
- The Highway Economic Requirements System (HERS), one of the family of HPMS data and analytical tools, is now used for all highway investment analyses. All highway investment decisions are determined primarily by economic analysis rather than purely engineering factors. With HERS, investments are made only as warranted by marginal benefit/cost analysis, using initial capital cost as the cost factor and changes in vehicle operating costs, safety, and travel time as the benefits factors. In the 1995 report, only one of the two investment scenarios was based on HERS.
- Travel demand elasticity has been introduced into HERS to recognize that as a highway becomes more congested, and the cost of traveling the facility increases, the volume of travel on the facility is constrained. Conversely, when lanes are added, and the cost of traveling the facility decreases, the volume of travel may increase. The transit model will include a similar feature in the future.
- Transit investment analysis is now based on the Transit Economic Requirements Model (TERM). In previous editions of this report, transit investment needs were determined using a series of investment evaluation approaches. TERM consolidates these evaluation tools and introduces a cost/benefit analysis to ensure that

investment benefits exceed investment costs. Specifically, TERM identifies the investments needed to replace and rehabilitate existing assets, improve operating performance, and expand transit systems to address the growth in travel demand, and then evaluates these needs on the basis of costs and benefits to select future investments.

Report Format

This report has two sections: (1) a bulleted summary covering conditions and performance, finance, and investment requirements for highways, bridges, and transit; and (2) a series of significant and relevant questions and answers about these topics. In addition, special new sections are included on the National Highway System, the backbone of the intermodal surface transportation system, and the U.S. freight industry. A table of contents keyed to the topics and specific questions addressed is included for quick reference. Also included are names and addresses of key contacts in the U.S. Department of Transportation for further information on the report.

Future Report Improvements

The Department intends to submit an integrated surface transportation report in 2000. This report will include intermodal performance indicators, as presented in the DOT Strategic Plan, as well as systems-level intermodal investment options where possible.

EXECUTIVE SUMMARY

Our roads, bridges, and transit systems are the foundation of our surface transport system. Our 3.9 million miles of road, 581,000 bridges, 135,000 public transit vehicles, and their support infrastructure, are the result of decades of technical development and innovation, investment, and maintenance. The result of this sustained public commitment is a system that provides the reliability and service that we have come to expect, and on which we depend, to sustain economic performance, provide personal mobility, and help ensure national security. Our surface transport system has, in large measure, shaped the face of America. As we enter the 21st century and broaden our social and economic interaction with other nations in the global economy, the performance of our surface transport system will influence individual and corporate decision making. Sustaining transportation performance through investment and system management will complement other national efforts to improve productivity.

The U.S. surface transport asset base, and our reliance on it, is growing. National public road mileage has increased 1.3 percent since 1985, while highway travel has increased 36.5 percent. Congestion has increased as a result of this disparity but, with increased focus on system preservation, transport agencies have been able to mitigate most physical decay through aggressive pavement and bridge management systems and strategic investment. This is particularly true on higher classes of roads, including the National Highway System. With concerted efforts in driver education and seatbelt usage, elimination of roadside hazards, improvements in ride quality and road geometrics, and safety management, even in the face of this significant growth in highway travel demand, transport agencies have continued to reduce fatalities and crashes, although recent years have seen a stabilization in that trend.

The transit vehicle fleet increased 32 percent from 1985 to 1995 and similar expansions occurred in transit rail and bus capacities. This reflects the adoption by transit agencies of maintenance management strategies to prolong vehicle life. Highway travel growth exceeded transit travel over that period, but recent years have seen a moderation in highway demand and an increase in transit travel. State and metropolitan planning predict that this trend in highway demand moderation and transit travel increase will continue through the 1996-2015 analysis period covered by this report.

Condition and Performance - The amount of pavement in good and/or fair condition continues to increase, while poor pavement continues to decrease. This is particularly true on the higher order roadways, including the National Highway System. The number of deficient bridges has decreased since 1990. Highway safety continues to improve, but at a decreasing rate. These improvements reflect a continued shift in investment toward system preservation, development and deployment of pavement and bridge management systems, and emphasis on removal of roadside safety hazards.

Transit speed of service has increased over the past 10 years. About 80 percent of transit riders have wait times of less than 10 minutes. The condition of light rail equipment has improved, but there has been a slight decline in the condition of buses and heavy rail equipment. Condition of transit facilities, including power systems, stations, structures, and maintenance yards and facilities, continue to improve.

Highway congestion is a continuing problem, and potential decay in system reliability threatens to undermine other corporate and public efforts to improve national productivity. Highway peak-hour congestion has stabilized at a high level, but overall congestion, measured in density of use or hours of delay, continues to increase, and is occurring in more and more locations. Increases in delay add operating cost and inconvenience to users. More important, however, delay threatens system reliability, imposing risk and uncertainty on users and impeding industry's ability to adopt manufacturing and distribution strategies to control warehouse and distribution costs, thus enabling them to compete more effectively in the global economy.

Investment - Public investment in surface transport is at its highest level ever. In 1995, all units of government invested $92.5 billion in highways and bridges, with $43.1 billion of this devoted to capital improvements. All units of government invested $16.5 in transit systems, with $7 billion of this devoted to capital improvements. The surface transportation system is jointly funded by the Federal, State, and local governments, and the private sector. Each level of government has a different role in the improvement, maintenance and operation of the surface transportation system, and different methods for raising revenue.

Funding for highways and transit, which has exceeded inflation over the last 20 years, has not kept pace with inflation since 1993. The percentage of both highway and transit funding provided by the Federal government has risen since 1993. Since 1993 there has been a shift in the type of highway capital improvements made, towards preserving the existing system, and away from adding new capacity. For transit, this period saw a continuation of a shift from operating assistance to capital investment, including rolling stock and facilities.

Investment Requirements - Current system condition and performance provides a useful benchmark for system evaluation and analysis of trends over time. It is also a point of departure for analysis of investments that we must make to ensure system performance for future years.

In the tradition of previous reports, this version contains a maintain and an improve scenario each, for highways, bridges, and transit systems. The highway scenarios are developed using the Highway Economic Requirements System (HERS), a simulation tool introduced in the 1995 report. The HERS defines highway deficiencies and potential improvements through analysis of marginal benefits and costs. Transit scenarios are based on the Transit Economic Requirements Model (TERM), a new simulation procedure that applies benefit/cost tests to potential transit improvements identified on the basis of good practices in asset replacement and transit enhancement.

The two simulation procedures are similar in concept, but different in execution. Both procedures address investment analysis through the use of economic analysis, as directed by Executive Order 12893, "Principles for Federal Infrastructure Investments", published January 26, 1994. The bridge investment requirements, based on engineering assessment in this report, will be based on economic analysis in future versions. The transition to economic analysis is consistent with continued emphasis within transportation agencies toward value engineering, asset management, and greater cost-effectiveness in decision making.

The average annual cost to maintain highway user costs and bridge conditions for the period 1996-2015 is $46.1 billion in 1995 dollars. The average annual cost to improve highways and bridges for the same period is $79.6 billion. The actual 1995 total investment in pavement, highway capacity, and bridge improvements was 13 percent lower than the maintain scenario for that year. Highway and bridge investments could double and still provide user benefits that exceed costs. Any investment up to the improve scenario, referred to as the Maximum Economic Investment scenario, are estimated to yield marginal benefit/cost of greater than 1.0.

The economics based maintain highways estimate is lower than the engineering based estimate used in previous reports. The reduction is due primarily to a slight decline in the highway travel demand growth forecast used in the analysis and full incorporation of the 1994 Highway Capacity Manual, reflecting recent changes in driver behavior. Without these two factors, the maintain scenario would have remained much closer to the 1995 report estimate in constant dollar terms, even with the transition to an economics based approach.

The average annual cost to maintain transit conditions for the period 1996-2015 is $9.7 billion in 1995 dollars. The average annual cost to improve transit conditions is $14.2 billion. The maintain scenario for transit is higher than in previous reports because of a more comprehensive database of transit assets and better understanding of transit unit costs. The total 1995 capital investment in transit was 28 percent lower than the maintain scenario for that year. The improve transit scenario indicates that transit investment could also double and still provide marginal user benefits that exceed costs.

The investment analyses for both highways and transit require assumptions on future travel demand by mode. Highway travel forecasts assume a continuation in the moderation of highway demand. Transit estimates assume continuation of the growth in travel, which has occurred, in recent years. These assumptions reflect planning expectations of many of our larger urbanized areas, where environmental constraints, social and fiscal concerns, and adoption of demand management policies may result in improved travel demand management and encouragement of transit usage. These travel growth assumptions will influence both the surface transport investment requirements and the requirements for each mode to meet its service expectations.

The final section of this report focuses on the U.S. freight transportation system, including all modes of transport. This section provides an overview of the freight system through the use of modal profiles and provides a look at the forces of change that are or will impact freight providers as we move into a new century.

SECTION 2

Highlights

Highway and Bridge System and Usage Characteristics

- The rural principal arterial system accounted for 4.2 percent of rural mileage and 3.3 percent of total mileage in 1995, while accounting for 47 percent of rural travel and 18 percent of total travel.
- The urban principal arterial system accounted for 9 percent of urban mileage and 1.9 percent of total mileage in 1995, while accounting for 58 percent of urban travel and nearly 56 percent of total travel.
- Total National public road and street center-line mileage reached 3.9 million miles in 1995, an increase of 1.3 percent from 1985.
- The share of total miles in rural areas decreased from 82 percent to 79 percent between 1985 and 1995 because of the expansion of Federal-aid urban and urbanized area boundaries and the reclassification of certain U.S. Forest Service roads as nonpublic roadways.
- Rural highway lane-mileage decreased an average of 0.3 percent annually between 1985 and 1995 reflecting urban boundary changes as a result of the 1990 census.
- Urban highway lane-mileage increased 1.7 percent annually between 1985 and 1995 and 2.3 percent annually between 1991 and 1995. Urban boundary changes contributed to this increase.
- With the expansion of urban and urbanized area boundaries, urban freeways, including Interstates, experienced the largest lane-mileage increase of any category of highway—3.4 percent per year between 1991 and 1995.
- Total highway travel reached 2.4 trillion vehicle miles in 1995.
- Vehicle miles traveled increased in all highway categories between 1985 and 1995, with urban travel increasing 3.6 percent per year and rural travel increasing 2.5 percent per year.
- Combination trucks (trailers and semitrailers) accounted for 16.5 percent of total travel on rural Interstate highways but only 5.4 percent of travel on urban Interstate highways in 1995.
- There are 581,862 highway bridges, an increase of about 1 percent over the past 2 years.

Transit System and Usage Characteristics

- In 1995, 537 local public transit operators provided transit services in 316 urbanized areas. An additional 5,010 organizations provided transit services in rural and small urban areas.
- There were 135,564 transit vehicles, 9,582 miles of track, 2,620 rail stations, and 1,165 maintenance facilities in 1995.
- The urban transit fleet increased 32 percent from 1985 to 1995, an annualized growth rate of 3.2 percent.
- The combined route miles of rapid rail, commuter rail, and light rail (or streetcar) transit services reached 8,206 miles in 1995. The comparable reported rail figure in 1985 was 5,761 route miles.
- Nonrail route miles, including buses, ferryboats, vans, and other conveyances reached 158,078 miles in 1995, compared to 138,973 route miles in 1985.

- In 1995, transit rail capacity consisted of 16,729 rail passenger vehicles providing 1.6 billion equivalent vehicle miles, an annualized increase of 2.4 percent since 1985. Nonrail capacity provided 1.7 billion vehicle miles in 1995, an annualized increase of 1.2 percent since 1985.
- Total transit travel equaled 38 billion passenger miles traveled (PMT) in 1995.

Highway Conditions and Operational Performance

- The pavement condition of the Nation's urban and rural highways as measured by the International Roughness Index has improved or remained stable, depending on the system. The percentage of poor pavement on rural Interstates declined from 6.9 percent to 5.1 percent and on urban Interstates increased from 9.5 percent to 9.8 percent from 1993 to 1995.
- The condition of the Nation's bridges as measured by the percentage of deficient bridges on public roads has improved since 1990. The percentage of deficient bridges on Interstate highways has declined from 28.6 percent in 1990 to 24.8 percent in 1996.
- While the overall fatality rate for all highways declined from 2.47 to 1.73 per 100 million vehicle miles of travel between 1985 and 1995, the rate of decline has slowed. Since 1993 the fatality rate has remained nearly constant, dropping from 1.75 to 1.73.
- Since 1993, fatality rates on rural interstates declined from 1.25 to 1.20. Fatality rates on urban interstate, urban other arterials, and rural other arterials rose. Fatality rates on collectors and local roads declined.
- The percent of peak-hour urban Interstate travel that occurs under congested conditions has increased from 49.7 percent in 1990 to 52.2 percent in 1995. Congestion is defined as a volume/capacity ratio of 0.8 or greater. The volume of urban Interstate travel per lane mile has increased at an average rate of 2.4 percent per year since 1985.

Transit Conditions and Performance

- This report makes use of the Transit Economic Requirements Model (TERM). Compared to prior approaches, TERM provides a more accurate depiction of the relationship between asset age and condition, more detailed data for the creation of asset condition measures, and more current and better defined transit asset inventories. TERM subjects proposed transit investments to a benefit-cost analysis so that the investment scenarios in this report include only projects with net benefits.

Bus

- The overall weighted condition of the bus and urban paratransit fleet in 1995 was "adequate," reflecting a slightly declining bus condition trend since 1985.
- Forty-five percent of bus maintenance facilities are less than 20 years old. The remainder range in age from 21 to 100 years, with the age range of 21 to 30 years having the highest percentage (34 percent).

Rail

- In 1995, the average weighted condition of all rail vehicles was "good."
- The average condition of the rapid rail and commuter rail fleets declined between 1985 and 1995 while the light rail fleet condition improved. The average condition rating for each vehicle type remained "good."

- The average fleet age of all classes of rail vehicle types in 1995 was greater than one-half the useful-life guideline of 25 years. As a result, there is a backlog of overage rail vehicles in need of replacement.
- Seventy-three percent of transit track in 1995 was in "good" or "excellent" condition.

Highway Finance

- All levels of government provided $95.3 billion for highway programs in 1995, with the Federal Government contributing $19.9 billion; the States $49 billion; and counties, cities, and other local government entities $26.4 billion.
- Highway user revenues (the total amount generated from motor fuel taxes, motor vehicle fees, and tolls) were $84.1 billion in 1995, with $59.6 billion of this total going to highway programs. This represented 62 percent of total funding for highways.
- Highway user revenues from all sources would have been sufficient to cover 91 percent of all highway expenditures if the full amount had been used for highways. This was the highest percentage since 1956 and a substantial increase from the low of 62 percent in 1980.
- Of the $95.3 billion provided for highway programs in 1995, $43.1 billion went for capital outlay, $44.8 billion for noncapital expenditures, and $4.7 billion for debt retirement, while $2.8 billion was placed in reserves for future expenditures.
- Federal funds accounted for $19.2 billion, or 44 percent of the $43.1 billion in highway capital outlay. As a percentage of capital outlay, the Federal share has remained in a range of 41 to 46 percent since 1985.
- Growth in highway spending has outpaced inflation over time, rising 31 percent in constant dollar terms from 1975 to 1995. Since 1993, highway expenditures have not kept pace with inflation, falling 3.3 percent in constant dollar terms. This is due to a slowing growth rate of highway spending, and a 12.7 percent increase in highway construction prices over this 2 year period. Federal highway spending has outpaced inflation over this period, growing 0.7 percent in constant dollar terms.
- There has been a shift in the types of highway capital improvements, being made with the portion of highway capital outlay used for system preservation growing from 45 percent in 1993 to 50 percent in 1995; the portion used for capacity expansion falling from 49 percent to 41 percent; and the portion used for other improvements such as safety enhancements, traffic operations improvements, and environmental enhancements climbing from 6 percent to 9 percent.
- Expenditures for new construction of roadways and bridges dropped from $7.5 billion in 1993 to $5.5 billion in 1995.

Transit Finance

- All levels of government provided $16.5 billion for transit operations and capital improvements in 1995, with the Federal Government contributing $4.1 billion and State and local governments contributing $12.4 billion.
- Federal funding for transit in constant dollars (1995) peaked in 1984 at $5.7 billion and was at $4.1 billion in 1995. State and local support has remained over $12 billion annually in constant dollars since 1991.
- After reaching a low of 45 percent in 1980, the State and local share of transit funding climbed steadily until about 1991. Since then, during the ISTEA era, the state and local share of total transit funding has remained near 77 percent.

- Of the $23.2 billion spent for transit in 1995, $7 billion went for capital and $16.2 billion for operating costs. Approximately $7 billion of this total was from fare boxes and other system generated revenue.
- Federal capital assistance to transit remained relatively stable between 1988 and 1995, while the level of State and local contributions increased.
- Bus services accounted for 55 percent of total operating expenses in 1995, while heavy rail accounted for 22 percent and commuter rail 14 percent. Demand-responsive service and light rail accounted for 4 percent and 2 percent, respectively.

Highway and Bridge Investment Requirements

- The average annual highway investment by all levels of government required for the period 1996-2015 to maintain highway user costs at 1995 levels (Maintain User Costs scenario), and to maintain the current state of bridge deficiencies, is $46.1 billion.
- The average annual highway investment by all levels of government required for the period 1996-2015 to implement all cost beneficial improvements on highways (Maximum Economic Investment scenario), and to eliminate all bridge deficiencies is $79.6 billion.
- The Maintain User Cost scenario replaces the Cost-to-Maintain scenario in the 1995 C&P report. The new scenario is based on economic analysis as directed by Executive Order 12893, "Principals for Federal Infrastructure Investment", published January 26, 1994. The Maintain User Cost scenario uses the Highway Economic Requirements System (HERS) model to estimate the investment required to maintain user costs (delay, vehicle operating and crash costs). The Cost-to-Maintain scenario used in the 1995 C&P report estimated the amount required to maintain highway physical conditions and operational performance. By making improvement selections based on benefit/cost analysis, the HERS model can achieve its goal of maintaining user costs at a lower capital cost than under the previous scenario.
- The average annual investment requirements under the Maintain User Cost scenario are 18.5 percent lower than the amount shown under the Cost-to-Maintain scenario in the 1995 C&P report. This reduction is primarily due to the change in scenario goals, the full incorporation of the 1994 Highway Capacity Manual procedures into the analysis, and a reduction in the projected travel demand provided by the States.
- The Economic Efficiency scenario from the 1995 C&P report was renamed as the Maximum Economic Investment scenario in this report, but was otherwise unchanged. As in the 1995 report, this scenario was developed using HERS. The average annual investment requirements under this scenario were 7.8 percent higher than those in the C&P report. This increase was less than the amount of construction price inflation.
- Travel demand elasticity has been introduced into HERS to recognize that as a highway becomes more congested, and the cost of traveling the facility increases, the volume of travel on the facility is constrained. Conversely, when lanes are added, and the cost of traveling the facility decreases, the volume of travel may increase. This report uses travel demand elasticity factors of -0.8 for short-term elasticity, and -1.0 for long term elasticity. This means that if highway-user costs on a facility were to increase by 10 percent, the model assumes that travel on the facility would decline by 8 percent within five years, and by an additional 2 percent within 20 years. The elasticity factors do not affect the Maintain User Cost scenario, but they do increase effective highway travel demand under the Maximum Economic Investment scenario by 0.29 percent per year, or 5.6 percent over 20 years.
- The investment requirements in this report are based on an assumption that average annual VMT growth will decline to 1.96 percent for the period 1996 to 2015 under the Maintain User Cost scenario and 2.25 percent under the Maximum Economic Investment scenario. The VMT growth rate in 1995 was 2.77 percent. If the projected growth rates are too low, then the investment requirements may be understated.

- Based on 1995 expenditures, the level of investment by all levels of government would need to increase by 13 percent to reach the estimated 1996 investment requirements under the Maintain User Costs scenario, and would need to increase by 93 percent to reach the estimated 1996 investment requirements under the Maximum Economic Investment scenario.

Transit Investment Requirements

- An estimated annual average of $9.7 billion in transit investments would be required from all sources to maintain transit conditions and performance at 1995 levels. Actual investment in 1995 was $7 billion, 72 percent of the amount required.
- An estimated annual average of $14.2 billion in transit investments would be required to bring transit assets to a condition rating of "good" by 2016 and improve transit performance in terms of service levels, average vehicle speed and convenience.

National Highway System

- The National Highway System (NHS) consists of 156,986 miles, 4.0 percent of total mileage. Total VMT on the NHS was 1.0 trillion in 1995, 43.0 percent of total VMT.
- Historical data on NHS pavement condition, bridge condition and congestion trends are not available, since the system was only recently designated.
- The percentage of poor pavement on the rural portion of the NHS was 2.8 percent better than all rural arterials and major collectors; on the urban portion of the NHS 9.2 percent of the mileage was poor, slightly worse than all urban arterials and collectors.
- On the NHS, 45.1 percent of the urban peak-hour travel occurs with a volume/capacity ratio of 0.8 or greater, which is considered congested travel.
- The percentage of deficient NHS bridges was 23.8 percent in 1995, better than the national percent of deficient bridges.
- In 1995, all levels of government spent $20.3 billion for capital outlay on the NHS. This represents 47.2 percent of total capital outlay of $43.1 billion.
- An estimated $12.5 billion of Federal grants to States and local governments was used for capital outlay on the NHS in 1995. This is the equivalent of 61.7 percent of the total capital outlay, and represents 66.7 percent of total Federal grants to State and local governments of $18.8 billion.
- Of the $20.3 billion spent for capital outlay on the NHS in 1995, $17.1 billion was related to the investment requirements outlined in this report.
- The average annual investment required by all levels of government to maintain user costs on the NHS at the 1995 level for the next 20 years is $19.9 billion; to accomplish all improvements on the NHS that are economically justified would require an average of $36.8 billion.

SECTION 3

Questions and Answers

System Characteristics

This section describes these elements of infrastructure by type and ownership, and provides detailed information on highway and transit system and usage characteristics and trends in recent years. The surface transport asset base consists of roads, bridges, and public transit systems classified according to the service they provide. Since public transit systems also own and operate vehicle fleets, public transit vehicles, equipment, and supporting infrastructure also form part of the transport asset base.

National public road mileage has increased a total of 1.3 percent since 1985, to over 3.9 million miles. Highway travel has increased 36.5 percent over the same period, but the annual rate of increase in highway travel has moderated in recent years. This trend toward moderated rates of growth in highway travel is consistent with the travel forecast discussed later in this report, and used in the investment requirements estimations.

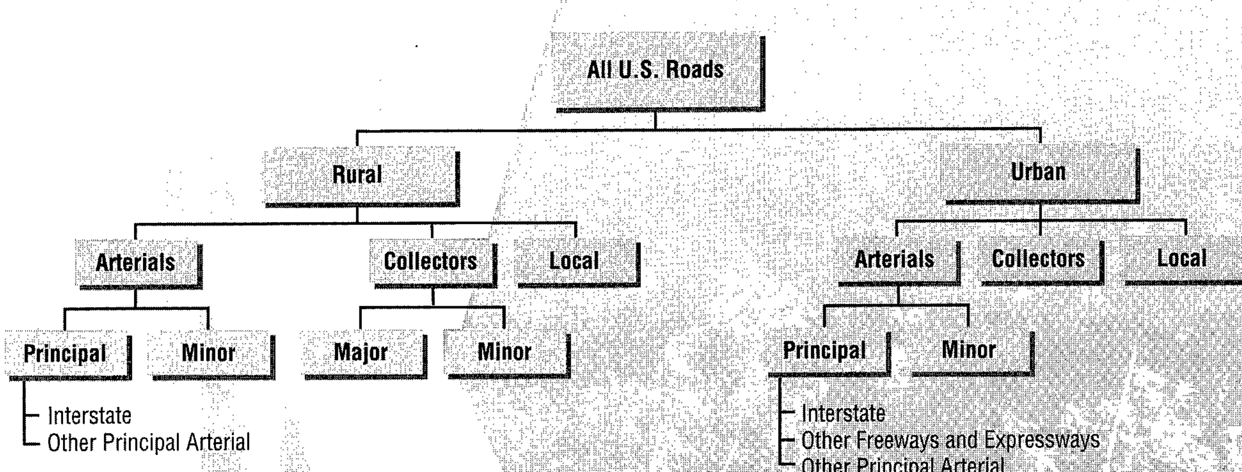
The urban transit vehicle fleet increased 32 percent from 1985 to 1995. Transit rail capacity, a measure combining fleet size and extent of service offered, increased annually 2.4 percent and bus capacity increased annually 1.2 percent over the same period. Total transit travel remained almost unchanged over the period, with rail ridership increases offset by bus ridership losses. Total transit travel has increased in recent years, with indications that this upturn will continue when more recent data are available.

Highway and Bridge System Characteristics

Q: What is the total length of the nation's highway system?

A: Total national public road and street center-line mileage reached 3.91 million miles in 1995.

Exhibit 3-1
Highway Functional Classification Hierarchy



Q: How are different types of public roads and streets classified?

A: All public roads and streets in the United States are functionally classified as arterials, collectors, and local roads depending on the type of service they provide. These major systems are further subdivided into both rural and urban areas. The arterial system, which includes the Interstate, provides the highest level of mobility, at the highest speed, for long uninterrupted distances. Arterials generally have higher design standards than other roads, often with multiple lanes and some degree of access control. The collector system provides a lower level of mobility than arterials at lower speeds and for shorter trips. Collectors are usually two-lane roads that collect and distribute travel to and from the arterial systems. The majority of public road and street mileage is classified as local. Local roads provide the access between residential and commercial properties and the higher functional systems. *[See Exhibit 3-1]*

Q: What percentage of miles, lane miles and vehicle-miles traveled is on each functional system?

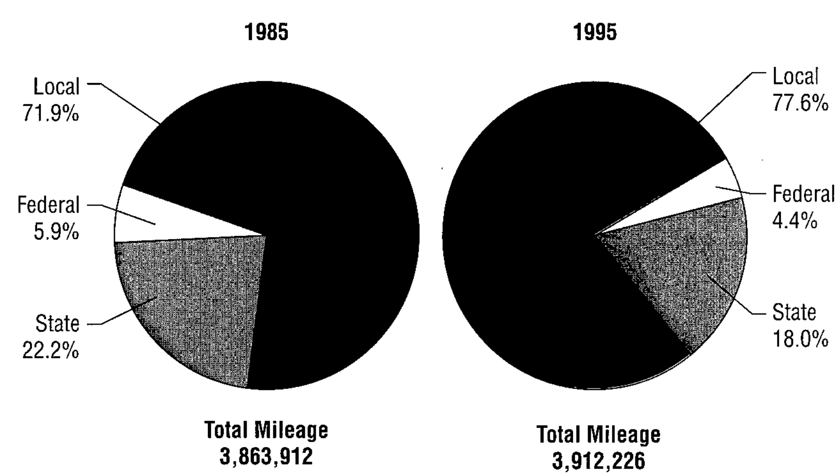
A: While the rural and urban local roads comprised 68.7 percent of total public road mileage in 1995, they carried only 12.8 percent of total vehicle-miles traveled (VMT). Collectors accounted for 20.2 percent of mileage and carried 15.1 percent of VMT. Arterials comprised 11.0 percent of mileage, and 72.1 percent of travel. *[See Exhibit 3-2]*

Exhibit 3-2
Percent Highway Miles, Lane Miles, and Vehicle-Miles Traveled by Functional System 1995

Functional System	Miles	Lane-Miles	Vehicle-Miles Traveled
Rural Highways			
Interstate	0.8%	1.6%	9.2%
Other Principal Arterial	2.5%	3.0%	8.9%
Minor Arterial	3.5%	3.5%	6.3%
Major Collector	11.0%	10.7%	7.7%
Minor Collector	7.0%	6.7%	2.1%
Local	54.1%	51.9%	4.3%
Subtotal Rural	**78.9%**	**77.4%**	**38.5%**
Urban Highways			
Interstate	0.3%	0.9%	14.1%
Other Freeway & Expressway	0.2%	0.5%	6.2%
Other Principal Arterial	1.4%	2.2%	15.3%
Minor Arterial	2.3%	2.8%	12.1%
Collector	2.2%	2.3%	5.3%
Local	14.6%	13.9%	8.5%
Subtotal Urban	**21.0%**	**22.6%**	**61.5%**
Total Highway	**100.0%**	**100.0%**	**100.0%**

Source: Highway Statistics, 1995

Exhibit 3-3
Highway Mileage by Jurisdiction 1985-1995



Source: Highway Statistics, Summary to 1995

Q: How has the mileage for all levels of government changed in recent years?

A: Total national public road and street center-line mileage reached 3.91 million miles in 1995, an increase of 1.3 percent over 1985. In 1995, 77.6 percent of total mileage was under local government jurisdiction, 18.0 percent was under State government jurisdiction and 4.4 percent was under Federal jurisdiction. *[See Exhibit 3-3]*

Q: How is this total divided among rural and urban roads?

A: In 1995, there were 3.09 million miles of rural highways, representing 79.0 percent of total mileage. The remaining 0.82 million miles, 21.0 percent, were urban highways.

Q: How are rural and urban defined in this report?

A: Rural areas include only those with a population of under 5,000. The urban figure includes all mileage in areas with a population of 5,000 or greater, including both small urban areas with a population of 5,000 to 50,000, and urbanized areas with a population of greater than 50,000. Some areas that were formerly rural have been reclassified as urban, as their population has grown.

Q: Did the mileage of both urban and rural highways increase between 1985 and 1995?

A: No. While urban highway mileage increased 1.7 percent annually between 1985 and 1995, rural mileage decreased by 0.3 percent annually over the same period. *[See Exhibit 3-4]* The decrease in rural mileage was the result of the expansion of Federal-aid urban and urbanized area boundaries and the reclassification of certain U.S. Forest Service roads as nonpublic roadways.

The functional class with the largest decline in mileage was rural minor collectors, down 0.8 percent annually. Urban Other Freeway and Expressways showed the greatest increase, up 2.3 percent annually.

Exhibit 3-4
Highway and Transit Route Miles by Functional System 1985-1995

Functional System	1985	1995	Annual Rate of Change
Rural Highway Miles (population < 5000)			
Interstate	32,760	32,580	-0.1%
Other Principal Arterial	80,722	97,948	2.0%
Minor Arterial	146,587	137,151	-0.7%
Major Collector	432,761	431,712	0.0%
Minor Collector	296,660	274,081	-0.8%
Local	2,183,477	2,119,048	-0.3%
Subtotal Rural	**3,172,967**	**3,092,520**	**-0.3%**
Urban Highway Miles (population > = 5000)			
Interstate	10,828	13,164	2.0%
Other Freeway & Expressway	7,169	8,970	2.3%
Other Principal Arterial	49,887	52,796	0.6%
Minor Arterial	72,178	88,510	2.1%
Collector	75,374	87,331	1.5%
Local	475,509	568,935	1.8%
Subtotal Urban	**690,945**	**819,706**	**1.7%**
Total Highway Miles	**3,863,912**	**3,912,226**	**0.1%**
Urban Transit Route Miles			
Rail	5,761	8,206	3.6%
Non-Rail	138,973	158,078	1.3%
Total Urban Transit	**144,734**	**166,284**	**1.4%**

Source: Highway Statistics, Summary to 1995; Federal Transit Administration National Transit Database (NTD)

Q: What is the mileage on each functional class, adjusted for number of lanes?

A: Total highway lane-mileage was 8.16 million in 1995. This total is broken down by functional class in Exhibit 3-5.

Q: How much did total highway travel increase between 1985 and 1995?

A: Between 1985 and 1995, total highway travel increased by 3.2 percent a year, reaching 2.4 trillion vehicle miles traveled (VMT) in 1995. *[See Exhibit 3-6]* Overall VMT grew 2.8 percent between 1994 and 1995.

Q: Did VMT increase in both urban and rural areas between 1985 and 1995?

A: Yes. Urban travel increased 3.6 percent a year between 1985 and 1995, partly because of expanding urban boundaries, while rural travel increased 2.5 percent per year. Between 1994 and 1995 urban VMT increased 2.8 percent while rural VMT increased 2.7 percent.

The functional class with the largest increase in VMT was urban interstate, which grew by 4.7 percent annually between 1985 and 1995.

Exhibit 3-5

Highway Lane-Miles and Transit System Equivalent Lane-Miles by Functional System 1985-1995

Functional System	1985	1995	Annual Rate of Change
Rural Highway Lane-Miles (population < 5000)			
Interstate	131,808	131,916	0.0%
Other Principal Arterial	202,398	244,888	1.9%
Minor Arterial	307,434	285,818	-0.7%
Major Collector	873,187	869,266	0.0%
Minor Collector	592,124	548,462	-0.8%
Local	4,363,070	4,238,096	-0.3%
Subtotal Rural	**6,470,021**	**6,318,146**	**-0.2%**
Urban Highway Lane-Miles (population > = 5000)			
Interstate	57,327	41,377	2.2%
Other Freeway & Expressway	31,598	40,293	2.5%
Other Principal Arterial	159,264	179,815	1.2%
Minor Arterial	180,940	225,720	2.2%
Collector	162,203	185,032	1.3%
Local	951,006	1,137,870	1.8%
Subtotal Urban	**1,542,338**	**1,840,107**	**1.8%**
Total Highway Lane-Miles	**8,012,359**	**8,158,253**	**0.2%**
Urban Transit Capacity Equivalent Miles			
Rail	1,330,595	1,645,789	2.1%
Non-Rail	1,503,958	1,688,729	1.2%
Total Urban Transit	**2,834,553**	**3,334,518**	**1.6%**

Source: Highway Statistics, 1985-1995; UPDATED AS OF 10/97
Federal Transit Administration National Transit Database (NTD), 1985-1995

Exhibit 3-6
Highway Vehicle and Passenger Miles of Travel (Millions of Miles) 1985-1995

Functional System	1985	1995	Annual Rate of Change
Rural Highway Vehicle-Miles (population < 5000)			
Interstate	154,357	223,382	3.8%
Other Principal Arterial	145,881	215,567	4.0%
Minor Arterial	136,922	153,028	1.1%
Major Collector	163,297	186,212	1.3%
Minor Collector	43,372	49,936	1.4%
Local	86,899	105,164	1.9%
Subtotal Rural	**730,728**	**933,289**	**2.5%**
Urban Highway Vehicle-Miles (population > = 5000)			
Interstate	216,188	341,528	4.7%
Other Freeway & Expressway	97,408	151,560	4.5%
Other Principal Arterial	279,121	370,338	2.9%
Minor Arterial	201,741	293,272	3.8%
Collector	89,578	126,929	3.5%
Local	160,062	205,907	2.6%
Subtotal Urban	**1,044,098**	**1,489,534**	**3.6%**
Total Highway Vehicle Miles	**1,774,826**	**2,422,823**	**3.2%**
Total Highway Passenger Miles	**2,845,893**	**4,017,442**	**3.5%**

Source: Highway Statistics, Summary to 1995

Q: What has been the rate of growth of travel by combination trucks (trailers and semitrailers)?

A: Between 1985 and 1995, travel by combination trucks grew by 4.0 percent a year, more than the average growth rate of 3.2 percent for all types of vehicles. *[See Exhibit 3-7]* Between 1994 and 1995 combination truck VMT increased 6.0 percent. In 1995, these trucks accounted for 16.4 percent of total travel on rural Interstate highways, but only 5.4 percent of travel on urban Interstates.

Q: Has the number of highway bridges increased?

A: There were 581,862 highway bridges in 1996, an increase of about 1 percent since 1994. *[See Exhibits 3-8 and 3-9]*

Exhibit 3-7
Highway Travel by System and Vehicle Type (Millions of Vehicle Miles) 1985-1995

Functional System		1985	1995	Annual Rate of Change
Rural				
Interstate	PV	124,719	180,031	3.7%
	SU	4,817	6,708	3.4%
	Combo	24,822	36,644	4.0%
Other Arterials	PV	255,571	331,539	2.6%
	SU	9,558	12,980	3.1%
	Combo	17,674	24,076	3.1%
Other Rural	PV	273,801	315,687	1.4%
	SU	10,724	12,948	1.9%
	Combo	9,043	12,676	3.4%
Subtotal Rural	PV	654,091	827,257	2.4%
	SU	25,099	32,636	2.7%
	Combo	51,539	73,396	3.6%
Urban				
Interstate	PV	198,876	315,888	4.7%
	SU	4,882	7,148	3.9%
	Combo	12,430	18,492	4.1%
Other Urban	PV	798,355	1,101,516	3.3%
	SU	15,461	22,923	4.0%
	Combo	14,095	23,567	5.3%
Subtotal Urban	PV	997,231	1,417,404	3.6%
	SU	20,343	30,071	4.0%
	Combo	26,525	42,059	4.7%
Total	PV	1,651,322	2,244,661	3.1%
	SU	45,442	62,707	3.3%
	Combo	78,064	115,455	4.0%

PV= Passenger Vehicles (including buses and 2-axle, 4-tire vehicles), SU= Single Unit Trucks (6 tires or more), Combo= Combination Trucks (trailers and semi-trailers).

Source: Highway Statistics, Summary to 1995

Exhibit 3-8
Bridges by Jurisdiction

Jurisdiction	Number of Bridges
Federal	6,171
State	273,198
Local	299,078
Private	2,378
Unknown/ Unclassified	1,037
Total	**581,862**

Source: National Bridge Inventory, June 30, 1996

Exhibit 3-9
Bridges by Functional System 1996

Functional System	Number of Bridges
Rural Bridge	
Interstate	28,638
Other Principal Arterial	34,445
Minor Arterial	38,525
Major Collector	96,576
Minor Collector	47,670
Local	211,059
Subtotal Rural	**456,913**
Urban Bridge	
Interstate	26,596
Other Fwy & Expwy	14,887
Other Principal Arterial	23,170
Minor Arterial	21,007
Collector	14,848
Local	24,441
Subtotal Urban	**124,949**
Unknown/ Unclassified	**0**
Total	**581,862**

Source: National Bridge Inventory, June 30, 1996

Transit System Characteristics

Transit receives funds from the Federal, State and local level but remains essentially a localized public service in execution. Increasingly, transit services transcend local jurisdictions and transit institutional and financial matters commonly are determined through regional decision making and institution building. Insofar as transit play an increasingly important role in regional job access, congestion mitigation, and shaping development, the institutional evolution of transit funding and governance is expected to accelerate, strengthening MPOs and regional transit authorities. These public policy roles are embodied in the transit's functions discussed below.

Q: How are public transit services classified?

A: Public transit services can be classified according to the public policy purposes served by individual trips. Transit performs three public policy functions: low-cost mobility, congestion management, and supporting livable metropolitan areas. Exhibit 3-11 illustrates these functions.

Q: What is transit's low-cost mobility function?

A: All transit systems in the United States provide low-cost mobility for people who do not or cannot operate a motor vehicle because of low income, disability, youth, or old age. It's an important characteristic of low-cost mobility service that regular access is provided to as many destinations as possible in the service area for a fare that low-income passengers can afford.

Q: What is transit's congestion management function?

A: Transit services that can compete effectively with the automobile are the most effective in mitigating congestion. If transit consistently provides rapid door-to-door travel speeds, a large proportion of automobile owners will choose transit to avoid the unreliability and delays of roadway congestion. Congestion management service commonly operates along a separate right-of-way such as a busway, high-occupancy vehicle lane, or rail line.

Q: What is transit's livable metropolitan areas function?

A: The livable metropolitan areas function is supported by transit operations that serve pedestrian-oriented and multiple-purpose central business districts and communities. Transit has its strongest role in supporting a livable metropolitan area when pedestrian access to transit enables households and businesses to reduce their use of motor vehicles.

Q: How many transit operators are there?

A: In 1995, 537 local public transit operators provided transit services in 316 urbanized areas. An additional 5,010 organizations provided transit services in rural and small urban areas.

Q: How many transit vehicles and facilities are there?

A: In 1995, there were 135,564 transit vehicles, 9,582 miles of track, 2,620 rail stations, and 1,165 maintenance facilities. The urban vehicle fleet increased 32 percent from 1985 to 1995, for an annualized growth rate of 3.2 percent. *[See Exhibit 3-10]*

Q: What are transit route miles?

A: Transit route miles are the number of miles covered by a particular transit route, regardless of how many transit vehicle runs operate over that route. In cases where transit routes overlap, the overlapping distance is counted separately for each route. For instance, when two different bus routes travel on the same road for a mile, that mile represents two route miles. *[See Exhibits 3-3]*

Q: How many transit route miles are there?

A: The combined route miles of rapid rail, commuter rail, and light rail (or streetcar) transit services reached 8,206 miles in 1995. The comparable reported rail figure in 1985 was 5,761 route miles. Nonrail route miles, including buses, ferryboats, vans, and other conveyances, reached 158,078 miles in 1995, compared to 138,973 route miles in 1985. *[See Exhibits 3-3]*

Q: What is transit capacity?

A: Transit rail and bus capacity is the average number of miles traveled by each transit vehicle multiplied by the number of vehicles, expressed as standardized "bus equivalent vehicles." For example, a rapid rail car might have seats for 95 passengers, or the seating capacity equivalent of 2.2 standard buses.

Q: What are the trends in transit capacity?

A: In 1995, transit rail capacity consisted of 16,729 rail passenger vehicles providing 1.6 billion equivalent vehicle miles, an annualized increase of 2.1 percent since 1985. Nonrail capacity provided 1.7 billion vehicle miles in 1995, an annualized increase of 1.2 percent since 1985. *[See Exhibits 3-5]*

Q: How is transit travel measured?

A: Transit travel is measured in passenger miles traveled (PMT), the total number of miles traveled on transit vehicles by all transit passengers.

Q: What are the trends in transit passenger miles traveled?

A: Total transit travel equaled 38 billion PMT in 1995, about the same as in 1985. *[See Exhibit 3-12]* Rail transit patronage totaled 19.7 billion PMT in 1995, an average increase of 1.3 percent a year since 1985. Bus transit patronage was 18.3 billion PMT in 1995, down 1.1 percent per year since 1985. Transit PMT is

Exhibit 3-10
Mass Transit Active Fleet and Infrastructure 1995

	Areas > 1 Million	Areas < 1 Million	Total
Vehicles			
Buses	40,962	17,443	58,405
Rapid Rail	10,157	0	10,157
Light Rail	917	38	955
Self-Propelled Commuter Rail	2,645	0	2,645
Commuter Rail Trailers	2,382	20	2,402
Commuter Rail Locomotives	565	5	570
Vans	12,751	5,573	18,324
Other (Including Ferryboats)	261	64	325
Rural Service Vehicles	0	12,450	12,450
Special Service Vehicles	4,400	24,931	29,331
Total Active Vehicles	**75,040**	**60,524**	**135,564**
Infrastructure-Track			
Rapid Rail	2,073	0	2,073
Light Rail	678	23	701
Commuter Rail	6,717	68	6,785
Other Rail	21	2	23
Total Miles of Track	**9,489**	**93**	**9,582**
Infrastructure-Stations			
Rapid Rail	989	0	989
Light Rail	441	37	478
Commuter Rail	1,097	7	1,104
Other Rail	42	7	49
Total Transit Rail Stations	**2,569**	**51**	**2,620**
Infrastructure-Maintenance Facilities			
Rapid Rail	53	0	53
Light Rail	20	3	23
Commuter Rail	42	0	42
Ferryboat	4	15	19
Bus	281	220	501
Demand Responsive	23	45	69
Other	8	0	8
Rural Transit Maintenance Facilities	0	450	450
Total Maintenance Facilities	**431**	**734**	**1,165**

Source: Federal Transit Administration National Transit Database (NTD)

about evenly divided between bus and rail travel.

Q: What are the trends in transit system utilization?

A: Transit system utilization is the ratio of transit passenger miles traveled (PMT) to transit capacity equivalent miles (see definitions above). From 1985 to 1995, the transit service utilization rate declined by 15 percent, with a greater decline (20 percent) in the use of nonrail service than in rail service (8 percent). Transit fares are a principal determinant of transit patronage. About half of this decline can be attributed to the increase in real transit fares of 22 percent between 1985 and 1995.

Exhibit 3-11
Public Policy Functions of Transit

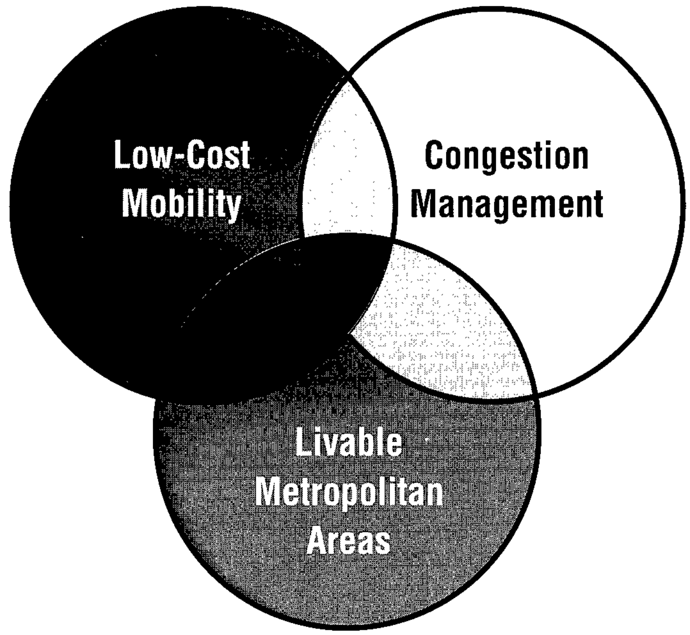


Exhibit 3-12
Transit Passenger Miles of Travel (Millions of Miles) 1985 - 1995

Transit Passenger Miles	1985	1987	1989	1991	1993	1995
Rail	17,334	18,131	19,766	18,551	17,867	19,682
Non-Rail	20,455	18,241	18,455	18,921	18,353	18,289
Total	**37,789**	**36,372**	**38,221**	**37,472**	**36,220**	**37,971**

Source: Federal Transit Administration National Transit Database (NTD)

Conditions and Performance

This section contains an assessment of highway and transit operational performance and condition. Operational performance is a portrayal of the quality of service provided by our highway and transit systems. Condition includes a survey of pavement ride quality, number of deficient bridges, and the condition of transit vehicles and facilities.

Highway system operational performance is an appraisal of how well the system accommodates travel demand. When the demand is not fully accommodated, congestion results. Congestion is currently measured by comparing travel during the peak hour to the capacity of the system to accommodate that travel. This point measure is limited because it only addresses peak-hour and disregards total hours of congestion. As congestion increases, peak-hour congestion tends to stabilize, even as total hours of congestion continue to increase. Focusing on peak-hour values, alone, leads to erroneous conclusions about highway operational performance. This report augments peak-hour congestion measures with daily vehicle miles-of-travel per lane-mile, a better measure of overall density of highway use. In future reports, total vehicle hours of delay will be reported. Delay is considered the single most informative measure of congestion and highway operational performance, impacting user costs, emissions, accidents, and productivity measures.

Transit system performance is measured by speed of service, wait times, number of transfers, portion of passengers with seats, and travel time. The condition of transit systems is measured by the age and conditions of busses and rail transit vehicles, and the condition of other transit infrastructure.

Pavement ride quality, the indicator used in this report to characterize highway condition, is measured by International Roughness Index (IRI), a recognized measure of surface roughness. The IRI is the only standardized measure used today by all transportation agencies to characterize highway condition. It is considered highly objective and consistent over time. Bridge conditions are measured by the number of deficient bridges, categorized as structurally deficient or functionally obsolete.

Overall, congestion continues to increase slightly on most urban highways. The portion of poor pavement continues to decrease. The number of deficient bridges has decreased since 1990. Highway fatality rates, which had declined for several years, have remained nearly constant since 1993. Transit speed of service has increased over the past 10 years. There has been a slight decline in the condition of buses over the past decade. The condition of rail cars has also declined slightly, although the condition of light rail equipment has improved over the same time period.

Highway Operational Performance and Safety

Q: Has traffic congestion become better or worse in the last several years?

A: Congestion in urban areas measured during the peak travel hour on arterial streets and highways has become slightly worse over the past 5 years. Exhibit 3-13 shows the percentage of peak-hour travel that occurred in congested conditions from 1990 to 1995, based on the procedures in the most recent *Highway Capacity Manual* (HCM). Note that in urban areas congestion has increased on the Interstate system, decreased on other freeways and expressways, and increased on other principal arterials. Since 1993 the peak-hour congestion appears to have somewhat stabilized, both on urban Interstate and on urban principal arterials overall. However, this does not address congestion during the rest of the day. *[See Exhibit 3-13]*

Q: How is highway congestion measured?

A: The traditional measure is the ratio of the volume of traffic using a road in the peak travel hour to the capacity or service flow of that road (V/SF). The higher the value of this ratio, the more congested the facility. Above 0.80, travelers on the road experience significant interference with free travel flow. Above 0.95, congestion is likely to be severe. The likelihood of severe disruption to the traffic flow increases dramatically as 1.00 is approached, and any incident will cause stop-and-go travel. (It should be noted that the V/SF ratio measures only the severity of peak-hour congestion, not its extent or duration.) The procedure for calculating the V/SF ratio is contained in the HCM. The Transportation Research Board updates the HCM when studies indicate that the actual capacity of highways to accommodate traffic has changed or when research provides more accurate procedures.

Q: Has the HCM been updated recently?

A: The HCM was updated in 1994. The 1994 HCM supported a substantial increase in the maximum traffic flow, particularly for freeways. This increase is caused by the willingness of drivers to travel at higher speeds and with less space between cars—closer headways—than in the past, allowing more vehicles per lane to pass a given point in a given period of time.

Q: How did updating the HCM affect congestion measures?

A: The calculated value of peak-hour congestion decreased when the 1994 procedures were introduced. For the last 5 years when 1985 HCM procedures were used, urban Interstate peak-hour travel was calculated to be approximately 68 to 70 percent (1989 to 1993). When the 1994 revised procedures are used (calculations have been carried back to the 1990 data) the percentage measures about 50 to 52 percent.

Q: What is the significance of the changes in driver behavior reflected in the 1994 HCM?

A: Headways between vehicles, at the current HCM freeway capacity values, average approximately 1.6 seconds. This provides very little cushion between vehicles, and when something happens to disrupt the traffic stream, the rate of traffic flow decreases very rapidly. The decrease in headways between vehicles at higher speeds has significant safety implications. Any incident causes a delay condition that usually persists for several hours, or until the rush period is over.

Q: The average daily travel per lane mile for both rural and urban Interstate highways continues to increase. What is the significance of that trend?

A: Rural Interstate travel is increasing rapidly, although the volume per lane is much less than in urban areas. Congestion increases with the increase in travel per lane, and while it is true that drivers are adapting to driving in more congested surroundings, this does not mean the congestion has no effect. Incidents that occur on more highly congested routes cause greater delays than those on less congested highways. *[See Exhibit 3-14]*

Exhibit 3-13
Percentage of Congested Travel on Urban Principal Arterial Highways
Peak-hour travel with V/SF over 0.80 Based on 1994 Highway Capacity Manual

Year	All Urban Principal Arterial Highways	Urban Interstate Highways	Urban Other Freeways & Expressways	Urban Other Principal Arterials
1990	40.1%	49.7%	48.2%	29.5%
1991	40.0%	50.1%	47.4%	29.0%
1992	39.7%	48.7%	46.2%	29.3%
1993	42.3%	52.7%	48.4%	31.3%
1994	41.0%	52.7%	46.6%	29.9%
1995	41.1%	52.2%	44.7%	30.2%

Source: HPMS Data, various years

Exhibit 3-14
DVMT per Lane-Mile

	1985	1987	1989	1991	1993	1995	Annual Rate of Change
Rural							
Interstate	3200	3530	3880	4120	4310	4640	3.8%
Other Principal Arterial	1970	2090	2210	2220	2310	2410	2.0%
Minor Arterial	1220	1300	1390	1440	1390	1470	1.9%
Major Collector	510	540	580	600	560	590	1.5%
Urban							
Interstate	10340	11230	11990	12420	12520	13110	2.4%
Other Expressway & Freeway	8440	9240	9910	10140	9770	10300	2.0%
Other Principal Arterial	4800	5010	5240	5280	5540	5650	1.6%
Minor Arterial	3050	3220	3420	3460	3490	3560	1.6%
Collector	1510	1600	1650	1780	1830	1880	2.2%

Source: HPMS Master Data Sets, various years and Highway Statistics, various years

Note: DVMT = Daily Vehicle Miles of Travel

Q: Is there a better way than the peak-hour V/SF ratio to measure congestion?

A: It is difficult to measure congestion. The V/SF ratio does not address the total number of hours of congested travel or the number of miles of routes that are congested more than one or two hours per day. Recent studies have recommended that delay be used as the most accurate indicator of congestion, but delay is difficult to quantify. Research is under way to estimate delay using available data, and we plan to use this measure in later versions of this report.

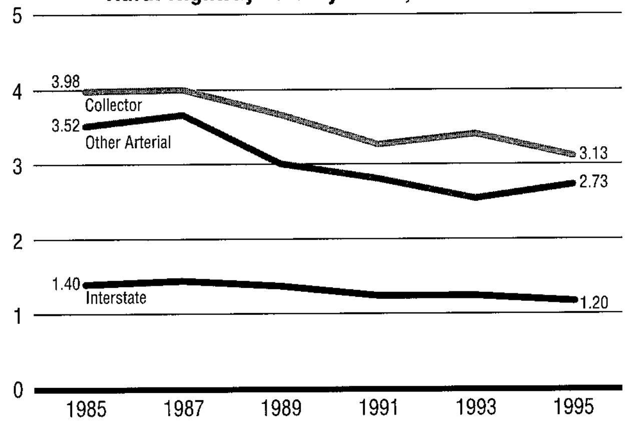
Q: The Texas Transportation Institute (TTI) has published estimates of the cost of congestion in 50 of the Nation's cities for a number of years. Are these estimates reasonable?

A: The TTI estimates use a simple but serviceable procedure to estimate the cost of congestion. This procedure is not based directly on HCM procedures, but assumes that a given traffic volume per lane per day (dependant on the type of facility) defines the threshold of congestion. To the cost of recurring delay based on the amount of travel above this threshold, TTI adds an estimate of the cost of delay caused by incidents and an allowance for increased fuel consumption. In 1994, the latest report available in the TTI series, the annual cost of congestion in the 50 cities studied is estimated to be $53 billion. Since 1987, the beginning of the report series, the cost of congestion has risen at an annual rate of 3.8 percent after adjustment for inflation. The TTI reports do not account for changes in driver behavior over time, as do the revisions to the HCM procedures. While future research may provide more sophisticated procedures to estimate delay and the total costs of congestion, the trend shown in the TTI report series may be a reasonable representation of what is happening in the Nation's cities.

Q: What has been the trend of fatality rates on our Nation's highways?

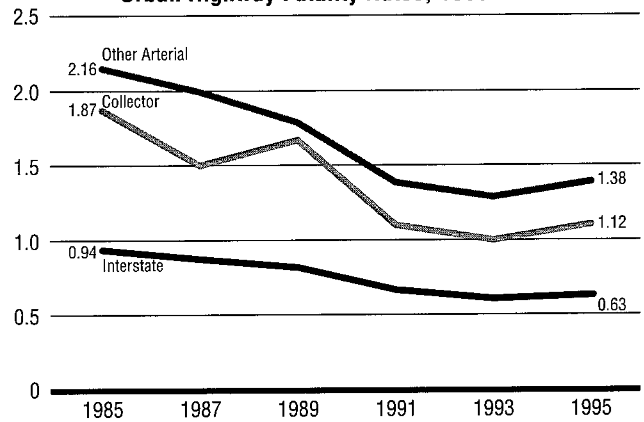
A: While the overall fatality rate has declined from 2.47 to 1.73 per 100 million vehicles traveled since 1985, the rate of decline has slowed in recent years. Since 1993 the overall

Exhibit 3-15
Rural Highway Fatality Rates, 1985-1995



Source: Highway Statistics, Various Years

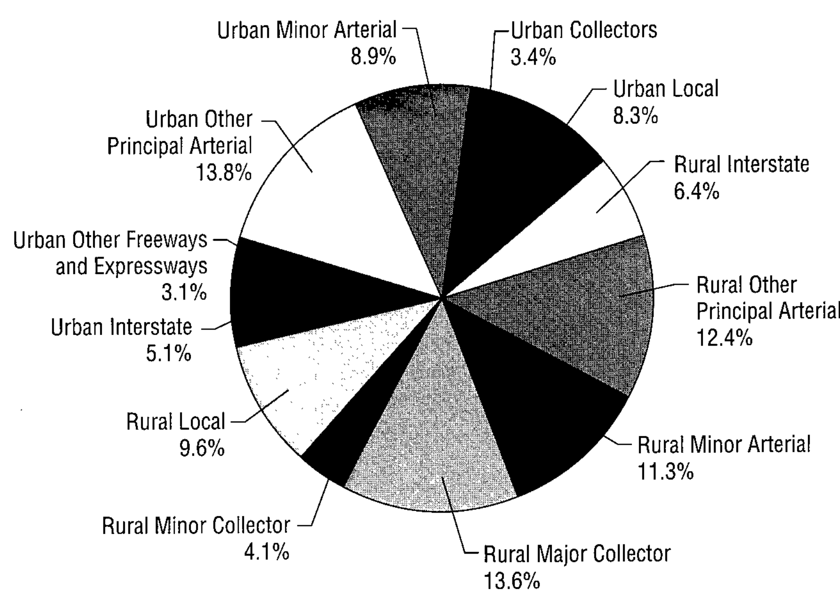
Exhibit 3-16
Urban Highway Fatality Rates, 1985-1995



Source: Highway Statistics, Various Years

fatality rate has remained nearly constant, dropping from 1.75 to 1.73. While fatality rates on rural interstates declined since 1993 from 1.25 to 1.20, they increased on other rural arterials from 2.55 to 2.73. Fatality rates on urban interstate increased from 0.61 to 0.63, while the rate on other urban arterials increased from 1.02 to 1.38. In both rural and urban areas, these increases in arterial fatality rates were offset by decreases in fatality rates on collectors and local roads. There are still areas of the highway system that need improvement. Most changes made to improve pavement conditions and bridges on our nation's highways (e.g., repairing potholes, reducing rutting, improving pavement markings, widening lanes on bridges, adding shoulders on bridges) will have a positive influence on highway safety. In addition, run-off-the-road crashes account for 32 percent of the total number of traffic-related fatalities, and bicycle- and pedestrian-involved crashes for 15 percent. These areas—run-off-the-road crashes, and bicycle- and pedestrian-involved crashes—will be key elements of FHWA's future focus on highway safety. *[See Exhibits 3-15, 3-16, and 3-17]*

Exhibit 3-17
Distribution of Fatalities by Functional Class 1995



Source: Highway Statistics 1995

Highway Conditions

Q: Based on the best available data, what are the pavement conditions on the Nation's highways?

A: Exhibit 3-18 shows the percentages of pavement in each of five roughness categories: poor, mediocre, fair, good, and very good.

Q: Are the conditions of the Nation's highway pavements getting better or worse?

A: Conditions measured by pavement roughness have improved on most highway systems over the past two years. However, during the same two years the Department has continued the shift from using the Present Serviceability Rating (PSR) to using the International Roughness Index (IRI) for rural arterials and urban principal arterials as the measure for assessing pavement, and the trend may have been biased because of this change. Also, two years is really too short a period to provide a significant pavement condition trend. Nonetheless, the apparent decline in the mileage of poor pavement is consistent with the trends of the past decade. IRI is the cumulative deviation from a smooth surface in inches per mile. PSR is still reported for rural major collectors and urban minor arterials and collectors. *[See Exhibit 3-19]*

Q: Why did you change from PSR to IRI?

A: The change to a recognized international standard was made to obtain an objective

Exhibit 3-18
Percent Miles by Pavement Roughness Category

	Poor	Mediocre	Fair	Good	Very Good
Rural					
Interstate	5.3%	20.6%	22.8%	37.4%	13.9%
Other Principal Arterial	1.9%	7.0%	53.2%	29.0%	8.9%
Minor Arterial	2.6%	8.9%	53.3%	26.4%	8.9%
Major Collector	7.3%	12.7%	31.9%	21.2%	27.0%
Subotal Rural	**5.5%**	**11.5%**	**38.7%**	**24.1%**	**20.3%**
Urban					
Interstate	9.8%	26.5%	23.7%	28.4%	11.6%
Other Freeway & Expressway	4.3%	9.2%	54.8%	21.0%	10.6%
Other Principal Arterial	11.8%	14.5%	47.8%	16.2%	9.7%
Minor Arterial	6.7%	13.6%	36.3%	21.0%	22.3%
Collector	9.7%	16.8%	38.6%	17.9%	16.9%
Subtotal Urban	**8.9%**	**15.4%**	**39.5%**	**19.3%**	**16.8%**
Total	**6.4%**	**12.6%**	**38.9%**	**22.8%**	**19.4%**

Source: HPMS Data, 1995. Includes Puerto Rico and the District of Columbia

Note: Data as of 10/97

Exhibit 3-19
Poor Pavement – Percent Miles

	1993 Percent Poor	1995 Percent Poor	2 Year Change
Rural			
Interstate	6.9%	5.3%	-1.6%
Other Principal Arterial	9.3%	1.9%	-7.4%
Minor Arterial	11.0%	2.6%	-8.4%
Major Collector	6.8%	7.3%	0.5%
Subtotal Rural	**8.0%**	**5.5%**	**-2.4%**
Urban			
Interstate	9.5%	9.8%	0.3%
Other Freeway & Expressway	9.9%	4.3%	-5.6%
Other Principal Arterial	15.0%	11.8%	-3.2%
Minor Arterial	7.9%	6.7%	-1.2%
Collector	10.6%	9.7%	-0.9%
Subtotal Urban	**10.5%**	**8.9%**	**-1.6%**
Total	**8.6%**	**6.4%**	**-2.2%**

Source: HPMS Data, 1995. Includes Puerto Rico and the District of Columbia

Note: Data as of 10/97. Does not include unpaved or unreported data measurement of pavement roughness. PSR was being measured in a variety of ways, using both subjective evaluations and mechanical equipment. This made comparisons over time and across jurisdictions inconsistent and of dubious value. IRI is an objective measurement and can therefore be tracked over time and compared across jurisdictional boundaries with greater confidence. This improvement in our ability to assess pavement roughness more than outweighed the temporary anomalies that the change might have created in the trend measurements of pavement conditions.

Q: How do current pavement conditions compare with conditions over the past 10 years?

A: Exhibit 3-20 shows pavement conditions from 1985 to 1991 based on PSR, not IRI. Therefore, this information is not directly comparable to the information on current conditions. It is clear, however, that the percentage of poor pavement declined and the percentage of good to very good pavement increased from 1985 to 1991. This overall improvement agrees with the 1993–1995 trend, which is based primarily on IRI.

Q: What is the impact of poor pavement roughness or condition on the traveling public?

Exhibit 3-20
Pavement Condition History

	1985	1987	1989	1991
Rural				
Interstate				
Poor	10.8%	11.6%	9.1%	7.6%
Mediocre	14.1%	15.5%	15.4%	15.6%
Fair	15.4%	14.4%	17.1%	15.9%
Good & Very Good	59.7%	58.4%	58.4%	60.8%
Other Arterials				
Poor	8.3%	6.6%	4.8%	3.9%
Mediocre	10.0%	11.0%	9.9%	8.0%
Fair	36.7%	37.3%	37.4%	38.3%
Good & Very Good	44.9%	45.0%	47.8%	49.8%
Collectors				
Poor	12.8%	12.0%	10.5%	8.2%
Mediocre	13.4%	13.0%	12.7%	12.0%
Fair	27.2%	26.9%	27.9%	29.8%
Good & Very Good	24.2%	26.5%	28.6%	30.1%
Unpaved	22.3%	21.7%	20.3%	19.9%
Urban				
Interstate				
Poor	11.1%	11.1%	9.6%	7.7%
Mediocre	19.5%	18.5%	16.1%	15.6%
Fair	13.5%	15.0%	16.7%	16.6%
Good & Very Good	56.0%	55.4%	57.6%	60.1%
Other Arterials				
Poor	9.0%	8.7%	7.7%	6.8%
Mediocre	13.9%	14.0%	13.4%	13.2%
Fair	34.7%	35.2%	36.5%	36.0%
Good & Very Good	42.0%	41.7%	42.1%	43.6%
Collectors				
Poor	13.1%	13.6%	17.6%	11.3%
Mediocre	17.4%	17.4%	16.5%	17.4%
Fair	35.3%	36.6%	33.3%	36.0%
Good & Very Good	32.5%	31.1%	31.3%	34.2%
Unpaved	1.7%	1.3%	1.4%	1.1%

Source: HPMS Data, various years

Note: Where unpaved is not shown, the percentage is less than 1 percent

A: Rough pavement affects the cost of travel on the roadway. These costs include vehicle operating costs, delay, and crash or accident costs. Poor road surfaces cause additional wear or even damage to vehicle suspensions, wheels, and tires. Vehicles slowing for potholes can cause delay. In a heavy flow of traffic, such slowing can create significant queuing and subsequent delay. Inadequate road surfaces can lead to crashes when unexpected changes in the surface and reduction in the road surface friction due to age or wear affect the stopping ability or maneuverability of vehicles.

Bridge Conditions

Q: Are Interstate bridge conditions getting better or worse?

A: Bridge conditions on the Interstate system, measured by the number of deficient bridges, have improved over the past several years. Since 1990, the percentage of deficient Interstate bridges has declined from 28.6 percent to 24.7 percent. This means that there are fewer Interstate bridges that cannot carry expected loads or that lack adequate horizontal or vertical clearances. *[See Exhibit 3-21]*

Exhibit 3-21
Interstate Bridge Deficiencies 1990-1996

	1990		1992		1994		1996	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural Bridges	29,171		29,148		28,865		28,638	
Deficient Bridges	6,811	23.4%	5,659	19.4%	5,342	18.5%	5,479	19.1%
Structural	1,521	5.2%	1,330	4.6%	1,162	4.0%	1,249	4.4%
Functional	5,290	18.1%	4,329	14.9%	4,180	14.5%	4,230	14.8%
Urban Bridges	24,012		25,013		25,861		26,596	
Deficient Bridges	8,397	35.0%	8,066	32.3%	7,920	30.6%	8,181	30.8%
Structural	2,327	9.7%	2,367	9.5%	2,141	8.3%	2,070	7.8%
Functional	6,070	25.3%	5,699	22.8%	5,779	22.4%	6,111	23.0%
Total Bridges	53,183		54,161		54,726		55,234	
Deficient Bridges	15,208	28.6%	13,725	25.3%	13,262	24.2%	13,660	24.7%
Structural	3,848	7.2%	3,697	6.8%	3,303	6.0%	3,319	6.0%
Functional	11,360	21.4%	10,028	18.5%	9,959	18.2%	10,341	18.7%

Source: National Bridge Inventory

Exhibit 3-22
Other Arterial Bridge Deficiencies 1990-1996

	1990		1992		1994		1996	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural Bridges	72,997		78,123		72,453		72,970	
Deficient Bridges	18,639	25.5%	19,884	25.5%	15,693	21.7%	15,693	21.5%
Structural	8,430	11.5%	9,965	12.8%	6,914	9.5%	6,622	9.1%
Functional	10,209	14.0%	9,919	12.7%	8,779	12.1%	9,071	12.4%
Urban Bridges	51,618		54,589		57,012		59,064	
Deficient Bridges	20,852	40.4%	20,481	37.5%	20,506	36.0%	20,710	35.1%
Structural	7,559	14.6%	7,544	13.8%	7,247	12.7%	6,902	11.7%
Functional	13,293	25.8%	12,937	23.7%	13,259	23.3%	13,808	23.4%
Total Bridges	124,615		132,712		129,465		132,034	
Deficient Bridges	39,491	31.7%	40,365	30.4%	36,199	28.0%	36,403	27.6%
Structural	15,989	12.8%	17,509	13.2%	14,161	10.9%	13,524	10.2%
Functional	23,502	18.9%	22,856	17.2%	22,038	17.0%	22,879	17.3%

Source: National Bridge Inventory

Exhibit 3-23
Collector Bridge Deficiencies 1990-1996

	1990		1992		1994		1996	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural Bridges	152,435		147,148		147,612		144,246	
Deficient Bridges	51,145	33.6%	42,270	28.7%	39,398	26.7%	37,158	25.8%
Structural	30,703	20.1%	25,933	17.6%	23,645	16.0%	21,375	14.8%
Functional	20,442	13.4%	16,337	11.1%	15,753	10.7%	15,783	10.9%
Urban Bridges	11,865		13,647		14,702		14,848	
Deficient Bridges	5,477	46.2%	5,847	42.8%	5,932	40.3%	5,976	40.2%
Structural	2,353	19.8%	2,440	17.9%	2,415	16.4%	2,337	15.7%
Functional	3,124	26.3%	3,407	25.0%	3,517	23.9%	3,639	24.5%
Total Bridges	164,300		160,795		162,314		159,094	
Deficient Bridges	56,622	34.5%	48,117	29.9%	45,330	27.9%	43,134	27.1%
Structural	33,056	20.1%	28,373	17.6%	26,060	16.1%	23,712	14.9%
Functional	23,566	14.3%	19,744	12.3%	19,270	11.9%	19,422	12.2%

Source: National Bridge Inventory

Q: What portion of Interstate bridges is structurally deficient?

A: Only 6 percent of Interstate bridges are structurally deficient, a decline from 7.2 percent in 1990.

Q: What portion of Interstate bridges is functionally deficient?

A: Approximately 18.7 percent of Interstate bridges are functionally deficient, a decline from 21.4 percent in 1990.

Q: What is the condition of bridges that are not on the Interstate system?

A: Measured by the number of deficient bridges, the condition of bridges not on the Interstate system has improved over the past several years. Since 1990, the percentage of deficient bridges on arterial highways other than Interstates has declined from 31.7 percent to 27.6 percent. The percentage of deficient bridges on collector systems has declined from 34.5 percent to 27.1 percent. *[See Exhibits 3-22 and 3-23]*

Q: What is the difference between a structurally deficient and a functionally obsolete bridge?

A: A structurally deficient bridge is a bridge that has been restricted to light vehicles, requires immediate rehabilitation to remain open, or is closed. A functionally obsolete bridge is a bridge that has deck geometry, load carrying capacity, clearance, or approach roadway alignment that no longer meets the criteria for the system of which the bridge is a part.

A deficient bridge is not necessarily unsafe or one that requires special posting for speed or weight limitations. It does require significant maintenance, rehabilitation, or sometimes replacement. Some of these bridges are posted and may require trucks over a certain weight to take a longer route. For further information on the status of bridges, please refer to the report to the Congress *The Status of the Nation's Highway Bridges: Highway Bridge Replacement and Rehabilitation Program and National Bridge Inventory*, May 1997.

Transit Performance

Q: What are the principal sources of information on transit conditions and performance?

A: Information on transit conditions and performance comes from several sources. The most important is the data reported to the Federal Transit Administration (FTA) under the National Transit Database (NTD) reporting requirements in Federal transit laws. Data are reported by all transit operators receiving or benefiting from Federal capital or operating assistance. The data used in this report include local fiscal years ending during calendar year 1995. Selected transit performance information such as wait time, seat availability, and trip travel time comes from the 1990 Nationwide Personal Transportation Survey (NPTS).

Exhibit 3-24
Passenger Mile Weighted Average Speed by Transit Mode 1985-1995

	1985	1995	1985-1995 Change
Rail	24.4	26.6	9.0%
Non-Rail	13.5	13.7	1.5%
Total	**18.5**	**20.4**	**10.3%**

Source: Federal Transit Administration National Transit Database (NTD)

This edition of the report includes transit vehicle and maintenance facility conditions generated by the Transit Economic Requirements Model (TERM), an analytical model which calculates estimated measures of transit conditions and performance and investment requirements. TERM uses information from the NTD, data collected directly from transit agency asset inventories, and known condition experience of existing transit assets to determine overall fleet and facilities conditions.

Q: What are the measures of transit system performance?

A: This report uses service level measures as an approach to monitoring transit performance. Important dimensions of performance include the speed of transit service, waiting time, the number of transfers, the percentage of passengers who have a seat for all or part of their trip, and travel times.

Exhibit 3-25
Percentage of Transit Riders Waiting Less than 5 or 10 Minutes, by Transit Function

	Minutes	
	<5	<10
Livable Metropolitan Area	59	80
Low-Cost Mobility	57	77
Congestion Management	61	83
Total	**59**	**80**

Note: A single transit trip can serve one or more of the functions above, resulting in a total unequal to 100 percent

Source: 1990 Nationwide Personal Transportation Survey (NPTS)

Q: What are the trends in transit system speed?

A: The average speed of rail transit increased 9 percent from 1985 to 1995, to 26.6 miles per hour. Bus transit speed increased 1.5 percent over the same period, to 13.7 miles per hour *[See Exhibit 3-24]* Passenger mile-weighted system speeds are much higher on rail transit systems than on bus systems, primarily because of the availability of separated guideways for rail systems and the longer distances between stations or stops. More disaggregated bus data would show similarly higher speeds on bus services that operate on separated rights-of-way. The overall weighted average increased faster than did either mode because of a transit use from buses to rail.

Exhibit 3-26
Percentage of Transit Riders Who Must Transfer, by Transit Function

Livable Metropolitan Area	57
Low-Cost Mobility	39
Congestion Management	62
Total	**51**

Source: 1990 Nationwide Personal Transportation Survey (NPTS)

Exhibit 3-27
Percentage of Transit Riders with Available Seat by Transit Function

Seat Availability	Entire Trip	Part of Trip	Seat Not Available
Livable Metropolitan Area	67	8	12
Low-Cost Mobility	78	7	13
Congestion Management	67	9	23
Total	**71**	**9**	**20**

Source: 1990 Nationwide Personal Transportation Survey (NPTS)

Q: What are the most recent transit system transfer and wait time figures?

A: According to the most recent available NPTS data, over half of all riders (59 percent) reported wait times of 5 minutes or less. About 80 percent of riders wait no longer than 10 minutes.

The amount of time spent waiting is related to the transit function that is being performed. Exhibit 3-25 shows the percentage of transit trips made with waiting times of less than five and less than 10 minutes. Congestion management trips, which are typically work trips, have the shortest waiting time. This reflects the higher level of service in peak periods and work trip travelers' lower tolerance for waiting.

The need to transfer between transit vehicles also affects transit patronage. As shown in Exhibit 3-26, 51 percent of transit trips involve one or more transfers. In addition, approximately 17 percent of transit trips involve a transfer from a private vehicle, as in park-and-ride facilities. Trips serving the low-cost mobility function involve substantially fewer transfers than those serving the livable metropolitan area and congestion management functions.

Exhibit 3-28
Percentage of Transit Riders by Trip Time and Transit Function

	Minutes <10	Minutes <20	Minutes <30
Livable Metropolitan Area	24	54	74
Low-Cost Basic Mobility	29	64	81
Congestion Management	20	51	71
Total	**25**	**57**	**76**

Source: 1990 Nationwide Personal Transportation Survey (NPTS)

Q: What are the most recent findings on transit system seat availability?

A: The capacity of a transit vehicle is generally measured in three ways: seated capacity, full capacity, and peak capacity. Seated capacity is defined by the number of seats on a particular vehicle. Full capacity includes seated capacity plus one standee for every 5.5 square feet of open floor space. Peak capacity is the maximum passenger load, seated and standing, that a vehicle can accommodate.

The presence of standees, conveys a sense of crowding. As shown in Exhibit 3-27, 29 percent of transit trips involve standing for at least part of the trip. Seat availability varies by the function represented by the trip. Trips that serve the low-cost mobility function provide more seats than those serving the livable metropolitan areas and congestion management functions, since low-cost basic mobility trips tend to be taken during off-peak hours.

Q: How is transit safety measured?

A: Transit safety can be measured by the number and rate of incidents. For National Transit Database reporting, an incident is defined as an unforeseen occurrence which results in collision, derailment, personal casualty, non-arson fire, or property damage in excess of $1,000.

Q: What are the most recent findings on transit trip travel time?

A: According to data from the most recently available NPTS, about 25 percent of all transit users reported trip times of 10 minutes or less, and nearly 76 percent of transit trips were reported to take less than half an hour. Travel time and trip function are related, as shown in Exhibit 3-28. Trips for low-cost mobility purposes are generally shorter than those serving other functions, while work trips included in the congestion management function tend to be the longest.

Q: What is the most recent information on transit safety?

A: According to the National Transit Database, the total number of transit incidents in 1995 was 61,744. The overall rate was 24 incidents per million vehicle miles traveled. Commuter rail had the lowest incident rate (13 per million vehicle miles) and light rail had the highest incident rate (37 per million vehicle miles). The bus rate was 25 incidents per million vehicle miles. Additional measures and more detailed information about transit safety is found in the annual FTA National Transit Database report *National Transit Summaries and Trends.*

Transit Conditions

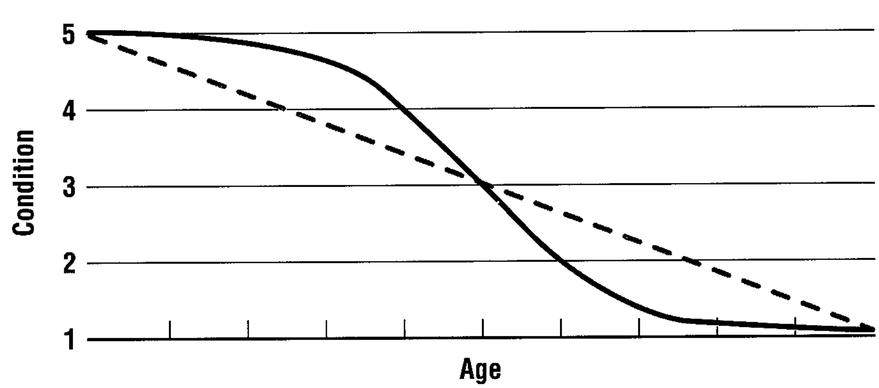
Q: How does the use of the Transit Economic Requirements Model (TERM) in this report affect the description of transit infrastructure and vehicle conditions?

A: The introduction of TERM in this report represents a change in the method used to report transit asset conditions. The principal differences between TERM and prior approaches include a more accurate depiction of the relationship between asset age and condition, more detailed data for the creation of asset condition measures, and the use of more extensive current transit asset inventories.

In previous reports, age was used as a surrogate for the condition of transit vehicles and other assets, such as maintenance facilities. The condition of a vehicle was assumed to deteriorate on a straight-line basis based on the vehicle's age. The nonlinear deterioration curves introduced in this report were developed from actual transit asset condition and replacement records. The deterioration curves have been applied to the assets reported to the National Transit Database and to additional asset information collected for this report. This approach is being used to assess the condition of bus, rail, and other transit assets evaluated in the report. To assist in the transition from reporting transit age to transit conditions, this report includes

Exhibit 3-29

Transit Asset Deterioration Curves: Non-Linear and Straight-Line Deterioration Functions



Source: Transit Economic Requirements Model (TERM)

Exhibit 3-30
Urban Transit Vehicle Fleet Count, Age, and Condition 1985-1995

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Articulated Buses											
Total Fleet	1,423	1,694	1,712	1,751	1,730	1,717	1,764	1,698	1,807	1,613	1,716
Number of Overage Vehicles	0	0	0	0	0	0	230	312	295	279	574
Average Age	3.4	4.0	4.9	5.9	6.7	7.6	8.2	9.1	9.5	10.1	10.7
Average Condition	4.8	4.8	4.7	4.5	4.4	4.1	3.9	3.6	3.4	3.1	2.9
Full-Size Buses											
Total Fleet	46,138	46,945	46,231	46,164	46,446	46,553	46,660	46,757	46,824	46,987	46,335
Number of Overage Vehicles	9,227	9,509	9,592	10,389	10,372	9,016	8,047	8,188	9,362	11,210	10,614
Average Age	8.1	8.3	8.2	8.2	8.4	8.2	8.0	8.3	8.5	8.7	8.6
Average Condition	4.0	3.9	3.9	3.9	3.9	3.9	4.0	3.9	3.8	3.7	3.8
Mid-Size Buses											
Total Fleet	2,569	2,654	2,821	3,002	2,928	3,106	3,268	3,204	3,598	3,693	3,879
Number of Overage Vehicles	237	244	275	431	402	553	748	846	865	889	874
Average Age	5.6	6.0	5.9	6.5	6.5	6.6	6.7	6.8	6.4	6.9	6.8
Average Condition	4.6	4.5	4.5	4.4	4.4	4.4	4.4	4.3	4.4	4.3	4.3
Small Buses											
Total Fleet	1,685	1,811	2,127	2,116	2,428	2,684	3,415	3,716	4,064	4,738	5,447
Number of Overage Vehicles	280	269	236	305	375	304	490	530	513	693	692
Average Age	4.8	4.4	3.9	4.2	4.1	3.9	4.0	4.1	4.0	4.1	4.0
Average Condition	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Vans											
Total Fleet	1,733	2,610	3,241	3,243	3,288	3,778	6,261	7,028	8,353	10,785	11,969
Number of Overage Vehicles	790	982	964	950	690	830	1,400	1,074	1,804	2,084	2,497
Average Age	3.8	3.5	3.1	3.6	2.9	2.8	3.0	3.1	3.1	3.0	3.2
Average Condition	2.6	3.0	3.6	2.9	3.8	4.0	3.7	3.6	3.6	3.7	3.5
Weighted Average Condition	4.0	3.9	4.0	3.9	3.9	4.0	4.0	3.9	3.9	3.8	3.8

Source: Transit Economic Requirements Model (TERM)

information about both asset age and condition.

A second difference between TERM and previous approaches is the asset data sample used by each study. The transit asset repair and replacement records used by TERM reflect a more complete sampling of the nation's transit asset base than was previously available. For instance, TERM includes primary asset inventories of the larger bus-only operators and all but one of the Nation's rail operators. In contrast, previous asset data collections, such as the Rail Modernization Study, used a partial sample that did not include any bus operators.

A third factor contributing to the difference between TERM's estimates of transit asset physical conditions and those published in previous reports is the level of investment in new start projects and rail modernization in recent years. The 1995 report, which derived its asset physical condition estimates from the 1992 Rail

Modernization Study, did not reflect investments in the years since 1992. In contrast, the TERM-based results in this report include nearly all recent investments in rail and busway/ high occupancy vehicle lanes.

Q: How does TERM determine the condition of the bus and rail fleets?

A: The bus and rail fleets' condition is determined on the basis of deterioration associated with vehicle age, use, and maintenance history. TERM examines the bus and rail fleets in the National Transit Database and applies deterioration curves *[See Example in Exhibit 3-29]* to establish the condition of fleets, facilities and other assets. Separate deterioration curves for different types of transit vehicles and facilities were developed using asset age and rehabilitation histories collected from transit agencies. Because the deterioration curves are nonlinear, asset conditions tend to cluster around the high- and low-condition ratings, with less time spent at the midrange rating compared to a linear approach. The nonlinear deterioration curves represent a slower rate of change in condition near the beginning and end of an asset's life. In future editions of this report, national conditions reporting will account for variation in asset deterioration caused by different operating climates.

Q: What are the trends in bus and urban paratransit vehicle fleet conditions?

A: Exhibit 3-30 shows the average condition for all classes of bus and urban paratransit vehicles. The overall weighted condition of the bus and urban paratransit fleet was 3.8 in 1995, reflecting a condition rating of "adequate" *[See Exhibit 3-31]* and a slight decline in bus condition since 1985. The average condition of the full-size bus fleet was 3.8, or "adequate." Full-size buses account for 67 percent of the total fleet, and the condition of these vehicles has declined slightly since 1985. More noticeably, the articulated bus fleet has not been replaced at a sufficient rate to maintain a good condition, and the 1995 average condition of the articulated bus fleet was 2.9, indicating that the condition of the overall fleet bordered on substandard condition. The deterioration of bus fleets results in diminished physical conditions and operating performance.

Q: What are the trends in the age of bus and urban paratransit fleets?

A: Exhibit 3-30 also shows the average age of the fleet for each type of vehicle. In 1995, the average fleet age for all classes of bus and urban paratransit vehicles was greater than one-half the useful-life guideline. For example, the 1995 average age for the articulated bus fleet was 10.7 years, while one-half the Federal useful-life guideline is 6 years. As a result, there is a backlog of overage vehicles in need of replacement. The number of vehicles replaced over the last several years has been only sufficient to maintain the average fleet age at the current average age. Thus, the number of overage vehicles has stayed about the same. In contrast, the number of vans in the urban paratransit fleet has increased significantly. The number of overage vans has also increased—to 2,497 vehicles, or 21 percent of the van fleet. Since 1990, the number of vehicles replaced has fallen below that required to maintain current average age. Therefore, the number of overage vehicles has increased and the average condition has declined.

Q: What are the Federal replacement requirements for transit vehicles?

A: To manage the Federal investment in transit efficiently, FTA has established requirements for the period of time an asset must remain in mass transit service before Federal funding for a replacement may be made available. These guidelines are based on such factors as industry practices, manufacturer recommendations, and studies of the trade-off between capital investments and operating costs. The minimum useful-life guidelines for vehicles used in bus and urban paratransit service are: standard full-size transit bus, 12 years; medium-size transit bus, 10 years; small transit bus, 7 years; and urban paratransit bus, 4 years. The useful life for rail transit is 25 years. It should be noted, however, that there is no recent information on whether these guidelines represent optimal replacement ages or at

Exhibit 3-31
Bus and Fleet Conditions Ratings Description

Rating	Condition Definition
5.0 - 4.9	Excellent
4.9 - 4.0	Good
3.99 - 3.0	Adequate
2.99 - 2.0	Substandard
1.99 - 0.0	Poor

Source: Transit Economic Requirements Model (TERM)

what point reduced maintenance costs justify increased replacement costs.

Q: What are the information sources for rural and paratransit fleet conditions?

A: Information reported here is from the Community Transportation Association of America (CTAA). The Elderly and Persons with Disabilities Program fleet described here includes all vehicles owned by private non-profit human service agencies that are recipients of Section 5310 funds, not just those acquired with FTA funds.

Q: What are the trends in rural and paratransit vehicle fleet age?

Exhibit 3-32
Number of Overage Vehicles and Average Vehicle Age in Rural and Special Service Transit

	Rural Operators			Special Service Operators		
	Total Fleet	Average Age	Share Overage	Total Fleet	Average Age	Share Overage
Medium-Size Buses	740	10.4	51%	310	8.4	19%
Small Buses	3,660	4.9	24%	5,250	4.5	18%
Vans and Other	8,050	4.5	44%	23,770	4.4	43%

Source: Community Transportation Association of America, 1994

Q: How do the condition deterioration curves relate to the Federal asset replacement requirements?

A: On this schedule, the average age of each type of vehicle would be one-half the useful life guideline and based on the asset deterioration curves, the average vehicle condition rating would be "good." As noted above, the current weighted average bus fleet vehicle condition is "adequate."

A: Exhibit 3-32 displays the average age of all classes of vehicles funded by the Nonurbanized Area Formula program (Section 5311) and the Elderly and Persons with Disabilities Program (Section 5310). There is a significant number of overage vehicles of all types in the rural and paratransit fleets. For example, the average age of both the rural and paratransit fleets exceeds the minimum useful life of four years.

Q: What are the conditions of urban bus maintenance facilities?

A: Seventy-four percent of the nation's bus maintenance facilities are in good or better condition. This reflects recent investments in the rehabilitation and construction of new maintenance facilities. Nineteen percent are reported in substandard or poor condition. Exhibit 3-33 provides more data on the condition of bus maintenance facilities.

Q: How are urban bus maintenance facility conditions measured?

A: To determine bus maintenance facility conditions, TERM applies an asset deterioration curve that models the effects of aging, utilization, and maintenance. The rating for each facility is along a spectrum of excellent, good, adequate, substandard or poor. This scale corresponds to the one used in the FTA's Bus Support Facilities Study. *[See Exhibit 3-33]*

Exhibit 3-33
Condition of Urban Bus Maintenance Facilities–1995

Condition	Percent
Excellent	21%
Good	53%
Adequate	7%
Substandard	6%
Poor	13%
Total	**100%**

Source: Transit Economic Requirements Model (TERM)

Exhibit 3-34
Age of Urban Bus Maintenance Facilities–1995

Age (years)	Number	Percent
0-10	100	21%
11-20	118	24%
21-30	165	34%
31+	101	21%
Total	**484**	**100%**

Source: Transit Economic Requirements Model (TERM)

Q: What are the ages of urban bus maintenance facilities?

A: Forty-five percent of urban bus maintenance facilities are less than 20 years old. The remainder range in age from 21 to 100 years, with the age range of 21 to 30 years having the highest percentage (34 percent). Exhibit 3-34 provides more data on the age of urban bus maintenance facilities.

Q: How are the urban bus maintenance condition measures used in this report different from those used in previous reports?

A: This edition of the report introduces TERM-produced assessments of urban bus maintenance facilities' conditions, as described above. Previous reports provided conditions from the FTA's Bus Support Facilities Study, conducted during 1992. The Bus Support Facilities Study results were based on a one-time survey of transit operators. This is the only comprehensive review of these maintenance facilities ever undertaken. The TERM conditions are generated from bus maintenance facility information in the National Transit Database.

Exhibit 3-36
Definitions of Urban Bus Maintenance Facility Condition

Condition	Description
Excellent	The facility meets or exceeds most reasonable requirements of a transit bus maintenance program.
Good	The facility meets most reasonable requirements of a transit bus maintenance program but may have some less than optimum characteristics.
Adequate	The facility has shortcomings in its ability to support a transit bus maintenance program. While these shortcomings hinder the department's effectiveness or efficiency, they are not deemed to significantly impact performance.
Substandard	The facility has shortcomings in its ability to support a transit bus maintenance program, and these shortcomings are deemed to be below industry standards. The deficiencies adversely affect the efficiency and/or effectiveness of the operation.
Poor	The facility has significant shortcomings in its ability to support a transit bus maintenance program.

Source: Transit Economic Requirements Model (TERM)

Q: What are the conditions of rural bus maintenance facilities?

A: According to the most recent information available from the Commuter Transportation Association of America (CTAA), 30 percent (about 350) of rural transit operators own maintenance facilities, and an additional 9 percent (about 100) lease a facility. The remainder send their vehicles elsewhere for maintenance. Of the facilities owned by rural operators, 74 percent are reported to be of adequate size and 68 percent are adequately equipped. Of leased facilities, 61 percent are reported to be of adequate size and 55 percent are adequately equipped. The overall condition of the owned or leased rural transit facilities are shown in Exhibit 3-35.

Exhibit 3-35
Condition of Rural Bus Maintenance Facilities–1992

Condition	Percent
Excellent	30%
Good	52%
Poor	14%
Very Poor	4%
Total	**100%**

Source: Community Transportation Association of America

Q: How are rural bus maintenance facility conditions measured?

A: The rural maintenance facilities conditions are based on reporting by transit operators to the CTAA. The results are from a one-time survey. The results reported in

Exhibit 3-35 match results reported in previous editions of this report, reflecting the intermittent nature of rural transit facility assessment.

Q: What are the trends in rail vehicle fleet conditions?

A: Exhibit 3-37 displays the average condition for commuter rail, rapid rail, and light rail vehicles. In 1995, the average weighted condition of all rail vehicles was 4.2, representing a "good" condition on the scale shown in Exhibit 3-39. Since

Exhibit 3-37
Rail Transit Vehicle Fleet Count, Age and Condition 1985 - 1995

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Locomotives											
Total Fleet	364	463	491	564	451	472	467	479	556	554	570
No. of Overage Vehicles	129	127	149	131	87	94	81	81	97	154	120
Average Age	16.3	15.1	16.9	14.9	14.6	15.7	15.3	15.8	15.6	17.3	15.6
Average Condition	4.6	4.7	4.5	4.7	4.7	4.6	4.7	4.6	4.6	4.5	4.6
Rapid Rail Cars											
Total Fleet	9,326	8,963	10,344	10,419	10,246	10,325	10,170	10,161	10,074	10,153	10,157
No. of Overage Vehicles	1,587	1,796	1,539	2,012	1,785	2,912	2,925	3,031	2,763	3,202	3,720
Average Age	17.1	16.5	15.2	15.2	15.4	16.2	16.9	17.7	17.8	18.7	19.3
Average Condition	4.5	4.6	4.7	4.7	4.6	4.6	4.5	4.4	4.4	4.3	4.2
Unpowered Commuter Rail Cars											
Total Fleet	1,587	1,918	2,137	2,266	2,138	2,154	2,226	2,240	2,402	2,401	2,402
No. of Overage Vehicles	540	624	883	724	687	619	644	794	700	841	865
Average Age	19.1	18.3	19.6	17.3	18.0	17.6	17.3	19.3	18.6	19.5	20.1
Average Condition	4.3	4.4	4.2	4.5	4.4	4.4	4.5	4.2	4.3	4.2	4.1
Powered Commuter Rail Cars											
Total Fleet	2,205	2,407	2,563	2,552	2,421	2,492	2,529	2,541	2,526	2,570	2,645
No. of Overage Vehicles	49	47	41	106	128	126	114	126	154	182	628
Average Age	12.3	12.5	13.3	14.3	15.0	15.9	16.5	17.6	18.2	19.0	19.7
Average Condition	4.8	4.8	4.8	4.7	4.7	4.6	4.6	4.4	4.4	4.3	4.2
Light Rail Vehicles											
Total Fleet	797	668	879	890	917	903	954	977	943	969	955
No. of Overage Vehicles	335	191	238	263	186	159	184	182	99	97	112
Average Age	20.6	16.9	17.2	18.9	15.6	15.2	16.6	17.0	14.9	14.8	16.8
Average Condition	4.0	4.5	4.5	4.3	4.6	4.7	4.5	4.5	4.7	4.7	4.5
Weighted Average Condition	**4.5**	**4.6**	**4.6**	**4.6**	**4.6**	**4.6**	**4.5**	**4.4**	**4.4**	**4.3**	**4.2**

Source: Transit Economic Requirements Model (TERM)

Exhibit 3-38
Physical Condition of U.S. Transit Rail Infrastructure–Selected Years 1984 - 1995

	Bad			Poor			Fair			Good			Excellent		
	1984	1992	1995	1984	1992	1995	1984	1992	1995	1984	1992	1995	1984	1992	1995
Track	0%	0%	9%	7%	5%	6%	49%	32%	12%	31%	49%	51%	12%	14%	22%
Power Systems															
Substations	6%	2%	12%	23%	19%	8%	5%	17%	9%	43%	56%	59%	23%	6%	11%
Overhead	20%	0%	5%	12%	33%	10%	27%	10%	14%	36%	52%	35%	5%	5%	36%
Third Rail	13%	0%	10%	26%	21%	8%	19%	20%	10%	36%	53%	48%	6%	6%	24%
Stations	0%	0%	15%	15%	5%	12%	56%	29%	12%	23%	63%	47%	6%	3%	14%
Structures															
Elevated Structure	n/a	n/a	7%	n/a	n/a	20%	n/a	n/a	16%	n/a	n/a	56%	n/a	n/a	1%
Bridges	1%	0%	n/a	16%	11%	n/a	51%	28%	n/a	28%	54%	n/a	4%	7%	n/a
Elevated Sections	0%	0%	n/a	1%	1%	n/a	80%	72%	n/a	3%	15%	n/a	16%	12%	n/a
Underground	0%	0%	7%	5%	5%	11%	49%	34%	13%	35%	51%	59%	11%	10%	9%
Maintenance															
Facilities	4%	2%	5%	54%	34%	15%	14%	12%	15%	24%	35%	56%	4%	17%	8%
Yards	4%	2%	2%	53%	7%	11%	26%	26%	5%	16%	55%	29%	1%	9%	53%

Source: 1984 and 1992, Federal Transit Administration Rail Modernization Study, and Federal Transit Administration Transit Economic Requirements Model (TERM)

1985, the average rapid rail fleet condition has declined slightly. The average condition of the light rail vehicle fleet held nearly constant during the 1985–1995 period, reflecting the introduction of new vehicles as light rail systems have initiated service. The average overall condition of the commuter rail fleet declined in the 1985–1995 period but remains at a rating of good.

Q: What are the trends in rail vehicle fleet age?

A: Additional information on the condition of the rail transit fleet is available from an assessment of the average age of the fleet and the number of rail vehicles that have exceeded useful-life guidelines. From the

Exhibit 3-39
Definitions of Rail Vehicle Conditions

Rating	Condition	Description
5.0 - 4.95	Excellent	Brand new, no major problems exist, only routine preventive maintenance.
4.95 - 4.0	Good	Elements are in good working order, requiring only nominal or infrequent minor repairs (greater than six months between minor repairs).
3.99 - 3.0	Adequate	Requires frequent minor repairs (less than six months between repairs) or infrequent major repairs (more than six months between repairs).
2.99 - 2.0	Substandard	Requires frequent major repairs (less than six months between major repairs).
1.99 - 0	Poor	In sufficiently poor condition that continued use presents potential problems.

Source: Transit Economic Requirements Model (TERM)

1985–1995 period, for each type of vehicle, Exhibit 3-37 shows the total number of vehicles, the number that exceeded FTA's minimum useful-life standards (25 years for all types of rail vehicles), and the average age of the fleet.

The average age of all vehicles except powered commuter rail cars improved between 1986 and 1989. Since 1990, the average age of all vehicle types has increased to 15.6 years for locomotives, 20.1 years for unpowered commuter rail cars, 19.3 years for rapid rail cars, and 16.8 years for light rail vehicles. The average age of all vehicle types in 1995 was well in excess of one-half of FTA's minimum useful life standard.

Q: What are the conditions of rail infrastructure and maintenance facilities?

A: Rail transit requires fixed infrastructure such as power systems, stations, bridges, tunnels, and maintenance facilities. Exhibit 3-38 shows that 73 percent of transit track and 61 percent of stations were in good or excellent condition.

Q: How are rail infrastructure and maintenance facility conditions measured?

A: To determine rail infrastructure and maintenance facility conditions, TERM applies an asset deterioration curve that models the effects of aging, utilization, and maintenance. The rating for each facility is on a scale ranging from excellent to poor *[See Exhibit 3-39]* This scale corresponds to the one used in FTA's Rail Modernization Study.

Q: How are the rail infrastructure and maintenance facility condition measures in this report different from those in previous reports?

A: This edition introduces TERM-produced assessments of rail infrastructure and maintenance facility conditions. Previous reports described conditions based on FTA's Rail Modernization Study, conducted in 1984 and revised in 1992. The Rail Modernization Study provided benchmarks for the condition of rail infrastructure elements based on on-site inspections and transit operator–reported conditions.

TERM uses data from the Rail Modernization Study and supplements it with additional information collected from transit operators. Deterioration curves developed for specific infrastructure items (e.g., tunnels, curved track, station track) are then applied to generate the transit conditions reported here.

It is important to note that the conditions reported in Exhibit 3-38 for 1984 and 1992 are based on the Rail Modernization Study, while the 1995 conditions are from TERM. Although there are some similarities in the approaches used to obtain these conditions, the 1995 condition results are not fully comparable to the results from prior years.

As noted earlier, the previous edition of this report derived its asset physical condition estimates from the 1992 Rail Modernization Study and did not reflect investments made after 1992. In contrast, the results reported here reflect TERM's inclusion of nearly all recent investments in rail and busway/HOV lanes.

Finance

The surface transportation system is jointly funded by the Federal, State, and local governments, and the private sector. Each level of government has a different role in the improvement, maintenance and operation of the surface transportation system, and different methods for raising revenue. This section documents the sources and uses of public funds expended for highways and transit.

"Conditions and Performance (C&P)-related" expenditures relate to investment requirements outlined later in this report. For highways, this excludes certain types of capital expenditures that are not incorporated into the investment requirements analysis. For transit, all capital expenditures are related to the transit investment requirements shown in the next section.

Funding for highways and transit by all levels of government, which had

Exhibit 3-40
Revenue Sources for Public Sector Financing of Highways, Billions of Dollars 1995

	Federal	State	Local	Total	Percent
User Charges					
Motor-Fuel Taxes	$ 15.3	$ 24.1	$ 0.7	$ 40.1	42.1%
Motor-Vehicle Taxes and Fees	$ 3.0	$ 11.7	$ 0.7	$ 15.4	16.1%
Tolls	$ 0.0	$ 3.5	$ 0.6	$ 4.1	4.3%
Subtotal	**$ 18.3**	**$ 39.3**	**$ 2.0**	**$ 59.6**	**46.4%**
Other					
Property Taxes and Assessments	$ 0.0	$ 0.0	$ 5.2	$ 5.2	5.4%
General Fund Appropriations	$ 0.8	$ 1.6	$ 9.7	$ 12.1	12.7%
Other Taxes and Fees	$ 0.2	$ 1.8	$ 2.1	$ 4.1	4.3%
Investment Income and Other Receipts	$ 0.5	$ 1.9	$ 4.3	$ 6.7	7.1%
Bond Issue Proceeds	$ 0.0	$ 4.3	$ 3.3	$ 7.6	8.0%
Subtotal	**$ 1.6**	**$ 9.7**	**$ 24.5**	**$ 35.7**	**53.6%**
Total Revenues	**$ 19.9**	**$ 49.0**	**$ 26.5**	**$ 95.3**	**100.0%**
Funds Drawn from (or Placed in) Reserves	$ 0.1	($ 2.2)	($ 0.7)	($ 2.8)	-2.9%
Total Expended During 1995	**$ 20.0**	**$ 46.8**	**$ 25.8**	**$ 92.5**	**97.1%**

Source: Highway Statistics Summary to 1995 Table HF-210

exceeded inflation over the last 20 years, has not kept pace with inflation since 1993. The percentage of highway and transit funding provided by the Federal government has risen since 1993, partly offsetting the decline that had occurred since 1985. Since 1993 there has been a shift in the type of highway capital improvements made, towards preserving the existing system, and away from adding new lanes. For transit, this period saw a continuation of a shift from operating assistance to capital investment, including rolling stock and facilities.

Highway Finance

Q: How much is spent on highways by all levels of government?

A: In 1995, all levels of government spent $92.5 billion, dollars for highway programs. An additional $2.8 billion was placed in reserves for future spending on highways.

Q: What portion of total highway expenditures were funded by each level of government?

A: Of total 1995 highway expenditures of $92.5 billion, the Federal Government funded $20.0 billion (21.6 percent); States $46.8 billion (50.6 percent); and counties, cities, and other local governments the remaining $25.8 billion (27.9 percent). *[See Exhibit 3-40]*

Q: What are the primary revenue sources for highways?

A: Of the $95.3 billion provided for highway programs in 1995 ($92.5 billion spent in 1995 plus $2.8 billion placed in reserves), 62.5 percent came from highway-user charges, including motor-fuel taxes, motor-vehicle taxes and fees, and tolls. The remaining 37.5 percent came from a number of sources, including local property taxes and assessments, other dedicated taxes, general funds, bond issues, and miscellaneous sources such as investment income, miscellaneous fees, development fees, and special district assessments. The degree to which highway programs are funded by highway-user charges differs widely between different levels of government. At the Federal level, 92.0 percent of highway revenues come from motor fuel and motor vehicle taxes. Highway-user charges also provide the largest share, 80.3 percent, at the State level. Many States do not permit local governments to impose significant motor-fuel and motor-vehicle taxes. Therefore, at the local government level, only 7.4 percent of highway funding is provided by highway-user charges. The majority of local government revenues for highways come from general fund appropriations and property taxes. *[See Exhibit 3-40]*

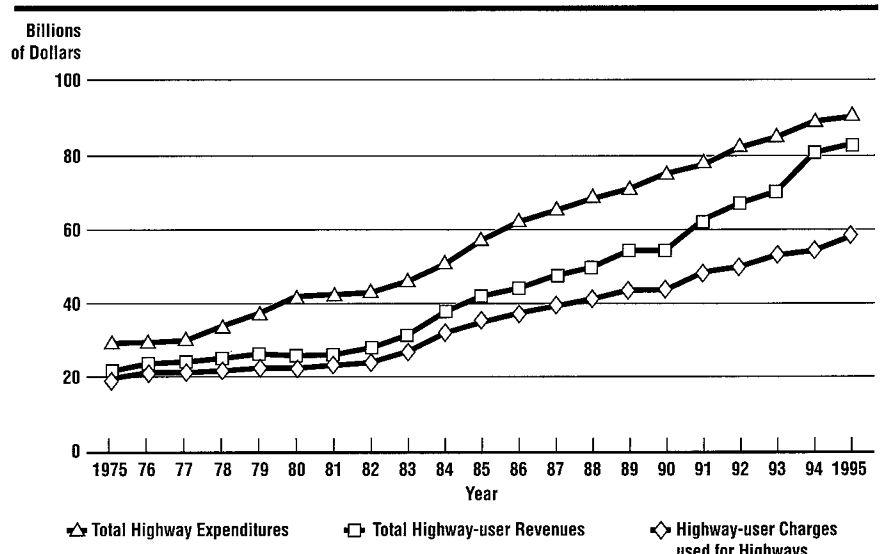
Q: Are all revenues generated by motor-fuel and vehicle taxes and tolls used for highways?

A: No. Highway-user revenues—the total revenues generated by motor fuel and motor vehicle taxes and tolls by all levels of government—totaled $84.1 billion in 1995. Of this total, $59.6 billion (70.8 percent) was used to fund highways, and $24.5 billion (29.2 percent) was used to finance other activities, such as transit, ports, schools, deficit reduction, collection costs, and general programs.

Q: If all highway-user revenues collected by all levels of government had been used for highways, would they have been sufficient to cover all highway expenditures?

A: No. The $24.5 billion of highway-user revenues used for purposes other than highways is more than offset by the $35.7 billion of highway funding that is derived from sources other than user charges. [See Exhibit 3-40]. In 1995, if all highway-user revenues were used for highways, they would have been sufficient to cover only 91 percent of the total highway expenditures of $92.5 billion. This ratio is currently at its highest percentage since 1956, and is up from a low of 62 percent in 1980. In each year since 1990, highway-user revenues have grown at a faster rate than highway expenditures. *[See Exhibit 3-41]*

Exhibit 3-41
Highway Expenditures, Total Highway-User Revenues, and Highway-User Charges Used for Highways 1975-1995



Source: Highway Statistics Summary to 1995

Q: What types of highway expenditures are currently being made?

A: Of the $92.5 billion spent on highways in 1995, $87.8 billion was used for current programs, including $43.1 billion for capital outlay, $24.5 billion for maintenance and traffic services, $20.3 billion for other non-capital expenditures such as administration, planning research, highway law enforcement, safety, and interest. The remaining $4.7 billion was used for debt retirement. *[See Exhibit 3-42]*

Q: What is each level of government's share of actual direct expenditures for highways?

A: While the Federal Government funded $20.0 billion, (21.6 percent) of the 1995 total highway expenditures of $92.5 billion, the majority of the Federal Government's contributions to highways are in the form of grants to State

Exhibit 3-42

Expenditures for Highways, by Expending Agencies and by Type–Billions of Dollars 1995

	Federal	State	Local	Total	Percent
Current Ependitures					
Capital Outlay					
Funded by Federal Government	$ 0.4	$ 18.1	$ 0.7	$ 19.2	20.8%
funded by State or Local Governments	$ 0.0	$ 14.4	$ 9.5	$ 23.9	25.8%
Subtotal	**$ 0.4**	**$ 32.5**	**$ 10.2**	**$ 43.1**	**46.6%**
Non-capital Expenditures					
Maintenance and Operations	$ 0.1	$ 10.4	$ 14.0	$ 24.5	26.4%
Administration	$ 0.7	$ 4.8	$ 2.8	$ 8.3	9.0%
Highway Patrol and Safety	$ 0.0	$ 4.4	$ 3.6	$ 8.0	8.6%
Interest on Debt	$ 0.0	$ 2.3	$ 1.7	$ 4.0	4.3%
Subtotal	**$ 0.8**	**$ 21.9**	**$ 22.1**	**$ 44.8**	**48.3%**
Total, Current Expenditures	**$ 1.2**	**$ 54.4**	**$ 32.2**	**$ 87.8**	**95.0%**
Bond Retirement	**$ 0.0**	**$ 2.6**	**$ 2.1**	**$ 4.7**	**5.0%**
Total All Expenditures					
Funded by Federal Government	$ 1.2	$ 18.1	$ 0.7	$ 20.0	21.6%
Funded by State or Local Governments	$ 0.0	$ 38.9	$ 33.6	$ 72.5	78.4%
Grand Total	**$ 1.2**	**$ 57.0**	**$ 34.3**	**$ 92.5**	**100.0%**

Source: Highway Statistics Summary to 1995 Table HF-210

and local governments.
Direct Federal spending on capital outlay, maintenance, administration, and research amounted to only $1.2 billion (1.3 percent). State governments combined $18.1 billion of Federal funds with $37.7 billion of State funds and $1.2 billion local funds to make direct expenditures of $57.0 billion, (61.6 percent). Local governments combined $0.7 billion of Federal funds with 9.0 billion of State funds and $24.6 of local funds to make direct expenditures of $34.3 billion (37.1 percent).

Most direct highway capital expenditures—$32.5 billion in 1995, 75 percent of the total—were made by State governments, although a significant portion of these were funded by the Federal government. Noncapital expenditures for State and local governments were roughly equal, with each responsible for 49 percent of total noncapital spending. The majority of spending on highway maintenance and traffic services occurs at the local government level. *[See Exhibit 3-42]*

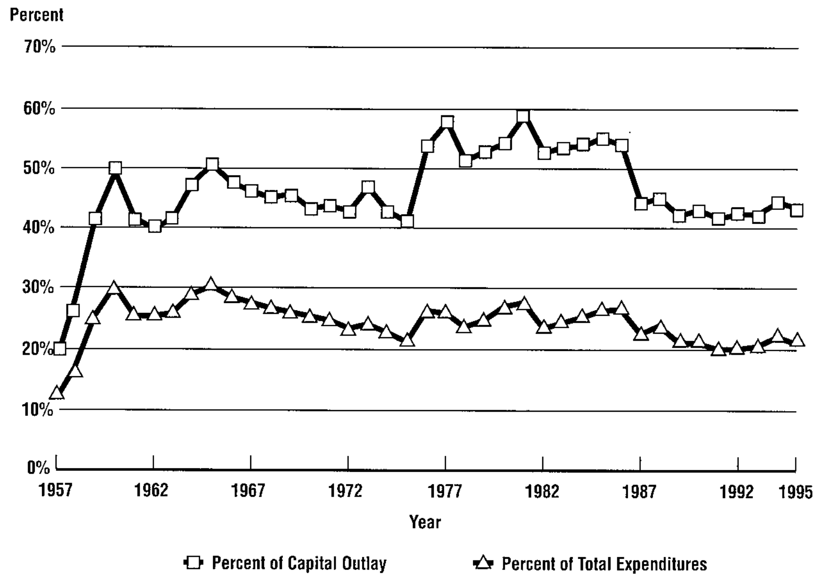
Q: How have the State and locally funded portions of total highway expenditures varied over time?

A: Local governments contributed the largest share of funding for total highway expenditures up until 1933, when States took over as the leading provider of funding. The local share of funding declined to a low of 18.4 percent in 1964, but increased in subsequent years. Since 1982, the local share has varied within a range from 25 to 28 percent, while the State share has varied within a range from 48 to 54 percent.

Q: What portion of total funding for highway capital outlay is provided by the Federal Government?

A: It is estimated that the Federal share of total funding for capital outlay was 44.5 percent. Federal agencies directly spent $400 million on capital outlay in 1995, 1.0 percent of the $43.1 billion spent by all levels

Exhibit 3-43
Federal Share of Highway Capital Outlay and Total Highway Expenditures



of government. Federal grants to State and local governments for highways totaled $18.8 billion, the equivalent of an additional 43.5 percent of total capital spending. Since the vast majority of Federal funds are restricted to being used for capital outlay, it is estimated that the Federal share of total funding for capital outlay was 44.5 percent in 1995.

Q: How has the Federally funded portion of highway capital outlay and total highway expenditures varied over time?

A: The Federal share of funding for total highway expenditures increased dramatically following the passage of the Federal-Aid Highway Act of 1956 and the establishment of the Highway Trust Fund, peaking at 30.1 percent in 1965. From 1965 to 1991 there was a gradual downward trend in the Federal share. Since 1991 the Federal percentage has edged upward slightly from a low of 20.0 percent, rising to 20.4 percent in 1993, and 21.6 percent in 1995.

The Federal share of capital outlay exceeded 40 percent in 1959, and has remained above this level ever since, peaking at 58.3 percent in 1981. Since 1987, the Federal share has remained in a range of 41 to 46 percent. Since 1993, the Federal share has risen from 42.7 to 44.5 percent. *[See Exhibit 3-43]*

Q: How has the composition of highway expenditures changed over time?

A: The percentage of total highway expenditures that went for capital outlay peaked at 61.3 percent in 1958. Subsequently capital outlay's share of total spending gradually decline to a low of 43.8 percent in 1983. Since 1985, capital outlay's share of total expenditures has varied within a narrow band from 46 to 48 percent. The percentage of total expenditures devoted to maintenance gradually declined from 28.9 percent in 1985 to 26.4 percent in 1995, but was virtually unchanged from the 26.5 percent in 1993.

Other non-capital expenditures grew from 20.0 percent of total expenditures in 1985 to 21.9 percent in 1995, off slightly from its all-time high of 22.5 percent in 1990. Since 1953, when other non-capital percentages comprised 9.4 percent of total expenditures, an increasing percentage of total highway expenditures is now devoted to the regulation of the existing highway system through research, highway law enforcement, and safety programs. This includes such activities as enforcement of traffic laws, supervision and direction of traffic, crash investigation, vehicle inspection, vehicle size and weight enforcement, driver education, safety awareness campaigns, and motorcycle safety programs. The increase in the noncapital share of total expenditures is also driven by increases in administrative costs. As the extent and complexity of the highway system and highway programs have grown over time, the relative resources required for planning, research, and general administration of highway programs have increased. *[See Exhibit 3-44]*

Q: Is highway spending keeping pace with inflation?

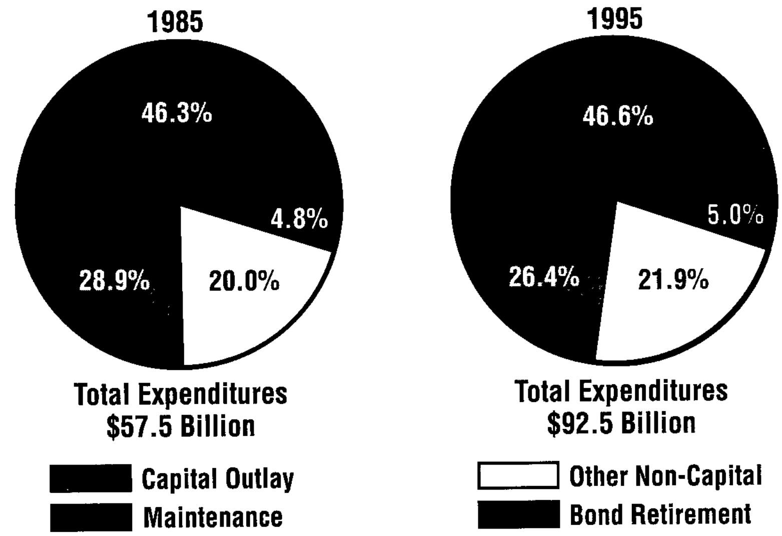
A: In constant dollar terms, total highway expenditures dropped 3.3 percent between 1993 and 1995. This decline was caused by a slowing of the rate of growth in highway spending coupled with a 12.7 percent increase in highway construction prices. Federal highway spending did keep pace with inflation from 1993 to 1995, rising 0.7 percent in constant dollar terms.

Over the last 20 years, highway spending by all levels of government has grown faster than inflation. Total expenditures rose 31.3 percent in constant dollar terms from 1975 to 1995. Constant dollar highway capital outlay rose 42.6 percent over this 20-year period, increasing much more quickly than noncapital expenditures. Highway construction costs grew more slowly than the CPI (consumer price index) during this period, so the purchasing power of funds used for capital outlay has not eroded so quickly.

Q: Has highway spending kept pace with travel growth?

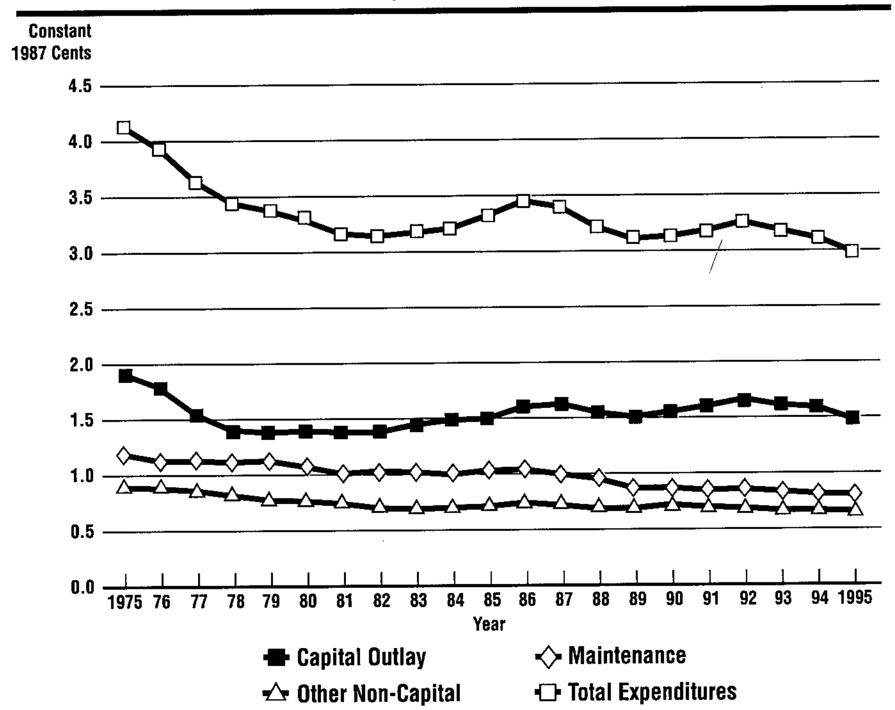
A: In current dollar terms, total expenditures per vehicle mile traveled (VMT) have grown steadily. From 1975 to 1995, expenditures per VMT increased 76.8 percent, from 2.2 cents to 3.8 cents. In constant dollar terms, however, total highway expenditures have not kept pace with travel growth. In constant 1987 cents per VMT, highway expenditures dropped 28.1 percent between 1975 and

Exhibit 3-44
Highway Expenditures by Type 1985 and 1995



Source: Highway Statistics Summary to 1995

Exhibit 3-45
Highway Expenditures Per Vehicle Mile of Travel 1975-1995 (Constant 1987 Cents)



Source: Highway Statistics Summary to 1995

Exhibit 3-46
Highway Capital Outlay by Functional System-1995

	State Capital Outlay (Billions)*	Total Capital Outlay (Billions)	Capital Per Lane-Mile (Dollars)	Capital Per VMT (Cents)
Rural Arterials and Collectors				
Interstate	$ 3.1	$ 3.1	$ 23,687	1.40
Other Principal Arterial	$ 5.1	$ 5.1	$ 20,814	2.36
Minor Arterial	$ 2.6	$ 2.7	$ 9,348	1.75
Major Collector	$ 2.0	$ 2.9	$ 3,364	1.57
Minor Collector	$ 0.3	$ 0.7	$ 1,341	1.47
Subtotal	**$ 13.1**	**$ 14.6**	**$ 6,996**	**1.76**
Urban Arterials and Collectors				
Interstate	$ 7.1	$ 7.1	$ 99,828	2.09
Other Freeways and Expressways	$ 2.6	$ 2.6	$ 65,115	1.73
Other Principal Arterial	$ 4.6	$ 5.7	$ 31,724	1.54
Minor Arterial	$ 1.9	$ 3.6	$ 16,058	1.24
Collector	$ 0.4	$ 1.4	$ 7,662	1.12
Subtotal	**$ 16.6**	**$ 20.5**	**$ 29,191**	**1.60**
Subtotal, Rural and Urban	**$ 29.6**	**$ 35.0**	**$ 12,597**	**1.66**
Rural and Urban Local	**$ 2.9**	**$ 8.0**	**$ 1,497**	**2.59**
Total, All Systems	**$ 32.5**	**$ 43.1**	**$ 5,283**	**1.78**

Source: Highway Statistics 1995 and unpublished FHWA data

* Note: State capital outlay includes $18.1 billion funded by Federal grants

1995, from 4.1 cents to 3.0 cents. It should be noted however that most of this decline occurred in the early part of this period. Since 1985, highway expenditures per VMT dropped only 9.9 percent in constant dollar terms. Capital outlay per VMT has dropped only 0.8 percent in constant dollar terms. *[See Exhibit 3-45]*

This comparison of highway spending and VMT is a frequently used measure of spending growth. While all types of highway expenditures would not necessarily be expected to grow proportionally to VMT, they would be expected to increase in constant dollar terms. Increases in VMT increase the wear and tear on existing roads, leading to higher capital and maintenance costs. As the extent of the system has grown to accommodate additional traffic, costs have risen since these new lanes and roads also need to be constructed and maintained. Traffic supervision and safety costs also are related in part to traffic volume. As the highway system has grown and become more complex, the cost of administering the system has grown as well.

Q: What types of roads are receiving the most funding for highway capital outlay?

A: Overall 1995 capital outlays amounted to $5,283 per lane-mile and 1.8 cents per VMT. Capital outlay per lane-mile was highest for the higher-order systems and was higher on urban than on rural roads. Outlay per VMT ranges from 1.1 cents on urban collectors to 2.4 cents on "rural other principal arterials," to 2.6 cents on rural and urban local. On a cents-per-VMT basis, capital outlay for rural roads was 10 percent higher than on urban roads. *[See Exhibit 3-46]* State government capital outlay (including the portion funded by the Federal government) is concentrated on the higher-order systems. Local governments

Exhibit 3-47
Capital Outlay by Major Categories on Arterials and Collectors
Billions of Dollars-1995

Functional Class	Estimated Capital Outlay	Percent
System Preservation		
Road	$ 11.0	31.5%
Bridge	$ 6.5	18.6%
Subtotal, System Preservation	**$ 17.5**	**50.0%**
Capacity Expansion		
Capacity Additions to Roads and Bridges	$ 8.9	25.4%
New Roads and Bridges		
Conditions and Performance-related	$ 3.6	10.2%
Economic Development-related	$ 1.8	5.1%
Subtotal, New Roads and Bridges	$ 5.4	15.3%
Subtotal, Capacity Expansion	**$ 14.3**	**40.7%**
Other Improvements	**$ 3.2**	**9.2%**
Total Capital Outlay on Nonlocal Roads	**$ 35.0**	**100.0%**

Source: Highway Statistics 1995 and unpublished FHWA data

control most local roads, and make most of the capital improvements on them.

Q: What types of highway capital improvements are being made?

A: Capital spending on highways can be categorized as follows:

- System preservation: improvements on existing roads and bridges that do not add capacity. This includes minor widening; restoration and rehabilitation; resurfacing; bridge replacement; and bridge rehabilitation.

- Capacity expansion: improvements that add capacity either by adding lane miles to existing facilities or by constructing new roads and bridges. Capacity expansions can be further categorized by whether they are related to conditions and performance (condition and performance related capacity improvements that are made to address existing deficiencies in conditions and performance) or economic development (capacity improvements that are made primarily to encourage economic development in a corridor rather than to address existing capacity deficiencies).

- Other improvements: improvements that are not for the purpose of system preservation or capacity expansion, such as safety enhancements, traffic operations improvements, and environmental improvements.

Highway capital outlay broken down by improvement category is shown in Exhibit 3-47. These totals are estimates, based on State government expenditure patterns, for spending by all levels of government on arterials and collectors. Spending on local functional class roads is excluded, since it cannot be disaggregated by type of improvement. Note that some improvements listed in the "other" category, such as Intelligent Transportation Systems, may add capacity without the addition of new lanes.

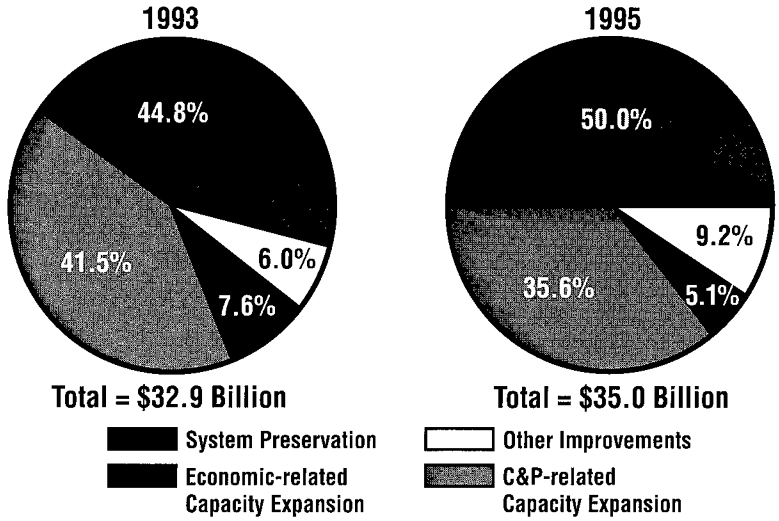
Q: Since the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), has there been a shift in the types of highway capital improvements being made?

A: There has been a significant change in the distribution of types of capital improvements in recent years. The share of total capital outlay that went for system preservation grew from 45 percent in 1993 to 50 percent in 1995, and the share of "other improvements" grew from 6 percent to 9 percent. The portion of capital expenditures used for capacity expansion dropped from 49 to 41 percent, mainly because of a reduction in spending on new roads and bridges. Capacity additions to existing roads and bridges increased, although this category shrank as a percentage of total spending. Insufficient expenditure data are available to draw a conclusion about why these changes have occurred. However, one explanation is that states have elected to use the flexibility provided under ISTEA for system preservation and the "other improvements" categories. The timing of this shift in expenditures is consistent with the passage of ISTEA, since there is normally a lag time between when funds are obligated and when they are spent. *[See Exhibit 3-48]*

Q: Do the types of capital improvements vary by functional class?

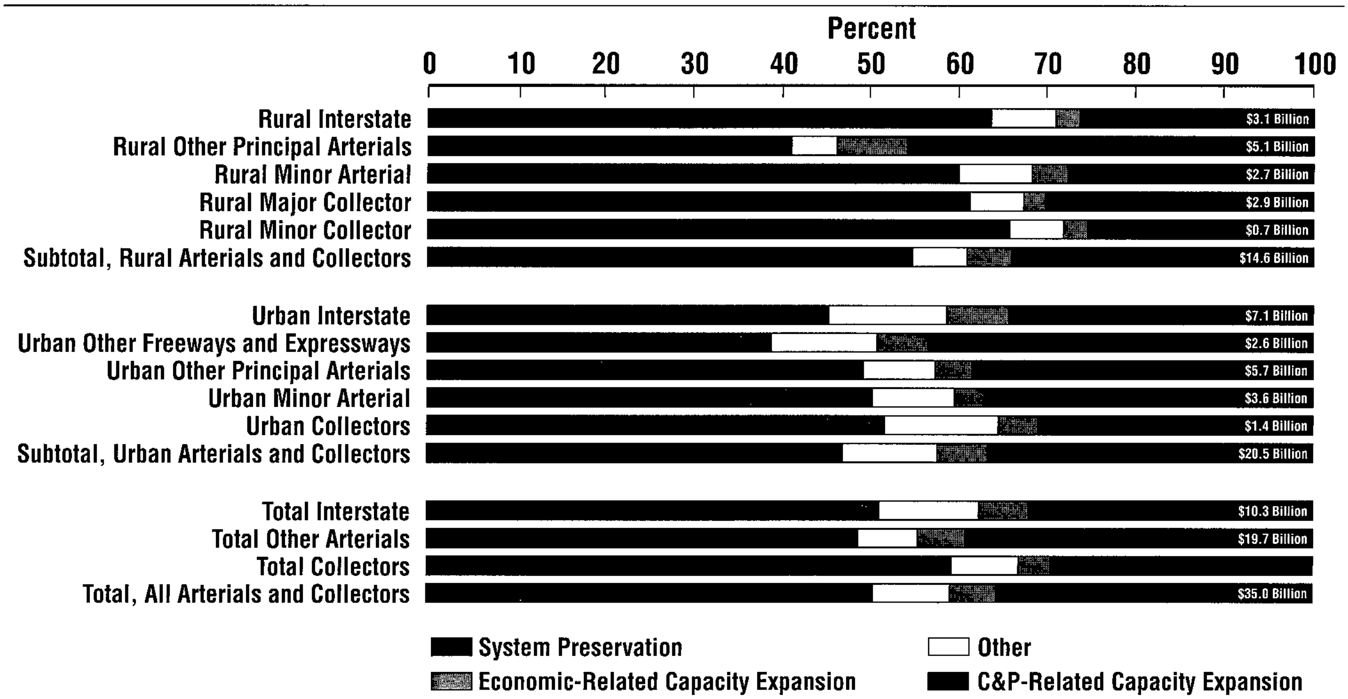
A: There are significant variations in the types of capital expenditures made by States on different functional classes. The portion of capital outlay devoted to system preservation ranges from 39 percent on "urban other freeways and expressways" to 66 percent on rural minor collectors. System preservation's share is generally higher on rural arterials and collectors (55 percent) than on those in urban areas (47 percent). The portion of capital outlay used for capacity expansion related to conditions and performance (C&P) is highest on "rural other principal arterials," at 46 percent. On other arterials generally, C&P-related capacity addition's share of total capital outlay is 39 percent, higher than its share on Interstates (32 percent) and collectors (30 percent). *[See Exhibit 3-49]*

Exhibit 3-48
Distribution of Highway Capital Outlay on Arterials and Collectors By Improvement Type



Source: Highway Statistics 1995 and unpublished FHWA data

Exhibit 3-49
Distribution of Capital Outlay by Improvement Type and Functional Class 1995



Source: Highway Statistics 1995 and unpublished FHWA data

Transit Finance

Q: How much transit funding is provided by all levels of government?

A: Public funding for transit in 1995 was $16.5 billion. The Federal share of this support was $4.1 billion; the State and local share was $12.4 billion.

Q: What are the trends regarding the State and local share?

A: After reaching a low of 45 percent in 1980, the State and local share of transit funding climbed steadily until 1991. Since then, during the ISTEA era, the local share of total transit funding has remained near 77 percent. Exhibit 3-50 shows the trend in funding for transit for selected years.

Q: What are the trends in public sector funding for transit in constant dollars?

A: Exhibit 3-51 shows public sector funding for transit in constant (1995) dollars. The highest total constant dollar level was $16.5 billion in 1995. Federal funding for transit in constant dollars peaked in 1984 at $5.7 billion and was at $4.1 billion in 1995. State and local support has remained over $12 billion annually since 1991. The recent peak in overall funding is the result of growth in transit funding at all levels since 1991.

Q: What are the Federal, State and local government revenue sources for transit expenditures?

A: Federal support for transit includes revenue from motor-fuel taxes (from the Mass Transit Account of the Highway Trust Fund) and general fund appropriations. Sources of transit revenue at the State and local levels include direct transit system taxing authority, property taxes, motor-fuel taxes, income taxes, and other unspecified tax sources.

All levels of general funds combined to provide the largest revenue source (34 percent), followed by motor-fuel taxes (18.5 percent) and State and local taxes (13.5 percent). This information is shown in Exhibit 3-52. State and local revenue other than general fund appropriations come from two primary sources: sales taxes and motor-fuel taxes. Local revenue sources include the indirect taxing support of transit systems, such as the set-aside of revenues each year, as well as direct taxing authority. In 1995, transit systems raised $2.9 billion in direct tax revenues. These included proceeds from the establishment of special benefit assessment districts and other land-related taxes.

Revenue directly generated from fares and other transit system sources totaled $7 billion in 1995. Directly generated revenue supplements the public sector financing of transit, resulting in total revenue for transit from all sources of

Exhibit 3-50
Funding for Transit by Government Jurisdiction (Millions of Dollars) Selected Years 1961 - 1995

Year	Federal		State and Local		Total
1961	$ 0	0%	$ 688	100%	**$ 688**
1966	$ 21	2%	$ 1,008	98%	**$ 1,029**
1971	$ 212	11%	$ 1,680	89%	**$ 1,892**
1976	$ 1,831	33%	$ 3,787	67%	**$ 5,618**
1978	$ 2,177	39%	$ 3,441	61%	**$ 5,618**
1980	$ 3,060	55%	$ 2,514	45%	**$ 5,574**
1982	$ 3,495	48%	$ 3,811	52%	**$ 7,306**
1983	$ 3,670	42%	$ 5,038	58%	**$ 8,708**
1984	$ 4,016	42%	$ 5,469	58%	**$ 9,485**
1985	$ 3,302	34%	$ 6,469	66%	**$ 9,771**
1986	$ 3,589	35%	$ 6,737	65%	**$10,326**
1987	$ 3,438	31%	$ 7,643	69%	**$11,081**
1988	$ 3,228	28%	$ 8,220	72%	**$11,448**
1989	$ 3,491	29%	$ 8,713	71%	**$12,204**
1990	$ 3,458	26%	$ 9,823	74%	**$13,281**
1991	$ 3,395	23%	$ 11,116	77%	**$14,511**
1992	$ 3,448	24%	$ 11,195	76%	**$14,643**
1993	$ 3,295	21%	$ 12,125	79%	**$15,420**
1994	$ 3,380	22%	$ 12,129	78%	**$15,509**
1995	$ 4,081	25%	$ 12,439	75%	**$16,521**

Source: Federal Transit Administration National Transit Database (NTD)

Exhibit 3-51
Funding for Transit by Government Jurisdiction
(Millions of Constant Dollars 1995) Selected Years 1961 - 1995

Year	Federal		State and Local		Total
1961	$ 0	0%	$ 3,162	100%	**$ 3,162**
1966	$ 88	2%	$ 4,207	98%	**$ 4,295**
1971	$ 708	11%	$ 5,607	89%	**$ 6,315**
1976	$ 4,364	33%	$ 9,026	67%	**$13,390**
1978	$ 4,517	39%	$ 7,139	61%	**$11,656**
1980	$ 5,310	55%	$ 4,362	45%	**$ 9,672**
1982	$ 5,313	48%	$ 5,794	52%	**$11,107**
1983	$ 5,373	42%	$ 7,375	58%	**$12,748**
1984	$ 5,679	42%	$ 7,733	58%	**$13,412**
1985	$ 4,514	34%	$ 8,843	66%	**$13,357**
1986	$ 4,786	35%	$ 8,983	65%	**$13,769**
1987	$ 4,440	31%	$ 9,872	69%	**$14,312**
1988	$ 4,010	28%	$ 10,210	72%	**$14,220**
1989	$ 4,172	29%	$ 10,413	71%	**$14,585**
1990	$ 3,949	26%	$ 11,217	74%	**$15,166**
1991	$ 3,751	23%	$ 12,281	77%	**$16,031**
1992	$ 3,712	24%	$ 12,053	76%	**$15,765**
1993	$ 3,457	21%	$ 12,722	79%	**$16,180**
1994	$ 3,460	22%	$ 12,417	78%	**$15,877**
1995	$ 4,081	25%	$ 12,439	75%	**$16,521**

Source: Federal Transit Administration National Transit Database (NTD)

$24.1 billion as shown in Exhibit 3-52.

Q: What is the source of dedicated Federal funding for transit?

A: Dedicated Federal funds for transit have existed since 1983, when the Mass Transit Account of the Highway Trust Fund was established. From April 1, 1983 through July, 1984, the Mass Transit Account received one ninth of Federal motor fuel tax receipts. From August, 1984, through November, 1990, the distribution was 1 cent per gallon. From December 1, 1990, to September 30, 1995, the distribution to the Transit Account was 1.5 cents per gallon. Since October 1, 1995, the distribution has been 2 cents per gallon. Effective October 1, 1997, the Mass Transit Account began receiving a total of 2.85 cents per gallon.

Exhibit 3-52
Revenue Sources for Public Sector Financing of Transit (Billions of Dollars) 1995

Tax Revenues	Federal	State	Local	Total	Percent
Motor Fuel Taxes	**$ 2,653**	**$ 374**	**$ 151**	**$ 3,178**	**18.5%**
General Fund Appropriations	**$ 1,429**	**$ 2,540**	**$ 1,875**	**$ 5,844**	**34.0%**
Other Dedicated Taxes	**$ 0**	**$ 1,673**	**$ 6,473**	**$ 8,146**	**47.5%**
Income	0	208	1,080	1,288	7.5%
Sales	0	372	1,949	2,321	13.5%
Property	0	65	154	219	1.3%
Other	0	1,028	3,291	4,318	25.2%
Total Tax Revenue	**$ 4,081**	**$ 4,588**	**$ 8,498**	**$17,168**	**100.0%**
Fares and Other System-Generated Revenue				**$ 7,015**	
Total, All Sources				**$24,183**	

Source: Federal Transit Administration National Transit Database (NTD)

Exhibit 3-53
Sources of Transit Capital Funds (Millions of Constant 1995 Dollars) 1988 - 1995

	1988	1989	1990	1991	1992	1993	1994	1995
Federal	2,395	2,667	2,636	2,545	2,599	2,383	2,518	*3,314*
Federal Share	*58%*	*57%*	*58%*	*50%*	*49%*	*42%*	*45%*	*47%*
State	671	790	645	638	778	1,317	1,006	989
Local	1,041	1,226	1,255	1,914	1,906	2,033	2,075	2,706
Total	**4,108**	**4,684**	**4,537**	**5,097**	**5,283**	**5,733**	**5,599**	**7,009**

Source: Congressional Budget Office (1988-89); Federal Transit Administration National Transit Database (NTD)

The share of the Federal transit program funded by the Mass Transit Account has increased in recent years. In 1992, 51 percent of the Federal transit program funding was from the Mass Transit Account, with the remainder from the general fund. In 1995, this figure was 62 percent.

Q: What transit funding sources and expenditures are not covered in this section?

A: The revenue sources and expenditures discussed here do not include rural or specialized transit activities. The National Transit Database reporting requirement does not apply to these services, although they are supported by Federal grant funds to States, State grants, and other funding sources. In FY 1995, Federal formula grant funding for rural (i.e., nonurbanized) transit service was $133 million, and elderly and disabled service was funded at $59 million.

Q: What are the trends in transit capital expenditures?

A: As shown in Exhibit 3-53, Federal capital assistance remained relatively stable between 1988 and 1995, while the level of State and local contributions to transit capital assistance increased. Investment in transit capital assets, for both existing and new systems, increased from $4.1 billion in 1988 to $7 billion in 1995. Total capital assistance levels in fiscal years 1994 and 1995 reflect recent growth in capital funding at both the Federal and local levels.

Q: What are examples of transit capital expenditures?

A: Capital expenditures are those sums spent for the design, engineering, construction, and reconstruction of fixed transit assets, as well as rolling stock. Fixed assets include bus garages, rail facilities, tracks and rights-of-way, ferryboat terminals, and park-and-ride lots for rail and bus services. Rolling stock includes buses, vans, railcars, and ferryboats used to provide public transit service. These assets have estimated useful lives ranging from four years in the case of vans to 30 years in the case of some rail and bus facilities.

Q: What activities do transit capital funds support?

A: Exhibit 3-54 shows transit capital expenditures by mode and type. As shown in the exhibit, the largest single component of transit capital expenditures in 1995 was rail facilities, at $2.9 billion. This reflects a general trend toward capital investment in facilities; rolling stock accounts for just 25 percent of transit capital

Exhibit 3-54
Transit Capital Expenditures by Type of Expenditure (Millions of Dollars) 1995

	Rolling Stock	Facilities	Other Capital	Total Expenditure
Rail	$ 751	$2,975	$1,209	$4,936
Bus	$ 881	$ 686	$ 290	$1,856
Other	$ 120	$ 72	$ 26	$ 217
Total	**$1,752**	**$3,733**	**$1,524**	**$7,009**

Source: Federal Transit Administration National Transit Database (NTD)

expenditures. There is, however, a significant difference between transit modes in this regard. While facilities account for more than 60 percent of rail capital expenditures, they are only 37 percent of bus capital expenditures. This is due both to the greater investment required for rail facilities, which include the rights-of-way, track, and structure over which the service operates, and to the long-term nature of certain rail expenditures like rights-of-way.

Q: What are the trends in transit non-capital operating expenditures?

A: Noncapital (operating) assistance increased from $10.2 billion to $16.2 billion between 1985 and 1995, a 59 percent increase in unadjusted dollars. During the same period, unadjusted transit capital investments increased by 71 percent. Operating expenditures increased at a faster rate from 1985 to 1990 (44 percent) than during the 1991-1995 period (5 percent). The earlier increases are partially explained by more complete reporting of expenditures, particularly in the rail transit sector, as well as significant enhancements in service. Both light rail and demand-responsive service experienced significant increases in vehicle revenue miles during the 1985-1995 period. For example, annual vehicle revenue miles for demand-responsive service increased 60 percent between 1991 and 1995. Exhibit 3-55 displays transit operating expenses by mode.

Exhibit 3-55
Transit Operating Expenses by Mode (Millions of Dollars) 1985-1995

Year	Bus	Heavy Rail	Commuter Rail	Light Rail	Demand Response	Other	Total
1985	6,017	2,848	732	140	154	306	**10,197**
1986	6,336	3,102	1,640	158	176	309	**11,721**
1987	6,737	3,235	1,748	172	211	254	**12,357**
1988	6,995	3,524	1,889	197	252	261	**13,118**
1989	7,295	3,704	2,068	209	323	284	**13,883**
1990	7,779	3,825	2,157	236	386	323	**14,706**
1991	8,330	3,841	2,175	290	443	325	**15,404**
1992	8,625	3,555	2,170	307	500	342	**15,499**
1993	8,866	3,669	2,203	314	561	358	**15,971**
1994	9,168	3,786	2,353	412	712	401	**16,832**
1995	8,972	3,523	2,207	375	689	415	**16,182**

Source: Federal Transit Administration National Transit Database (NTD)

Exhibit 3-56
Disbursements for Transit Operations–All Modes by Function (Millions of Dollars) 1995

Mode	Vehicle Operations		Vehicle Maintenance		Non-Vehicle Maintenance		General Administration		Purchased Transportation		Total	
Bus	$4,722	62%	$1,815	60%	$374	21%	$1,386	59%	$675	48%	$8,972	55%
Heavy Rail	1,532	20%	579	19%	918	51%	494	21%	0	0%	3,523	22%
Commuter Rail	826	11%	481	16%	376	21%	326	14%	198	14%	2,207	14%
Light Rail	154	2%	84	3%	81	5%	57	2%	0	0%	375	2%
Demand Response	141	2%	31	1%	4	0%	39	2%	474	34%	689	4%
Other	218	3%	58	2%	32	2%	50	2%	57	4%	415	3%
Total	**$7,594**	**100%**	**$3,048**	**100%**	**$1,787**	**100%**	**$2,353**	**100%**	**$1,404**	**100%**	**$16,182**	**100%**

Source: Federal Transit Administration National Transit Database (NTD)

Q: What activities do transit noncapital funds support?

A: Transit noncapital (operating) expenditures cover wages, salaries, fuel, spare parts, preventive maintenance, support services, and leases used in providing public transit service. Transit and highway expense classification methods differ, contributing to the fact that noncapital transit expenditures represent a substantially greater proportion of overall expenditures for transit than for highways. Of the $23.2 billion spent for transit in 1995, $7 billion was for capital and $16.2 billion for operating costs. Exhibit 3-54 reflects the dominance of bus services, which accounted for 55 percent of 1995's total operating expenses. Heavy rail accounted for 22 percent and commuter rail another 14 percent of total operating costs. Demand-responsive service and light rail accounted for 4 percent and 2 percent, respectively. Purchased transportation constitutes a larger share of demand-responsive service than other modes, while the rail modes show a higher need for facilities and maintenance.

Investment Requirements

Current system condition and performance provides a useful benchmark for system evaluation and analysis of trends. A current performance benchmark also provides a point of departure for national level analysis of capital investments that we must collectively make to maintain or reach specified levels of system performance in future years.

In the tradition of previous reports, this version contains a maintain and an improve scenario each, for highways, bridges, and transit systems. Both highway scenarios and the improve transit scenario are based on economic analysis, as directed by Executive Order 12893, "Principles for Federal Infrastructure Investments", published January 26, 1994. The remaining estimates for transit and bridge investment requirements will be based on economic analysis in future versions. The transition to economic analysis is consistent with continued emphasis within transportation agencies toward value engineering, asset management, and greater cost-effectiveness in decision making.

The economics based maintain highways estimate is lower than the engineering-based maintain condition and performance scenario used in previous reports. This is primarily due to the change in the scenario goals, the full incorporation of the *1994 Highway Capacity Manual* to reflect recent changes in driver behavior, and a slight reduction in the forecasts for future highway travel growth used in the analysis. The 1995 total investment by all levels of government in pavement, highway capacity, and bridge improvements was 13 percent lower than the maintain scenario. Highway and bridge investments could double and still provide user benefits that exceed costs.

The maintain scenario for transit is higher than in previous reports because of a more comprehensive database of transit assets and better understanding of transit unit costs. The total 1995 capital investment in transit was 16 percent lower than the maintain scenario. Transit investment, like highways, could also double and still provide user benefits that exceed costs.

Highway travel forecasts assume a continuation in the moderation of highway demand. Transit estimates assume substantial growth in ridership, relative to current levels and historic trends. These assumptions reflect planning expectations of many of our larger urbanized areas, where environmental constraints, social and fiscal concerns, and adoption of demand shaping policies may result in stronger travel demand management and encouragement of transit usage. To date, no American city has implemented any combination of policies consistent with the assumptions for transit demand used in this report. The degree to which these sets of travel growth assumptions are not realized will influence both the total surface transport investment requirements and the requirements for each mode to meet its service expectations.

Highway and Bridge Investment Requirements

Q: What are the Nation's highway and bridge investment requirements for the next 20 years?

A: There are two highway investment scenarios, the Maximum Economic Investment scenario and the Maintain User Costs scenario. Both are based on a combination of engineering and economic criteria. The Maximum Economic Investment scenario would correct all highway deficiencies when it is economically justified, when the benefits of making a highway improvement exceed the costs of the improvement. The Maintain User Costs scenario would make only those highway improvements that are required to maintain user costs at the level of 1995, the base year for this analysis. The average annual highway investment requirements for all levels of government for the Maximum Economic Investment scenario is $70.2 billion, while the average highway annual investment required to maintain 1995 user costs is $40.5 billion.

There are also two bridge investment scenarios included in this report, which are based strictly on engineering criteria, rather than economic criteria. The goal of the Cost-to-Maintain scenario is to maintain the current state of bridge deficiencies. The goal of the Cost-to-Improve scenario is to eliminate all bridge deficiencies over the next 20 years. The average annual investment requirements for bridges under the Cost-to-Improve scenario is $9.3 billion, while the average annual cost to maintain bridges is $5.6 billion.

Exhibit 3-57
Summary of Highway and Bridge Investment Requirements Avg. Annual Amount for 1996 - 2015 in Billion of 1995 Dollars

Highways	Maintain User Costs	Maximum Economic Investment
Rural Highway	$ 13.3	$ 22.1
Urban Highway	$ 27.2	$ 48.2
Total Highway	**$ 40.5**	**$ 70.3**
Bridges	**Cost to Maintain**	**Cost to Improve**
Total Bridges	**$ 5.6**	**$ 9.3**
Total	**$ 46.1**	**$ 79.6**

The combined average annual costs of implementing all economically justifiable improvements on highways and improving bridges is $79.6 billion, while the average costs of maintaining user costs on highways and maintaining bridge conditions is $46.1 billion. *[See Exhibit 3-57]*

Q: What is the reliability of these investment requirement projections?

A: The models used to develop the projections are deterministic, rather than probabilistic, meaning that they provide a single predicted value, rather than a range of likely values. Therefore, we can not make specific statements about confidence intervals. However, we can make some general statements about the limitations of the projections, based on the characteristics of the process used to develop them.

As in any modeling process, simplifying assumptions have been made to make analysis practical, and to meet the limitations of available data. Potential highway improvements are evaluated based on a benefit/ cost analysis. However, this analysis does not include all external costs, such as environmental costs, or external benefits, such as the favorable impacts of highway improvements on system reliability, and on the economy. To some extent, such external effects cancel each other out, but to the extent that they don't the "true" investment requirements may be either higher or lower than those predicted by the model. Some projects that the model thinks are economically justifiable, may not be. Other projects that the model has rejected could actually be justifiable, if all factors were considered.

The models are intended to simulate, rather than replicate, the decision processes used by State and local governments. These national level models don't have access to the full array of information these local governments would use in making investment decisions. This means that the models may recommend making some highway and bridge improvements that simply are not practical due to factors the model doesn't consider. Excluding such projects would result in reducing the "true" level of investment that is economically justifiable. Conversely, the highway model assumes that State and local project selection will be economically "optimal", and does not consider external factors such as whether this will result in an "equitable" distribution of projects among the States or within each State. In actual practice, there are other important factors included in the project selection process aside from economic considerations, so that the "true" level of investment required to achieve the outcomes defined under the scenarios could be higher than that shown in this report.

Q: How do the investment requirements shown in this report compare with those shown in the 1995 report?

A: The investment requirements are not directly comparable, because one of the highway scenarios is different. In this report, the Maintain User Costs scenario replaced the Cost-to Maintain scenario for highways. This new scenario has a different goal and uses a different methodology for determining investment requirements. The Economic Efficiency scenario for highways from the 1995 report was renamed the Maximum Economic Investment scenario in this report, but the goal of the scenario did not change. The two bridge scenarios also did not change. Note that 1993 dollars were used in the 1995 report while 1995 dollars were used in this report, so the investment requirements would be expected to increase due to inflation.

The investment requirements for the lower of the two combined highway and bridge scenarios in this report are 15.9 percent less than for the lower of the two scenarios from the 1995 report, primarily due to the change in the highway scenario used. The investment requirements for the combined Maximum Economic Investment scenario for highways and Cost to Improve scenario for bridges are 7.4 percent more than those for the comparable scenarios in the 1995 report, primarily due to inflation. *[See Exhibit 3-58]*

Q: How much have the investment requirements changed because of inflation?

A: The bid price index, which is used to calculate the costs of highway improvements, changed significantly between 1993 and 1995. The rural index increased by 5.8 percent and the urban index rose by 18 percent.

Exhibit 3-58
Comparison of Highway Investment Requirements: 1995 and 1997 C&P Reports (Billions of Dollars)

Report Year	Lower Scenario	Higher Scenario
Highways		
1995 (Average Annual 1994 – 2013)	$ 49.7 Cost to Maintain	$ 65.1 Economic Efficiency
1997 (Average Annual 1996 – 2015)	$ 40.5 Maintain User Costs	$ 70.2 Maximum Economic Investment
Percent Change	**-18.5%**	**7.8%**
Bridges		
1995 (Average Annual 1994 – 2013)	$ 5.1 Cost to Maintain	$ 8.9 Cost to Improve
1997 (Average Annual 1996 – 2015)	$ 5.6 Cost to Maintain	$ 9.3 Cost to Improve
Percent Change	**9.8%**	**4.5%**
Highways and Bridges		
1995 (Average Annual 1994 – 2013)	$ 54.8	$ 74.0
1997 (Average Annual 1996 – 2015)	$ 46.1	$ 79.5
Percent Change	**-15.9%**	**7.4%**

Note: 1995 report values are in 1993 dollars, while 1997 report values are in 1995 dollars

The overall difference, weighted by the cost of improvements, is approximately 12.5 percent for the "maintain" scenario and 14 percent for the maximum economic investment scenario.

Q: What is the maintain user costs scenario, and why was it included in this report?

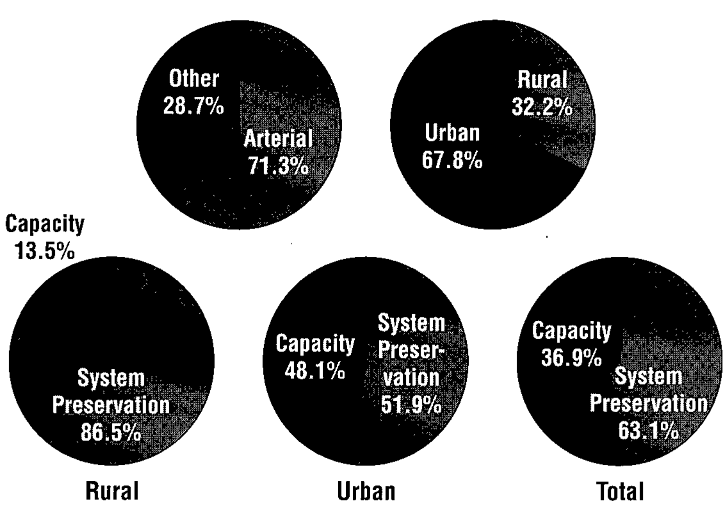
A: Historically, this report has provided two investment scenarios. In the past, the cost-to-maintain scenario was based on maintaining the physical condition and performance of the highway system primarily in terms of engineering standards for pavement condition and congestion. This report overlays the engineering approach with an economic methodology. The economic-based approach was introduced in the 1995 C&P Report for the economic efficiency maximum economic investment scenario only. In this report it is expanded to cover both scenarios. For the "maintain" scenario, the analysis sets the condition and performance of the highway system so that the cost of using the system per vehicle mile of travel will be the same as in 1995. The cost of achieving that goal is approximately 16 percent less than it would be for achieving the engineering-based goal because the analysis provides a more efficient way to maintain an acceptable condition and performance level.

Executive Order 12893, "Principals for Federal Infrastructure Investment", published January 26, 1994, directs that Federal infrastructure investment be based on a systematic analysis of expected benefits and costs. The shift to the Maintain User Costs scenario completes the transformation of the highway analysis from an engineering to an economics approach, in accordance with this Executive Order. Both highway scenarios now focus on the impact that the highway system has on highway users, by minimizing

Exhibit 3-59
Maintain User Costs Scenario–Average Annual Investments Requirements: 1996 - 2015–Billions of Dollars (1995 Dollars)

	Capacity	System Preservation			Total
		Highway	Bridge	Subtotal	
Rural					
Interstate	$ 0.8	$ 1.9	$ 0.4	$ 2.4	$ 3.2
Other Principal Arterial	$ 0.7	$ 2.6	$ 0.3	$ 2.9	$ 3.5
Minor Arterial	$ 0.3	$ 2.0	$ 0.1	$ 2.0	$ 2.4
Major Collector	$ 0.2	$ 2.8	$ 0.1	$ 2.9	$ 3.0
Minor Collector	$ 0.0	$ 1.2	$ 0.2	$ 1.4	$ 1.4
Local	$ 0.0	$ 0.8	$ 0.5	$ 1.3	$ 1.3
Subtotal	**$ 2.0**	**$11.3**	**$ 1.6**	**$12.8**	**$14.8**
Urban					
Interstate	$ 4.5	$ 2.2	$ 2.3	$ 4.5	$ 8.9
Other Freeway & Expressway	$ 1.8	$ 1.0	$ 0.6	$ 1.7	$ 3.4
Other Principal Arterial	$ 2.0	$ 4.0	$ 0.7	$ 4.7	$ 6.8
Minor Arterial	$ 1.5	$ 2.9	$ 0.2	$ 3.1	$ 4.6
Collector	$ 0.6	$ 1.5	$ 0.0	$ 1.5	$ 2.2
Local	$ 4.5	$ 0.6	$ 0.2	$ 0.8	$ 5.3
Subtotal	**$15.0**	**$12.2**	**$ 4.0**	**$16.2**	**$31.2**
Total	**$17.0**	**$23.5**	**$ 5.6**	**$29.1**	**$46.1**

Division of Funds
Maintain User Costs



costs that highway users absorb in the way of vehicle operating costs, travel time, and crash costs. The old engineering-based approach focussed on the impact that highway users (trucks and cars) have on the highway system. The economic-based approach allows for a more complete analysis of the desirability of making highway improvements.

Q: Why is the amount required for the Maintain User Costs scenario significantly lower than for the cost-to-maintain scenario in the 1995 report?

A: There are several reasons for the lowered investment requirement. The most important reason is that the scenario is not the same. For the "cost to maintain" physical conditions and operational performance in the 1995 report, the process maintained an index of the physical conditions of the pavement and the severity of peak-hour congestion over the 20-year analysis period regardless of whether this was cost-beneficial. The scenario used in this report maintains the characteristics of the highway system over the 20-year period such that the costs to the user remain the same as in 1995. By making improvement selections based on benefit/cost analysis, the scenario in this report can achieve its goals at a lower capital cost than the previous scenario.

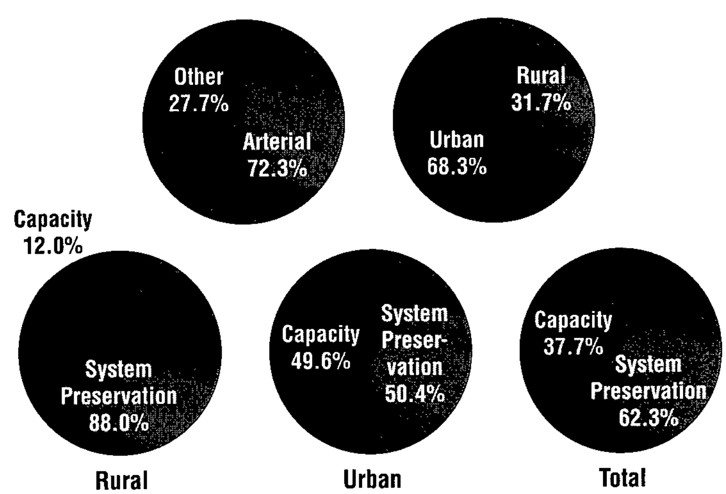
A second reason for lowered investment requirements is the full incorporation of updated Highway Capacity Manual (HCM) procedures. The procedures from the 1994 HCM have reduced the need for additional lanes. The new procedures provide for shorter headways at higher speeds, allowing more vehicles per hour to pass a given point. These changes are based on current driver behavior. Although an external procedure was applied to the 1995 results

Exhibit 3-60

Maximum Economic Investment Scenario–Avg. Annual Investments Requirements: 1996 - 2015–Billions of Dollars (1995 Dollars)

	Capacity	System Preservation			Total
		Highway	Bridge	Subtotal	
Rural					
Interstate	$ 1.2	$ 2.6	$ 0.7	$ 3.3	$ 4.6
Other Principal Arterial	$ 1.0	$ 3.5	$ 0.6	$ 4.1	$ 5.1
Minor Arterial	$ 0.5	$ 3.2	$ 0.4	$ 3.7	$ 4.2
Major Collector	$ 0.3	$ 6.4	$ 0.6	$ 7.0	$ 7.3
Minor Collector	$ 0.0	$ 0.8	$ 0.6	$ 2.7	$ 2.8
Local	$ 0.0	$ 0.8	$ 0.6	$ 1.3	$ 1.3
Subtotal	**$ 3.0**	**$19.1**	**$ 3.1**	**$22.1**	**$25.2**
Urban					
Interstate	$10.3	$ 4.1	$ 3.0	$ 7.1	$17.4
Other Freeway & Expressway	$ 4.5	$ 1.7	$ 1.1	$ 2.7	$ 7.2
Other Principal Arterial	$ 4.2	$ 5.0	$ 1.2	$ 6.2	$10.4
Minor Arterial	$ 2.5	$ 5.7	$ 0.5	$ 6.2	$ 8.7
Collector	$ 1.0	$ 4.1	$ 0.2	$ 0.8	$ 5.4
Local	$ 4.5	$ 0.6	$ 0.2	$ 0.8	$ 5.4
Subtotal	**$27.0**	**$21.2**	**$ 6.2**	**$27.4**	**$54.4**
Total	**$30.0**	**$40.2**	**$ 9.3**	**$49.6**	**$79.6**

Division of Funds
Maximum Economic Investment



to approximate the update, the inclusion of the procedures directly into the model has yielded more accurate results with a greater reduction in the number of lane-miles required to reach a given goal.

The third reason for lowered investment requirements is a reduction in the projected travel demand provided by the States. The adjustments to this forecast to align with MPO forecasts were the same. The adjusted travel growth projections for the 1995 to 2015 period were an annual average of 1.96 percent, while the projections for the 1993 to 2013 period used in the 1995 report were 2.15 percent.

Q: Is there a difference between the Maximum Economic Investment scenario in this report, and the Economic Efficiency Scenario in the last report?

A: No. Only the name of the scenario changed, not its goal or methodology.

Q: What is the Maximum Economic Investment scenario, and why are its investment requirements significantly higher than for the Maintain User Costs scenario?

A: The maximum economic investment scenario corrects all identified deficiencies that would result in a benefit/cost ratio greater than 1. The maintain user costs scenario merely maintains conditions and performance that yield the same user cost as in 1995, the base year of this analysis, while maximum economic investment scenario includes all improvements that are cost beneficial from a highway transportation standpoint and is included in the report as a benchmark. It represents the highest level of investment by all levels of government in highway improvements that can be economically justified.

Q: What would be the effects if highway investment over the next twenty years is different than the levels outlined under the two scenarios?

A: The goal of the Maintain User Costs scenario is simply to keep the cost to the users of the highway system from increasing over time. Assuming the level stated in this report is accurate, investment at a lower level than called for in this scenario would eventually result in increased costs to the users of the highway system, with resultant negative effects on the National economy. The goal of the Maximum Economic Investment scenario is to improve the highway system to the maximum level than is economically justifiable. This level of investment, it must be noted, far exceeds past and current expenditure levels by all levels of government, and existing State Transportation Improvement Plans. Investment at a level between the two scenarios would result in reduction in highway user costs, although maximum benefits would not be achieved.

Q: What are the highway investment requirements by functional system and by capacity and system preservation?

A: Under the Maintain User Costs scenario, $31.2 billion, or 67.8 percent of the total investment requirements of $46.1 billion, are in urban areas. Investment requirements on arterials are $32.9 billion or 71.3 percent of the total. For rural and urban areas combined, the average annual investment requirements for capacity additions are $17.0 billion, 36.9 percent of the total. The remaining $29.1 billion, 63.1 percent of the total, is for system preservation. *[See Exhibit 3-59]*

Under the Maximum Economic Investment scenario, $54.4 billion, or 68.3 percent of the total investment requirements, are in urban areas. Investment requirements on arterials are $57.6 billion or 72.3 percent of the total. For rural and urban areas combined, the average annual investment requirements for capacity additions are $30.0 billion, 37.7 percent of the total. The remaining $49.6 billion, 62.3 percent of the total, is for system preservation. *[See Exhibit 3-60]*

Q: How are system preservation and capacity defined?

A: System preservation consists of the investment required to preserve and maintain the pavement and bridge infrastructure. These improvements include resurfacing, rehabilitation, and some reconstruction. Capacity improvements involve adding lanes to the highway system or adding new roads to address capacity deficiencies. Additional highway construction intended to encourage economic development is not included in this report.

Highway Economic Requirements System (HERS)

Q: How are future highway investment requirements estimated?

A: The Highway Economic Requirements System (HERS), a simulation model that employs incremental benefit/cost analysis to evaluate highway improvements, is used to estimate highway investment requirements. The model identifies system deficiencies by using the Highway Performance Monitoring System (HPMS) dataset of Nationwide sample highway sections, the travel growth estimated by the States and included in the HPMS sections, and projected pavement deterioration based on estimated traffic loadings. HERS then selects alternative improvement actions and evaluates the effects of these actions to determine which improvements have the most economic value. The model then selects the set of actions that meets the criteria and falls within any specified funding constraint or which is required to meet a specified goal. The results included in this report are based on Nationwide analysis and are not the summation of individual State analyses.

Q: What is included in the HPMS dataset?

A: HPMS contains data furnished by the States that is maintained by the Federal Highway Administration and updated annually. The basis for the investment analysis is a Nationwide sample of 120,000 highway sections. The HPMS sample dataset includes data on pavements, geometric, traffic volumes, and other highway characteristics required for investment/performance analysis.

Q: What are the economic criteria used by HERS to evaluate projects?

A: HERS defines benefits as reductions in direct highway user costs, agency costs, and societal costs. Highway user benefits are defined as reductions in travel time costs, crashes, and vehicle operating costs. Agency benefits would include reduced maintenance costs and the residual (salvage) value of the projects. Societal benefits would include reduced vehicle emissions. These benefits are divided by the costs of implementing the improvements to arrive at a benefit/cost ratio that is used to rank projects.

Q: Were the costs of emissions used in the analysis for this report?

A: A comprehensive examination of the total costs and benefits of highways was beyond the scope of this report. Published studies are adequate to address the costs associated with vehicle operations, delay, crash costs, and agency costs, but no published studies adequately represent the costs of motor vehicle emissions. Because these costs are so important in assessing the total marginal costs of motor vehicle emissions, the Department currently is working closely with the Environmental Protection Agency to estimate air pollution costs of highway travel. However, no reliable air pollution cost estimates could be developed in time to be included in this report.

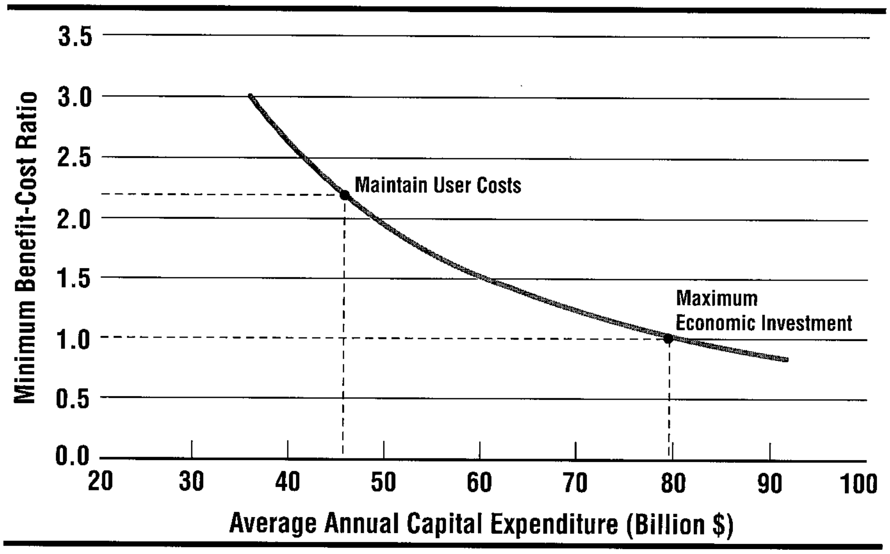
Q: What impact would including the costs of emissions have on the highway investment requirements under the two scenarios?

A: It is not possible to quantify the impacts of including emissions costs on highway investment requirements, because the exact value of these costs is unknown. However, it is possible to make conclusions about the general effect of their inclusion. Including emissions costs in the analysis would reduce net benefits, reducing the benefit/cost ratios (BCR) of individual improvements, all else being equal. This would cause the BCR for some improvements to drop below 1.0, so they would be excluded from the Maximum Economic Investment scenario. Therefore, the investment requirements under this scenario would be lower.

Including emissions costs in the analysis would not cause the investment requirements under the Maintain User Cost scenario to decline. The goal of this scenario is to maintain user costs at 1995 levels, rather than to attain a set BCR. The inclusion of emissions costs would reduce overall BCR's but would not result in fewer improvements being implemented.

Although it may seem counter-intuitive, including emissions costs could cause investment requirements under the Maintain User Costs scenario to increase. Under this scenario, only user costs are kept constant; agency and societal costs could either increase or decrease. However, emissions costs would have an impact on the analysis, because they would be included in the BCR calculation, on which potential improvements are ranked. Reordering the BCR rankings might cause a slightly different set of improvements to be implemented. Some projects that would generate relatively large reductions in user costs per dollar invested but that would also have relatively high emissions costs, might be rejected in favor of projects with lower rates of return in terms of reducing user costs, but higher overall BCR's (including emissions). This might make it necessary to implement more improvements, or to implement some slightly more expensive improvements, to achieve the goal of maintaining user costs.

Exhibit 3-61
Performance vs. Expenditure



Q: What benefit/cost ratios (BCR) would be obtained under the levels of investment presented for each of the two scenarios?

A: The HERS model implements improvements with the highest BCR first. Therefore, until funding reaches the maximum economic investment level of $79.6 billion (marginal BCR=1.0), for every additional dollar invested, total returns will increase, but marginal and average rates of return will decline. At the maximum economic investment, the average BCR would be 3.1, since many of the projects implemented would have a BCR that is much higher than the minimum of 1.0. This indicates that the average of $3.1 dollars of benefits would be obtained from every dollar of expenditure. At levels of $79.6 billion, the marginal BCR would drop below 1.0, meaning that costs would exceed benefits, which would cause total returns to decline.

At the Maintain User Costs level of $46.1 billion, all projects with a minimum BCR of 2.2 or higher could be implemented. At this level, the average BCR for all projects would be 5.4. *[See Exhibit 3-61]*

Q: What travel growth projections were used to develop the highway investment requirements?

A: The States furnish projected travel for each sample highway section in the HPMS dataset used for the analysis, resulting in an average annual VMT growth rate of 2.16 percent over 20 years. The HPMS estimates are the primary source of VMT growth projections used in this report. However, in the case of urbanized areas over one million in population, the aggregate projected travel growth rates were reduced from the 1.88 percent forecast in HPMS to conform to the aggregate growth rate of 1.5 percent that is compiled from rates developed by the metropolitan planning organizations, resulting in an overall average annual growth rate of 1.96 percent. The purpose of this adjustment in the larger urbanized areas is to assure that the estimates of highway investment requirements address the actions the MPOs are proposing to shape demand in their areas to attain air quality and other development goals. This may include transit expansion, congestion pricing, parking constraints, capacity limits, and other local policy options .

Exhibit 3-62
Highway Travel Growth Rates
Average Annual Projected Growth Rates

	Rural	Urban	Total
HPMS Submittal from States	2.28%	2.04%	2.16%
HPMS Adjusted per MPO plans	2.28%	1.76%	1.96%
Maintain User Costs Scenario, Effective Growth Rate	2.28%	1.76%	1.96%
Maximum Economic Investment Scenario, Effective Growth Rate	2.45%	2.12%	2.25%

Note: The projected travel growth for the urbanized areas greater than 1 million population was adjusted to conform in aggregate with the MPO travel forecasts. Urban forecas shown above are for all urban places over 5,000 population.

While the same VMT growth rate was used as an input for each of the two investment scenarios, the travel demand elasticity procedures now incorporated in HERS resulted in a different effective growth rate. Since the goal to Maintain User Costs scenario is to keep user costs constant, the net effect of the elasticity is negligible, so the overall average effective annual growth rate was 1.96 percent. The Maximum Economic Investment scenario increases highway capacity where it is economically justified, resulting in decreases in travel costs. Because of this decline in costs, the elasticity resulted in an increase in VMT over that in the base projection to an average effective annual growth rates of 2.25 percent. This increase in VMT creates additional demand beneficiaries because of increased investment. *[See Exhibit 3-62]*

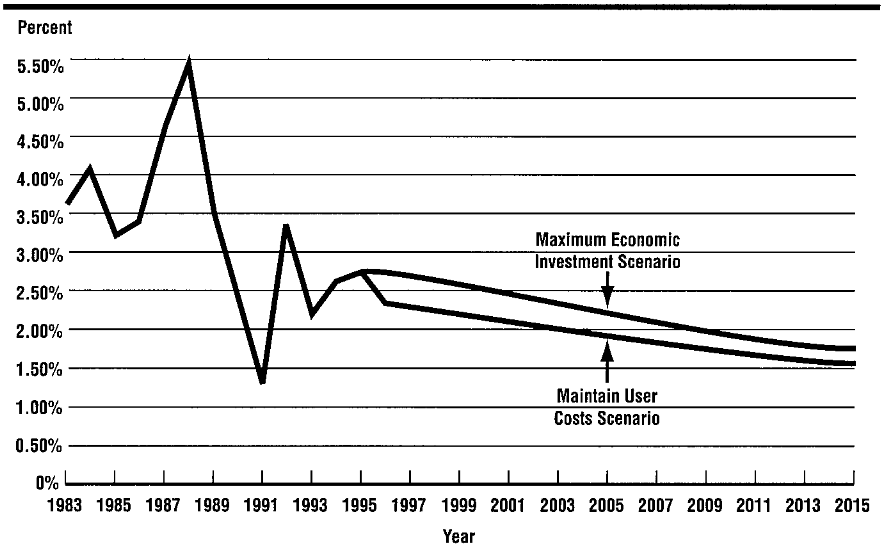
Q: How do the travel growth rates in the two scenarios compare with historic trends?

A: The average travel growth rates in both scenarios are below the actual 1995 VMT growth rate of 2.77 percent and the 3.16 percent average annual growth rate between 1985 and 1995. While average annual growth travel rates have been growing since 1993, the long term historical trend has been that growth rates are declining. In order to better reflect the historic decline in growth rates, the HERS model now assumes that VMT growth rates will gradually decline over time, rather than remain constant at the 20 year average annual rate. The model accomplishes this by assuming that VMT growth will be linear, and will grow by a constant amount annually, rather than growing by a constant rate. Under the Maintain User Costs scenario, the average annual growth rate of 1.96 percent would result in an increase in travel between 1995 and 2015 of 1.15 trillion vehicle miles. The HERS model assumes that VMT will increase by 1/20 of this amount, 57.5 million vehicle miles, during each of the twenty years. As VMT grows each year, this fixed annual increase will represent a smaller percentage of the existing VMT base. *[See Exhibit 3-63]*

Q: What are the implications of the use of MPO forecasts for urbanized areas over one million in population?

A: The MPO highway VMT growth rate forecasts are below historic trends, and are predicated in part on plans to implement travel demand shaping policies, in order to attain air quality and other development goals. If such policies are not implemented, it is likely that the MPO forecasts will not be achieved. If the forecast travel growth rates used to develop the highway investment requirement estimates are understated, then the resulting highway investment requirement estimates may be understated.

Exhibit 3-63
Annual VMT Growth Rates



Q: What are the implications of the higher VMT growth rates under the Maximum Economic Investment scenario?

A: If total highway investment rose to the Maximum Economic Investment scenario levels, average annual VMT growth would still be expected to decline from current rates, but it would not decline as quickly as under the Maintain User Costs scenario. This delay in reducing VMT growth may make it more difficult to achieve national air quality standards.

Some of this increased highway travel would be the result of new trips that would not otherwise have occurred, and some would be diverted from transit. Thus, if highway investment were increased to the Maximum Economic Investment scenario level, this would result in a decrease in assumed transit demand.

Q: Have any changes been made to HERS since the last report?

A: The following modifications have been made to HERS modules:

Capacity—The highway capacity calculations have been updated to incorporate the procedures contained in the most recent *Highway Capacity Manual* (1994, Special Report 209 of the Transportation Research Board). This is the recognized authority for calculating the capacity of a highway facility to accommodate traffic.

Speed model—A revised speed model has been implemented. The speed model is important in calculating estimates of delay and vehicle operating costs. This model was updated to reflect the higher speeds that are being experienced even with high volumes of traffic. It is consistent with the 1994 Highway Capacity Model.

Pavement model—Only minor enhancements were made to the pavement model, including updating the weights used for trucks. These weights are in the form of 18,000-pound-equivalent single-axle loads.

The following additions have been developed and incorporated into HERS:

Travel demand elasticity—HERS now recognizes that as a highway becomes more congested, the volume of travel on the facility is constrained. Conversely, when lanes are added and the cost of traveling the facility decreases, the volume of travel may increase. The model uses the cost of traveling the facility as a way to address this elasticity and adjusts the travel accordingly. The values of elasticity selected for use in this report are -0.8 for short-term elasticity and an additional -0.2 (total, -1.0) for long-term elasticity. Short-term elasticity is used in the five-year funding period being analyzed and long-term elasticity is used in the remainder of the overall analysis period.

Q: What do the travel demand elasticity values used in the report represent?

A: The basic principal behind demand elasticity is that as the price of a product increases, consumers will be inclined to consume less of it, and either consume more of a substitute product or simply do without. Conversely, if the price of a product decreases, consumers will be inclined to consume more of it, either in place of some other product, or in addition to their current overall consumption. The travel demand elasticity figures used in the report, -0.8 short-term elasticity, and the -1.0 long-term elasticity values used in the model represent the percentage that highway travel would change as a result of a change in user costs. For example, if highway-user costs on a facility were to increase by 10 percent, the model predicts that travel on the facility would decline by 8 percent within five years, and by an additional 2 percent within 20 years. Conversely, a reduction of user costs would cause a corresponding increase in highway travel.

The sensitivity of travel demand to changes in user costs can best be described using examples. If highway congestion worsens in an area, this would increase travel time costs. This might cause highway users to shift to mass transit, or it might cause some people living in that area to forgo some personal trips they might ordinarily make. For example, they might be more likely to combine multiple errands into a single trip, because the time spent in traffic on every trip discourages them from making trips unless it is absolutely necessary. In the longer term, people might make additional adjustments to their life-styles in response to changes in user costs, that would impact their travel demand. For example, if travel time in an area is reduced substantially for an extended period of time, some people may make different choices about where to purchase a home. If congestion is reduced, it would be less disadvantageous to purchase a home far out in the suburbs, since commuters would be able to travel further in a shorter period of time. The particular values of -0.8 for short term elasticity and -1.0 for long term elasticity are within the ranges of the available literature on this subject, and are intended to reflect that the majority of the impact on travel demand will occur in the short term, within 5 years.

Q: What effect did the changes in HERS have on the estimated investment requirements?

A: Precise effects cannot be determined because:

- The revised HERS model (version 3) cannot accommodate the data used for the 1995 report.
- The HERS model (version 2) used for the 1995 report cannot accommodate data used for the 1997 report.
- The effect of a single specific change is not necessarily reflected in the effects of combined changes. For example, changes in capacity affect elasticity results. Since the model as now constructed cannot run without elasticity, it is impossible to determine the separate effects of capacity and elasticity changes.
- Effects on the overall needs are different from the effects on the direct model output. This is because needs for local roads, rural minor collectors, bridges, and metropolitan expansion are added to model results and the effects of traffic system management/intelligent transportation systems (TSM/ITS) are subtracted to arrive at final needs numbers.
- The effects vary depending on the scenario and the set of assumptions used in any particular analysis.

Here are some general estimates of the effects of the changes:

Capacity and speed model—Changes in the Highway Capacity Manual (1994 update to the 1985 manual) were implemented in HERS for the analysis done for this report. In conjunction with this change, the speed estimation model was updated to agree with the new HCM. This update in the speed model also included changes in the effect of poor pavement on speed. The combined effect of these changes in the investment requirements is typically a 6 to 10 percent decrease.

Travel demand elasticity—Adjustments to traffic flow based on the cost of traveling a given section of highway are incorporated into HERS for the 1997 report. This was not addressed directly in the 1995 report. The elasticity selected for the current HERS runs is -0.8 for the short term (funding period under analysis) and an additional -0.2 for the longer term (future funding periods). This means that the total long-term elasticity is -1.0. The model is sensitive to the selected elasticity value, with extreme values (virtually zero or much greater than -1) changing the model results up to 20 percent or more, depending on the scenario. However, the effect of elasticity on the cost-to-maintain user costs are negligible, regardless of the value of elasticity. This is because the goal of the scenario is to maintain user costs per vehicle mile of travel (VMT) as close to current levels as possible. Thus the chosen improvements provide essentially the same quantity of capacity related to demand that exists today, eliminating the effects of elasticity. The effects of elasticity on the maximum economic investment scenario is to increase the volume of travel. This is because the model determines that it is cost beneficial to increase capacity, which in turn attracts additional travel. *[See Exhibit 3-62]*

Q: What external adjustments are made to the basic HERS results?

A: The following adjustments were made:

TSM/ITS—Construction of additional lanes is not the only option that can be considered in accommodating travel demand. Freeway surveillance and control, high-occupancy lanes, ramp metering, incident management, and signalization improvements are among the improvements that contribute to more efficient traffic flow in appropriate circumstances. An estimate is made of the effect of TSM/ITS actions and a reduction is made in the number of additional lanes that would otherwise be required. Estimated costs of these actions are also included in the total improvement cost. Lane-mile additions selected by HERS are reduced and the effect on total investment requirements is a reduction of 4.5 to 6.5 percent of the Maximum Economic Investment and the Maintain User Costs scenarios, respectively. The respective percent reductions of the investment requirements for capacity are 10.5 and 15 percent.

Metropolitan expansion—As the population of the nation increases, additional facilities a re required to accommodate the growth, especially in expanding urban areas. Costs of these additional facilities are included in the total improvement costs. The average annual cost of constructing these facilities is estimated to be $10 billion.

Local roads and rural minor arterial facilities—The HPMS database does not include data for minor collector facilities or rural and urban local roads and streets. Estimates of needs for these functional classes are based on previous studies of these facilities.

The investment requirements for local roads are estimated to be $6.6 billion annually for the Maintain User Cost scenario and $6.7 billion for the Maximum Economic Investment scenario. These values include estimates made in lieu of HERS analysis, bridge analysis, and metropolitan expansion. The investment requirements for rural minor arterials are estimated to be $1.4 billion for the Maintain User Cost scenario and $2.8 for the Maximum Economic Investment scenario.

Bridge Investment Requirements

Q: Can bridge investment requirements be further disaggregated from overall highway investment requirements?

A: Yes. See Exhibits 3-64 and 3-65. For the scenario Cost to Maintain bridge conditions, the 1995 report estimated that 203,794 bridges would be rehabilitated or replaced. This compares with 219,319 in the current report, an increase of 7.6 percent. For the Cost to Improve bridge conditions, the 1995 report estimated that 455,825 bridges would be rehabilitated or replaced. This compares with 455,380 in the current report, an insignificant change.

Exhibit 3-64
Cost to Maintain Bridge Conditions
1996-2015

Functional System	Number of Repaired or Replaced Bridges	1996-2015 Requirements (Billions)	Annualized Requirements (Billions)
Rural			
Interstate	12,577	$ 8.6	$ 0.4
Other Principal Arterial	8,136	$ 5.9	$ 0.3
Minor Arterial	2,582	$ 1.9	$ 0.1
Major Collector	1,570	$ 1.2	$ 0.1
Minor Collector	25,396	$ 3.4	$ 0.2
Subtotal Non-Local	50,261	$ 20.9	$ 1.0
Local	104,736	$ 10.4	$ 0.5
Total Rural	**154,997**	**$ 31.3**	**$ 1.6**
Urban			
Interstate	31,148	$ 45.0	$ 2.3
Other Freeway & Expressway	8,509	$ 12.7	$ 0.6
Other Principal Arterial	10,390	$ 14.8	$ 0.7
Minor Arterial	4,074	$ 3.9	$ 0.2
Collector	998	$ 0.7	$ 0.0
Subtotal Non-Local	55,120	$ 77.2	$ 3.9
Local	104,736	$ 3.3	$ 0.2
Total Urban	**64,322**	**$ 80.5**	**$ 4.0**
Total Non-Local	105,381	$ 98.1	$ 4.9
Total Local	113,938	$ 13.7	$ 0.7
Total	**219,319**	**$111.7**	**$ 5.6**

Q: How do the bridge investment requirements compare to those contained in the 1995 report?

A: When inflation is considered, the costs are quite comparable. Virtually all of the increase in both scenarios can be explained by inflation.

Q: HERS is used as an economic tool for roadway investment analysis. Is there a similar tool for bridge analysis?

A: Development of such a model, based on the optimization procedures of Pontis, is under way. Pontis is a bridge management system developed initially with input from FHWA, several States, the Transportation Research Board, and other interests. It is now supported by the American Association of State Highway and Transportation Officials and is being further enhanced at the suggestion of the States for use as their bridge management system. The national Bridge Investment Analysis System (BIAS) is being developed to take advantage of the Pontis optimization procedures and features that apply to a National system. Since BIAS is restricted to using National Bridge Inventory data, it cannot analyze individual bridges like Pontis can, but it can provide information by functional class. We expect that it will be available for use in future reports.

Q: How are bridge investment requirements currently determined?

A: The Bridge Needs and Investment Process (BNIP) uses an engineering approach. Using the National Bridge

Inventory the process identifies bridge deficiencies, selects improvements, and simulates and costs these improvements. An engineering ranking scheme is used to prioritize potential actions. The objective of the bridge Cost to Maintain scenario is to maintain the current state of deficiencies over the 20-year analysis period. The objective of the bridge Cost to Improve scenario is to correct all bridge deficiencies over the 20-year period, including those which would accrue during the period. This scenario would achieve improved conditions for both rural and urban bridges across all functional systems nationwide.

Exhibit 3-65
Cost to Improve Bridge Conditions
1996-2015

Functional System	Number of Repaired or Replaced Bridges	1996-2015 Requirements (Billions)	Annualized Requirements (Billions)
Rural			
Interstate	30,185	$ 14.4	$ 0.7
Other Principal Arterial	23,682	$ 12.2	$ 0.6
Minor Arterial	24,167	$ 8.6	$ 0.4
Major Collector	56,518	$ 11.3	$ 0.6
Minor Collector	32,003	$ 3.5	$ 0.2
Subtotal Non-Local	166,556	$ 50.1	$ 2.5
Local	147,803	$ 11.6	$ 0.6
Total Rural	**314,358**	**$ 61.7**	**$ 3.1**
Urban			
Interstate	49,202	$ 60.3	$ 3.0
Other Freeways & Expressways	21,363	$ 21.1	$ 1.1
Other Principal Arterial	25,041	$ 24.4	$ 1.2
Minor Arterial	17,567	$ 10.2	$ 0.5
Collector	11,873	$ 4.2	$ 0.2
Subtotal Non-Local	125,046	$120.1	$ 6.0
Local	15,975	$ 4.5	$ 0.2
Total Urban	**141,021**	**$124.6**	**$ 6.2**
Total Non-Local	291,602	$170.2	$ 8.5
Total Local	163,778	$ 16.1	$ 0.8
Total	**455,380**	**$186.4**	**$ 9.3**

Q: Are system preservation and capacity addressed in estimating bridge investment requirements?

A: The separate bridge investment requirements shown in this report are only for system preservation. Widening highways to accommodate more lanes is not part of the bridge analysis. However, the costs of all capacity improvements, including additional lanes on bridges, or parallel bridges, are included in the highway investment requirements. Since the costs used in the HERS model for adding lanes are average costs of highway and bridge widening combined, no separate costs for bridge or highway widening are available.

Highway Investment Requirements Versus Highway Capital Outlay

Q: What is the appropriate method for comparing the investment requirements outlined in this report with current levels of highway investment?

A: For simplicity, the investment requirements in this report are shown as average annual figures for the period 1996-2015. Actual investment requirements in 1996 would be lower than those in 2015. As new roads and lanes are added, the costs of preserving the system and meeting the challenge of future demand exceeds inflation because the highway system is growing.

For purposes of annual budget analysis, or other types of short term analyses, it is appropriate to use estimated 1996 investment requirements to address differences between current capital outlay and investment requirements. When making a longer term comparison, it is more appropriate to use the average annual values. In either case, some adjustments must be made to actual highway capital expenditures prior to making comparisons. Investment requirements in this report are related solely to condition and performance deficiencies. A portion of actual highway capital outlay is used for types of improvements not currently simulated in the investment requirement modeling process, and must be excluded when comparing investment requirements and current spending.

Q: What portion of total highway capital outlay is related to the investment requirements outlined in this report?

A: It is estimated that $38.1 billion of highway capital outlay in 1995 was related to the investment requirements outlined in this report. An additional $5.0 billion of highway capital outlay went for types of improvements that are not currently reflected in the simulation. This includes $1.8 billion of capacity expansions that were related to economic development rather than capacity deficiencies, and $3.2 billion used for some types of environmental, safety, and traffic operational improvements. *[See Exhibit 3-47]*

Exhibit 3-66
Capital Outlay Related to Condition and Performance on All Roads and Bridges
Billions of Dollars-1995

Functional Class	Total Capital Outlay	Percent C&P Related	Condition and Performance Related Capital Outlay		
			Total	Roadway	Bridge
Rural Arterials and Collectors					
Interstate	3.1	89.8%	2.8	2.4	0.4
Other Principal Arterial	5.1	86.3%	4.4	4.0	0.4
Minor Arterial	2.7	87.7%	2.3	1.8	0.6
Major Collector	2.9	91.4%	2.7	2.0	0.6
Minor Collector	0.7	91.2%	0.7	0.5	0.2
Subtotal	**14.6**	**88.6%**	**12.9**	**10.6**	**2.3**
Urban Arterials and Collectors					
Interstate	7.1	79.5%	5.7	4.1	1.5
Other Freeway & Expressway	2.6	82.2%	2.2	1.6	0.5
Other Principal Arterial	5.7	87.2%	5.0	3.5	1.5
Minor Arterial	3.6	87.2%	3.2	2.3	0.9
Collector	1.4	82.3%	1.2	0.8	0.3
Subtotal	**20.5**	**83.6%**	**17.1**	**12.4**	**4.7**
Subtotal, Rural and Urban	**35.0**	**85.7%**	**30.0**	**23.0**	**7.0**
Rural and Urban Local*	**8.0**	**100.0%**	**8.0**	**6.2**	**1.9**
Total, All Systems	**43.1**	**88.3%**	**38.1**	**29.2**	**8.9**

* Local functional class cannot be broken down by improvement type. All assumed to be related to C&P. Roadway/Bridge split based on Arterial and Collector percentages.

Source: Highway Statistics 1995 and unpublished FHWA data

Exhibit 3-67
1996 Investment Required for Highways and Bridges Versus 1995 Capital Outlay
Billions of Dollars

	1996 Maintain User Costs			1996 Maximum Economic Investment			1995 C&P-related Capital Outlay
	Capacity Expansion	System Preservation	Total	Capacity Expansion	System Preservation	Total	
Highway	14.0	23.5	37.5	24.2	40.2	64.4	29.2
Bridge	–	5.6	5.6	–	9.3	9.3	8.9
Total	**14.0**	**29.1**	**43.1**	**24.2**	**49.5**	**73.7**	**38.1**

Of the $43.1 billion spent on capital improvements by all levels of government, $35.0 billion was spent on arterials and collectors. An estimated $30.0 billion was spent on conditions and performance-related improvements on arterials and collectors. The $8.0 billion spent on roads and bridges in the local functional class cannot be broken down by improvement type with the available data. It is likely that most of this amount is related to conditions and performance on local roads and streets. Including this amount raises the total amount of capital outlay related to conditions and performance to $38.1 billion. *[See Exhibit 3-66]*

(NOTE: The $43.1 billion average annual Maintain User Cost estimate and the $43.1 billion in actual 1995 spending are purely coincidental).

Q: How do actual 1995 expenditures for highway capital improvements compare with the estimated 1996 investment requirements?

A: Based on 1995 expenditures, the level of investment by all levels of government would need to increase by 13 percent to reach the estimated 1996 investment requirements of $43.1 billion under the Maintain User Costs scenario and would need to increase by 93 percent to reach the estimated 1996 investment requirements of $73.7 billion under the Maximum Economic Investment scenario. *[See Exhibit 3-67]*

Q: What method is used to estimate highway investment requirements for individual years?

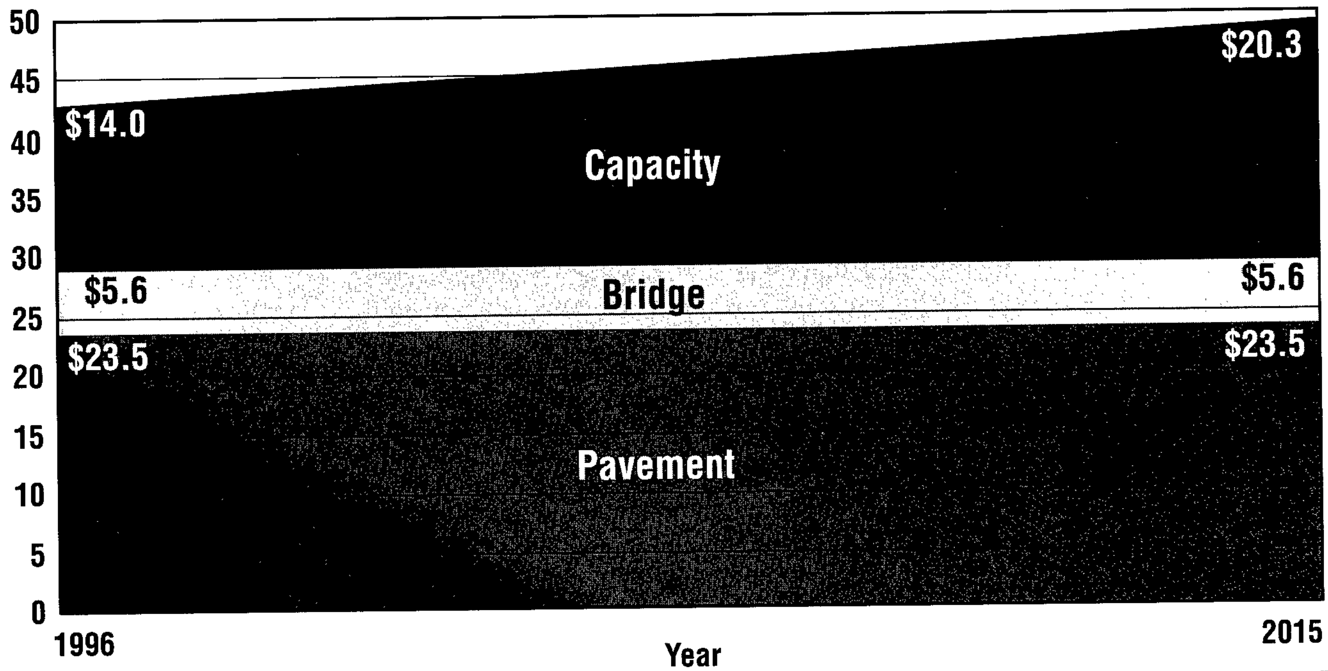
A: The amounts required for system preservation, both pavement and bridge, are assumed to be approximately the same for each year. The amount for capacity improvement is assumed to grow at the same rate as average annual growth in highway travel. As shown in Exhibit 3-68, the investment requirements for the Maintain User Costs are estimated to rise from $43.1 billion in 1996 to $49.4 billion in 2015, stated in constant 1995 dollars. The investment requirements under the Maximum Economic Investment scenario are estimated to rise from $73.7 in 1996 to $86.4 in 2015 stated in constant 1995 dollars. *[See Exhibit 3-68]*

Q: Using 1995 investment as a starting point, how much would investment have to increase annually to meet the investment requirements for the full 20 years under the two scenarios?

A: If highway investment by all levels of government continues at the 1995 level of $35.1 billion, total investment for the period 1996-2015 would be $720 billion. Based on the $46.1 billion average annual investment requirement under the Maintain User Costs scenario, the 20-year investment requirement would be $922 billion, stated in constant 1995 dollars. Assuming a constant rate of growth, investment by all levels of government must exceed the rate of inflation annually by 2.5 percentage points to meet the 20-year investment requirements under the Maintain User Costs scenario.

Based on the $79.6 percent average annual investment

Exhibit 3-68
Cost to Maintain User Costs



requirement under the Maximum Economic Investment scenario, the 20-year investment requirement would be $1,522 billion. Assuming a constant rate of growth, the $35.1 billion of highway investment by all levels of government in 1995 would need to annually increase 7.3 percent in constant dollars to meet the 20-year investment requirements under the Maximum Economic Investment scenario.

Q: If fuel taxes were increased to provide funding for raising capital investment to the Maximum Economic Investment scenario level, would this have an impact on the VMT growth rates predicted under this scenario?

A: The HERS model is not currently configured to predict the results of tax increases. However, in theory, if fuel taxes were increased significantly, this would result in a lower VMT growth rate.

The HERS model estimates an average annual growth rate of 2.25 percent under the Maximum Economic Investment. This is higher than the 1.96 growth rate in the Maintain User Costs scenario, because the travel demand elasticity feature of the model assumes that additional travel will be induced if highway-user costs decline. If fuel taxes were increased significantly, this would partly offset the reductions in user costs that would occur under the Maximum Economic Investment scenario. Therefore less travel would be induced, and the average annual growth rate would be lower than the 2.25 percent predicted under this scenario.

Transit Investment Requirements

Q: What are the nation's transit investment requirements for the next 20 years?

A: There are two transit investment scenarios in this report, the maintain transit conditions and performance scenario and the improve transit conditions and performance scenario. The average annual investment for the maintain conditions and performance scenario is $9.7 billion, while the average annual investment to improve conditions and performance is $14.2 billion. The maintain scenario would maintain equipment and facilities in the current state of repair while accommodating future transit travel growth. The improve scenario would make the maintain scenario investments and make additional investments to improve the condition of transit assets by the end of the twenty year investment period and improve the performance of transit operations. A more detailed discussion of the investment scenarios follows the discussion of the Transit Economic Requirements Model investment procedures.

Transit Economic Requirement Model (TERM)

Q: What is TERM?

A: The Transit Economic Requirements Model provides estimates of the total annual capital expenditures required to maintain or improve the physical condition of transit systems and the level of service they provide. The estimate represents the total urbanized area transit investment required by all levels of government. The model also generates estimates of current transit conditions and performance and evaluates the impact of varying levels and types of investment on future conditions and performance.

Q: How does TERM estimate transit investments?

A: TERM establishes investment expenditure estimates for each of three major investment categories, as reflected in the following TERM modules:

- Asset Rehabilitation and Replacement Module, which estimates reinvestment in existing assets to maintain and improve the assets' physical condition.

- Asset Expansion Module, which estimates investments in new, expansion assets such as vehicles and facilities (e.g., exclusive rights-of-way, stations, and track) to maintain operating performance to meet forecasts of travel demand.

- Performance Enhancement Module, which estimates investments in additional fixed-guideway transit capacity to improve operating performance.

- Benefit-Cost Module. All investments identified are analyzed on a benefit-cost basis, and only those with a benefit-cost ratio greater than 1 are included in the national investments estimate. The TERM modules are further subdivided by mode, asset type (vehicles, stations, structures, etc.), and urban area characteristics (e.g., size, FTA region). In addition to investment estimates, TERM generates estimates of the physical condition of the Nation's transit assets, as described in the section of this report on transit conditions and performance.

Q: How does the Asset Rehabilitation and Replacement Module work?

A: The Asset Rehabilitation and Replacement Module identifies investments to maintain and improve the physical condition of the existing transit asset base. This module uses statistically determined deterioration curves to simulate the deterioration of transit vehicles and facilities. As the assets are deteriorated by the model, their condition declines, requiring investments in rehabilitation and replacement.

The key inputs to the model are the National Transit Asset Inventory, the asset deterioration curves, and information on FTA rehabilitation and replacement policies. The National Transit Asset Inventory is a comprehensive list of transit assets owned and operated in the United States. It includes records from FTA's National Transit Database (NTD) vehicle inventory, the Rail Modernization Study, and an expanded and more thorough database of additional transit assets developed specifically for use in TERM. The specialized TERM database includes over 20,000 records, detailed by asset types such as structures, trackwork, stations, maintenance facilities, systems, and vehicles. This extensive database allows the synthesis of assets where agency-reported data are missing or incompatible with the other known agency assets. Values used in the model's input parameters determine the specific thresholds in the deterioration process at which assets are rehabilitated and replaced.

Asset deterioration curves predict asset condition as a function of asset type, age, usage rate, and maintenance history. For example, straight and curved track sections are deteriorated using different deterioration curves because these assets deteriorate at different rates. Assets that have greater use and/or lower maintenance typically have more rapid deterioration rates and a lower overall condition. The resulting asset condition ratings range from 5 (excellent) to 1 (poor). TERM rehabilitates and replaces assets at thresholds that are independently established for each asset category. (For further discussion of the asset deterioration process in TERM, see Exhibit 3-29 and related text in the Transit Condition and Performance section.)

The Rehabilitation and Replacement Module estimates only investments required to maintain the base year fleet; it does not account for expansion assets purchased during the 20-year model run. This function is performed by the Asset Expansion Module.

Q: How does the Asset Expansion Module work?

A: The Asset Expansion Module identifies investments required to maintain current operating performance. The module does this by accommodating growth in transit use at the base year level of performance. Using growth in transit PMT from MPO forecasts, the module programs the purchase of transit vehicles and other assets required to maintain the base year level of performance (e.g., passengers per peak vehicle). The MPO forecasts of PMT growing at an annual rate of 2.3 percent is used by TERM. This compares to a five year trend reported to the National Transit Database of flat transit PMT growth. The model screens asset investments to ensure that passenger miles per peak vehicle mile at least reach a national threshold. Investments are forgone in cases where occupancy fails to achieve the threshold. Investments estimated by the Asset Expansion Module during the first part of the twenty-year forecast period are then subject to the Asset Rehabilitation and Replacement Module later in the analysis period.

Q: How does the Performance Enhancement Module work?

A: The Performance Enhancement Module identifies transit capacity investments to improve operating performance beyond the asset expansion module. The Performance Enhancement module contains Performance Standard and New Starts Pipeline submodules.

The Performance Standard submodule identifies investments based on the national average vehicle operating speed. In the NTD, average rail operating speed exceeds the average bus operating speed *[see Exhibit 3-24]* and this principle is employed by the module in concert with the New Starts Pipeline and MPO-estimated regional growth to identify rail investments required to increase system speed and other performance indicators to specified levels. The Performance Standards submodule makes investments required to improve transit operating speeds in urban areas with the lowest speeds and to reduce vehicle utilization rates for the most crowded transit operators. The model estimates the investment level required to allow systems falling below the minimum operating speed threshold or above the maximum vehicle utilization threshold to add new transit capacity until these threshold values are attained.

The New Starts Pipeline submodule identifies investments in planned and TERM-forecast transit new starts (e.g., new fixed guideway systems) during the twenty year analysis period. First, TERM identifies future annual fixed guideway investments from the list of currently planned New Start projects, as identified by FTA's annual reporting of new start projects. TERM then uses the results of a regression analysis to estimate the total level of new start investment expected for each urbanized area given its population, historical ridership, and area size, and invests in additional transit fixed guideway right of way if the current mileage is less than the projected amount during the twenty year analysis period. To reflect the actual constraints on such projects, TERM limits the level of investment possible in an urban area in any given year (e.g., four track miles). Also, TERM will only invest in forecast track mileage once investment in planned projects is complete and added to the region's actual transit mileage investment levels. All investments identified in the Performance Enhancement Module are subjected to the benefit-cost analysis before inclusion in the national transit investment estimates.

Q: How is benefit-cost analysis applied to potential transit investments?

A: All investments identified in TERM are subject to a benefit-cost test. To analyze the investment modules' output, TERM utilizes two separate benefit-cost filters—the first is used to analyze investments proposed by the Rehabilitation and Replacement and Asset Expansion modules, and the second filter is used for investments proposed by the Performance Enhancement Module.

Q: How does the Rehabilitation and Replacement and Asset Expansion benefit-cost module operate?

A: The Rehabilitation and Replacement and Asset Expansion modules benefits and cost are modeled at the transit agency level and on a mode-by-mode basis. For each agency and mode in the TERM database, the model first estimates the mode's discounted stream of capital investment and operating and maintenance expenditure

Exhibit 3-69
Summary of Transit Average Annual Investment Requirements (Billions of 1995 Dollars) 1996 - 2016

All Systems (Includes Local)					
Cost to Maintain			Cost to Improve		
Capacity Expansion	System Preservation	Total	Capacity Expansion	System Preservation	Total
$2.7	$7.0	$9.7	$6.0	$8.2	$14.2

Source: Transit Economic Requirements Model (TERM)

over the twenty years of the model run (including Asset Enhancement Module generated investments). This stream is then compared to the discounted stream of benefits anticipated from continued operation of that agency mode. If the level of projected benefits is in excess of the estimated capital and operating and maintenance expenditures (i.e., if the benefit to cost ratio is greater than 1), the model's estimate of agency and mode capital investment needs is included in the overall national investment needs estimate. If the benefits to cost ratio is less than 1, the agency and mode is not considered to be cost-effective and is discontinued. The benefits accounted for in the model are discussed below.

Q: How does the Performance Enhancement benefit-cost module operate?

A: For Performance Enhancement projects, investments are evaluated on a project-by-project basis (for planned investments) and on an urbanized area basis (for TERM forecast investments). Each investment in a new start project is analyzed based on the known characteristics of the urbanized area the investment is expected to serve, the expected total cost and time period for project development, expected operating and maintenance costs, and the level and type of benefits associated with a typical new start investment of the proposed type (on a per mile basis). These benefits and costs are compared using a discounted net present value analysis, where projects with a benefit to cost ratio greater than 1 are included in TERM's national summary of Performance Enhancement investments while those failing the test are omitted.

Q: What benefits are considered in TERM's benefit-cost analysis?

A: TERM screens for benefits from three categories:

- Transportation system users benefits—Transportation system user benefits are travel time savings, reduced highway congestion and delay, reduced auto costs, and improved mobility.

- Transit agencies benefits—Agency benefits are fare revenue increases and reductions in operating and maintenance costs.

- Social benefits—Social benefits are reductions in air and noise emissions, reduced roadway wear, and transportation system administration.

Whenever possible, the total level of benefits associated with each investment type is modeled on a transit passenger mile basis or a vehicle mile traveled basis. Most of the benefits from reinvestment in current transit assets and new transit investments identified by TERM accrue to new and existing users of the transit system and are captured in the class of transportation system user benefits. Some of the benefits are used to evaluate Rehabilitation and Replacement and Asset Expansion investments (e.g., operating and maintenance costs), while others are used to evaluate Performance Enhancement investments (e.g., reduced new rider costs and reduced emissions).

Establishment of a Federal government-wide value for air and noise emissions is currently underway. Therefore, the air and noise emission benefit value was set at zero in the model runs used to produce investment needs for this report.

Q: What are the principal differences between previous investment requirements approaches and TERM?

A: In previous editions of this report, investment requirements were developed using a range of independent analytical techniques and data sources. In the 1995 report, the Highway Economic Requirements System (HERS) model was introduced to provide highway investment estimates. The use of TERM in this edition of the report marks the introduction of a similar unified modeling approach for transit investment requirements. As discussed earlier, the significant improvements represented by TERM include a more comprehensive database of transit assets, the introduction of field-derived deterioration curves for specific assets, the use of a more complete new starts investment model, and the application of a comprehensive benefit-cost analysis. However, TERM does not yet account for the interaction of supply and demand elasticity. Future versions of TERM will introduce a demand elasticity factor to account for changes in transit travel associated with varying transit investment levels.

Q: How is the replacement of rural and specialized service transit vehicles calculated?

A: As described in the sections on transit conditions and performance, information on rural and specialized transit fleets, including the number of vehicles and average fleet age, was collected from the Community Transportation Association of America. The cost to maintain conditions is calculated by determining the number of vehicles that must be replaced annually to maintain the current average fleet age and multiplying this number by the average cost per replacement vehicle. The vehicle replacement ages are set using FTA's minimum useful life guidelines. The resulting investment requirement estimates are then added to the TERM results.

Q: How is the replacement of rural and specialized service transit facilities calculated?

A: Recent data on the condition of rural transit facilities is reported in the transit conditions and performance section. However, no information is available on required capitalization costs. FTA grants for all urban facilities have about equaled the grants for vehicles over the last five years. Rural area facility needs are likely to be proportionately less than urban needs, since, because of the nature of rural service, there is less need for ancillary facilities like terminals, stations, transfer facilities, and park-and-ride lots. Similar considerations apply to specialized transit facilities. Accordingly, for the purposes of this analysis, rural and specialized facility needs are calculated at one-half of rural vehicle needs. This is based on the past relationship between transit bus and bus facility expenditures. The resulting investment requirement estimates are then added to the TERM results.

Cost to Maintain Transit Conditions and Performance

Q: What is the definition of investments to maintain transit conditions and performance?

A: The cost to maintain transit conditions and performance represents the investment level required to maintain facilities and equipment in the current state of repair and operating performance. The maintain existing conditions and performance scenario generated by the Transit Economic Requirements Model (TERM) includes the cost of expanding transit service to meet the projected growth in transit ridership forecast by Metropolitan Planning Organizations (MPOs) while maintaining current condition and performance levels. Under this scenario, the average condition of the Nation's existing transit fleet would remain constant over a 20-year analysis period.

In order to maintain performance, TERM estimates the level of investment in new vehicles and supporting assets required to maintain the existing ratio of transit passenger miles traveled (PMT) to peak vehicles over the 20-year forecast horizon. Investments are forecast on an urbanized-area basis using PMT growth forecasts obtained from a survey of MPOs. Investments in maintaining both conditions and performance are subject to a benefit-cost test by mode at the agency level. The benefit-cost test is also performed for investments in the scenario to improve existing conditions and performance.

Q: What is the average annual cost to maintain current transit conditions and performance?

A: The average annual cost to maintain transit conditions and performance levels for the 20-year period through 2016 is estimated at $9.7 billion. Of this amount, $7 billion is made up of measures to maintain transit conditions, including replacing and rehabilitating transit vehicles and nontransit infrastructure such as transit guideways and support facilities. The remaining funds would support bus and rail fleet expansion to maintain current performance levels of transit service such as average vehicle speeds and passenger wait times to accommodate future projected growth in transit passenger miles. This information is in Exhibit 3-69.

Q: What would the Nation's transit systems look like at this investment level?

A: At this level, transit passenger miles traveled are assumed to grow at an annualized rate of 2.3 percent through 2016. The increase in transit capacity would accommodate an increase in passenger-miles carried from the present 38 billion to an estimated 61 billion. Transit service would increase from 183 million revenue-vehicle hours to 293 million vehicle-hours. In 2016, average transit asset conditions would remain unchanged, with the typical bus and rail vehicle in "adequate" and "good" condition, respectively.

Q: What kinds of transit investments would be made at the "maintain conditions and performance" level?

A: Transit vehicles would be replaced at about the current rate, which is slightly slower than what is generally regarded as optimal. Existing rail systems would be maintained in about their current condition, with no major improvements. Investments to existing rail systems would be made at about the rate required to ensure that equipment and facilities are replaced as they wear out. Exhibit 3-70 provides detailed estimates of investments required to maintain transit condition and performance for each of the major types of services provided.

Cost to Improve Transit Conditions and Performance

Q: What is the definition of investments to improve transit conditions and performance?

A: Under the "improve conditions" scenario, transit assets would be rehabilitated and replaced to a physical condition of "good" by the end of the 20-year analysis period. By comparison, the "maintain conditions" scenario holds the average asset condition of the transit fleet (bus and rail vehicles, track, stations, etc.) unchanged at the end of the 20-year period.

Improvements in performance result from investments required to improve transit operating speeds for the Nation's lowest-performing operators and to reduce vehicle utilization rates for the most crowded transit operators. Systems falling below the minimum operating speed threshold or above the maximum vehicle utilization threshold would invest in new transit capacity until these threshold values are attained. Investments made in the improvement scenario include the maintenance scenario's expansion of the transit fleet to accommodate projected growth in transit ridership. Investments in improving both transit conditions and performance are subject to a benefit-cost test by mode at the agency level. For further infirmation, see the discussion of benefit-cost analysis beginning on page 71.

Q: What is the average annual cost to improve transit conditions and performance?

A: The cost to improve transit conditions and performance levels for the 20-year period through 2016 is estimated at $14.2 billion. Of this amount, $9.7 billion is for measures to maintain current transit conditions and performance, $1.2 billion is to retire the backlog of required rehabilitations and replacements, and $3.3 billion is to improve transit service levels in terms of speed and convenience. Exhibit 3-71 summarizes the cost of improving transit conditions and performance.

Exhibit 3-70
Cost to Maintain Transit Conditions and Performance, Annual Average (Millions of 1995 Dollars) 1996 - 2016

Mode and Type of Facility	Costs to Maintain Conditions	Incremental Cost to Maintain Performance	Total
Areas Over 1 Million			
Bus			
Vehicles (Replacement and Rehabilitation)	$822		$822
Non-Vehicles (Guideway Elements, Facilities, Systems, Stations)	$520		$520
Fleet Expansion (Vehicles)		$350	$350
Fleet Expansion (Non-Vehicles)		$490	$590
Elderly and Disabled Vehicles and Facilities	$50		$50
Subtotal Bus	**$1,392**	**$840**	**$2,232**
Rail			
Vehicles (Replacement and Rehabilitation)	$1,276		$1,276
Non-Vehicles (Guideway Elements, Facilities, Systems, Stations)	$3,271		$3,271
Fleet Expansion (Vehicles)		$598	$598
Fleet Expansion (Non-Vehicles)		$949	$949
Subtotal Rail	**$4,548**	**$1,547**	**$6,095**
Total Areas Over 1 Million	**$5,940**	**$2,387**	**$8,328**
Areas Under 1 Million			
Bus			
Vehicles (Replacement and Rehabilitation)	$291		$291
Non-Vehicles (Guideway Elements, Facilities, Systems, Stations)	$342		$342
Fleet Expansion (Vehicles)		$133	$133
Fleet Expansion (Non-Vehicles)		$143	$143
Elderly and Disabled Vehicles and Facilities	$284		$284
Nonurbanized Area Vehicles and Facilities	$167		$167
Subtotal Bus	**$1,084**	**$276**	**$1,360**
Rail			
Vehicles (Replacement and Rehabilitation)	$1		$1
Non-Vehicles (Guideway Elements, Facilities, Systems, Stations)	$6		$6
Fleet Expansion (Vehicles)		$1	$1
Fleet Expansion (Non-Vehicles)		$0	$0
Subtotal Rail	**$7**	**$1**	**$8**
Total Areas Under 1 Million	**$1,091**	**$277**	**$1,368**
Total	**$7,032**	**$2,664**	**$9,696**

Source: FTA Transit Economic Requirements Model (TERM).

Exhibit 3-71
Cost to Improve Transit Conditions and Performance, Annual Average (Millions of 1995 Dollars) 1996 - 2016

	Costs to Maintain Conditions and Performance	Incremental Cost to Improve Conditions and Maintain Performance	Incremental Cost to Improve Conditions and Performance	Total
Areas Over 1 Million				
Bus				
Vehicles (Replacement and Rehabilitation)	$822	$62		$884
Non-Vehicles (Guideway, Facilities, Systems, Stations)	$520	$14		$534
Fleet Expansion (Vehicles and Non-Vehicles)	$840			$840
New Bus (Vehicles and Non-Vehicles)			$380	$380
Elderly and Disabled Vehicles and Facilities	$50	$13		$63
Subtotal Bus	**$2,232**	**$89**	**$380**	**$2,701**
Rail				
Vehicles (Replacement and Rehabilitation)	$1,276	$210		$1,487
Non-Vehicles (Guideway, Facilities, Systems, Stations)	$3,271	$764		$4,035
Fleet Expansion (Vehicles and Non-Vehicles)	$1,547			$1,547
New Rail (Vehicles and Non-Vehicles)			$2,815	$2,815
Subtotal Rail	**$6,095**	**$974**	**$2,815**	**$9,884**
Total Areas Over 1 Million	**$8,327**	**$1,063**	**$3,195**	**$12,586**
Areas Under 1 Million				
Bus				
Vehicles (Replacement and Rehabilitation)	$291	$25		$316
Non-Vehicles (Guideway, Facilities, Systems, Stations)	$342	$3		$346
Fleet Expansion (Vehicles and Non-Vehicles)	$276			$276
New Bus (Vehicles and Non-Vehicles)			$125	$125
Elderly and Disabled Vehicles and Facilities	$284	$74		$358
Nonurbanized Area Vehicles and Facilities	$167	$42		$209
Subtotal Bus	**$1,360**	**$144**	**$125**	**$1,629**
Rail				
Vehicles (Replacement and Rehabilitation)	$1			$1
Non-Vehicles (Guideway, Facilities, Systems, Stations)	$6			$6
Fleet Expansion (Vehicles and Non-Vehicles)	$1			$1
New Rail (Vehicles and Non-Vehicles)				
Subtotal Rail	**$8**	**$0**	**$0**	**$8**
Total Areas Under 1 Million	**$1,368**	**$144**	**$125**	**$1,637**
Total	**$9,696**	**$1,207**	**$3,320**	**$14,223**

Source: FTA Transit Economic Requirements Model (TERM).

Q: What would the Nation's transit systems look like at this investment level?

A: At this level of investment, as in the maintenance scenario, transit passenger miles traveled are assumed to grow at an annualized rate of 2.3 percent through 2016. The level of service would improve, however, with an increase in average vehicle speeds and additional passenger seats. In addition, the improvement scenario brings the stock of transit assets to "good" condition in 2016. (See the section on transit conditions and performance, beginning on page 28, for asset condition definitions). If transit PMT were to grow at a rate 20 percent lower than assumed in TERM (e.g., 1.8 percent), the improve scenario investment requirement would be 7 percent lower.

Q: What kinds of transit investments would be made at the "improve conditions and performance" level?

A: In addition to meeting the costs in the maintenance scenario, the improvement scenario would eliminate the backlog of deferred rail and bus modernization and rehabilitation, improving the conditions to "good." This would include the investments required to provide the transit capacity described above.

Q: How do the actual expenditures for transit capital improvements compare with investment requirements?

A: The capital outlay for transit improvement was $7 billion in 1995 *[see Exhibit 3-54]* This compares to the maintenance scenario capital investment requirement of $9.7 billion and the improvement scenario of $14.2 billion. Both the actual 1995 funding and the TERM investment requirements levels are based on funding from all levels of government. In FY 1995, the Federal share of transit capital outlays was 47 percent.

The report's investment estimates are projected over a 20-year period. The investment required for capacity expansion to maintain or improve system performance is assumed to grow at a rate sufficient to accommodate increased travel growth. In any given year, transit investment levels may differ from the average annual investment requirement.

Combining Highway and Transit Investment Requirements

Q: Is it appropriate to combine the highway Maximum Economic Investment scenario with the transit Cost to Improve scenario to develop a single number for the maximum justifiable investment for highway and transit?

A: No. The highway travel demand elasticity feature assumes that under the Maximum Economic Investment scenario, as highway user costs fall, additional highway travel would occur. Some of this would be newly generated travel; some would be the result of travel shifting from transit to highways. Since the highway and transit analytical procedures are not linked at this time, it is not possible to estimate the magnitude of this modal trade off. Travel demand elasticity is not currently included in the transit analysis, but the same principles would apply. The maximum justifiable level of combined highways and transit investment would be less than the sum of these two scenarios, depending on the degree of modal shift.

Q: Does travel demand elasticity also preclude combining the highway Maintain User Costs scenario with the transit Cost to Maintain scenario to develop a single number for "maintaining" highways and transit?

A: No. Travel demand elasticity does not present an obstacle to combining these two scenarios. Under both scenarios, travel is neither induced nor constrained, as highway user costs are simply maintained. It is appropriate to combine the highway and transit estimates from these two scenarios.

National Highway System (NHS)

The National Highway System (NHS) was established by Congress by the National Highway System Designation Act of 1995. This system consists of the highways of greatest National interest, including all of the Interstate highways, a large portion of the other principal arterial highways, and a small portion of mileage on the other functional systems. Since there is no long-term history of data on the NHS, this section does not contain trends or comparisons with past years. The NHS contains approximately 4 percent of the highway miles and 43 percent of the travel in the Nation.

Q: What are the total number of miles on the NHS?

A: The NHS consists of 156,986 miles, 4.0 percent of total mileage.

Q: What portion of VMT occurs on the NHS?

A: Total VMT on the NHS was 1.0 trillion in 1995, 43.0 percent of total VMT.

Q: How congested is travel on the National Highway System (NHS) in urban areas?

A: Using the traditional measure of highway congestion, the ratio of the volume of traffic using a road in the peak travel hour to the capacity or service flow of that road (V/SF), the percentage of peak-hour urban travel on the NHS that occurs in congested conditions (V/SF more than 0.80) is 45.1. The higher the value of this ratio, the more congested the facility. When V/SF is above 0.80, travelers on the road experience significant interference with free travel flow. The 45.1 percent congested on the urban NHS compares to 41.4 percent congested for all urban principal arterials.

Q: What are the pavement conditions on the NHS?

A: The following exhibit contains the percentage of miles on the NHS in each of the same five categories—poor, mediocre, fair, good, very good—used for functional systems. The percent of poor pavement in rural areas on the NHS is 2.8, compared to 5.5 percent of poor pavement on all rural arterials and major collectors. The percent of poor pavement in urban areas on the NHS is 9.2 percent, compared to 8.9 percent on all urban arterials and collectors. *[See Exhibit 3-72]*

Exhibit 3-72
NHS Percent Miles by Pavement Roughness Category

	Poor	Mediocre	Fair	Good	Very Good	Percent
Rural						
Percent Mile	2.8%	10.7%	44.4%	31.4%	10.7%	100.0%
Urban						
Percent Mile	9.2%	17.2%	41.2%	22.0%	10.3%	100.0%

Source: National Bridge Inventory

Exhibit 3-73
NHS Bridge Deficiencies 1996

	Number	Percent
Rural Bridges	63,083	
Deficient Bridges	12,183	19.3%
Structural	3,682	5.8%
Functional	8,501	13.5%
Urban Bridges	64,653	
Deficient Bridges	20,737	32.1%
Structural	6,008	9.3%
Functional	14,729	22.8%
Total Bridges	127,736	
Deficient Bridges	32,920	25.8%
Structural	9,690	7.6%
Functional	23,230	18.2%

Source: National Bridge Inventory

Q: What is the condition of bridges on the NHS?

A: The percentage of deficient NHS bridges is 25.8 percent, with 7.6 percent of this total being structural deficiencies and 18.2 percent functional deficiencies. This compares to the percent deficient for all bridges in the Nation, with 31.4 percent total deficiencies (17.5 percent structural and 14.0 percent functional deficiencies). *[See Exhibit 3-73]*

Q: How much is spent for capital outlay on the National Highway System (NHS)?

A: In 1995, all levels of government spent $20.3 billion for capital outlay on the NHS. This represents 47.2 percent of the total capital outlay of $43.1 billion.

Q: What portion of total funding for highway capital outlay on the NHS is provided by the Federal Government?

A: An estimated $12.5 billion of Federal grants to States and local governments was used for capital outlay on the NHS in 1995. This is the equivalent of 61.7 percent of the total capital outlay for the NHS whereas the overall Federal contribution to capital is 44.5%. The $12.5 billion represents 66.7 percent of total Federal grants to State and local governments of $18.8 billion.

Q: What are the investment requirements for the NHS?

A: Of the $43.1 billion average annual investment requirements under the Maintain User Costs scenario, $19.9 billion, or 43.2 percent is for the NHS. Of the $79.6 billion average annual investment requirements under the Maximum Economic Investment scenario, $36.8 billion, or 46.2 percent is for the NHS. *[See Exhibit 3-74]*

Q: What portion of total capital outlay on the NHS is related to the investment requirements outlined in this report?

A: Of the $20.3 billion spent for capital outlay on the NHS in 1995, $17.1 billion (84.2 percent) was related to the investment requirements outlined in this report. An additional $3.2 billion of highway capital outlay went for types of improvements that are not currently reflected in the HERS model, such as capacity expansions that were related to economic development rather than to addressing existing capacity deficiencies, and some types of environmental, safety, and traffic operational improvements.

Q: How do actual 1995 expenditures for NHS capital improvements compare with the estimated 1996 investment requirements?

A: Investment by all levels of government on the NHS would need to increase approximately $2.0 billion (12 percent) above the 1995 level to reach the estimated 1996 investment requirements under the Maintain User Costs scenario and would need to increase by approximately $16.2 billion (95 percent) to reach the estimated 1996 investment requirements under the Maximum Economic Investment scenario.

Exhibit 3-74

Maintain User Costs–Highways and Bridges on NHS 1996-2015

	Highway	Highway Capacity	Highway Pavement	Bridge	Total
Rural	$5.9	$1.2	$4.6	$0.7	$6.6
Urban	$10.3	$5.8	$4.6	$3.0	$13.4
Total	**$16.2**	**$7.0**	**$9.2**	**$3.7**	**$19.9**

Maximum Economic Investment–Highways and Bridges on NHS 1996-2015

	Highway	Highway Capacity	Highway Pavement	Bridge	Total
Rural	$7.9	$2.0	$5.8	$1.2	$9.1
Urban	$23.3	$15.9	$7.4	$4.4	$27.7
Total	**$31.2**	**$17.9**	**$13.3**	**$5.6**	**$36.8**

Q: Using 1995 investment on the NHS as a starting point, how much would investment have to increase annually to meet the investment requirements for the full 20 years under the two scenarios?

A: If highway investment by all levels of government on the NHS continues at the 1995 level of $17.1 billion, total investment for the period 1996-2015 would be $342 billion. Based on the $19.9 billion average annual NHS investment requirement under the Maintain User Costs scenario, the 20-year investment requirement would be $398 billion, stated in constant 1995 dollars. Assuming a constant rate of growth, investment by all levels of government on the NHS must exceed the rate of inflation annually by 1.4 percentage points to meet the 20-year NHS investment requirements under the Maintain User Costs scenario.

Based on the $36.8 percent average annual NHS investment requirement under the Maximum Economic Investment scenario, the 20-year investment requirement would be $736 billion. Assuming a constant rate of growth, the $17.1 billion of highway investment by all levels of government in 1995 would need to annually increase 6.8 percent in constant dollars to meet the 20-year investment requirements under the Maximum Economic Investment scenario.

SECTION 4

U.S. Freight: Economy in Motion

Introduction

Because of the critical importance of freight transportation to the economy, FHWA commissioned the following special section on freight for inclusion in this report. This section provides an overview of the current status of freight transportation via the different transportation modes and outlines the forces of change are expected to transform freight transportation in the future. This section is a summary of a larger report entitled *U.S. Freight: Economy in Motion*. For more complete information, please refer to that report, which can be found in the National Transportation Library at www.dot.gov.

Preface

They sit silently in the stores—row upon row, rack upon rack, stacked, piled, arranged for our convenience—meat, produce, foodstuffs, clothing, household goods, cleaning supplies, even videotapes and ice cream. How do these things that comprise modern living get there? What happens in the United States that allows goods to flow effortlessly through the Nation? What processes occur so that a person in Minot, North Dakota, has the same range of choices as a person in New York City? Why doesn't the United States have the shortages of goods and the long lines of customers that characterize other countries with equally complex and long-distance transportation systems?

The reason U.S. consumers are the envy of the world is that our Nation essentially is an economy in motion. For a variety of reasons, including a freight logistics system that is second to none, our Nation has the ability to move raw materials, manufactured products, and finished goods with very high degrees of precision and reliability.

No one person or entity is responsible for this success. Rather, it is the sometimes cooperative, sometimes competitive actions of a range of players that make all of this possible. These players are public and private sector entities who must juggle a host of often conflicting and ever changing mandates in a world that is getting more compressed and time sensitive.

The purpose of this section is to explain the operation of these entities and their interactions, as well as to highlight the issues that will shape our continued ability to transport what we want when and where we want it.

Overview

Unpacking the things we buy in stores or through direct mail outlets is the last step in a process that industry professionals and public policy makers call the freight logistics system, or, more simply, logistics. In its most basic terms, logistics is finding the most efficient way to source, manufacture, and distribute a given product. Each of these steps is linked intrinsically with transportation—transporting raw materials to markets or production sites, moving semi-finished goods among production sites, sending finished goods to distribution centers for subsequent delivery to stores or consumers.

Freight transportation represents a significant share of the Nation's economy. Business and industry spent $421 billion in 1994 to move 3.5 trillion tons of freight over transportation networks totaling 2.3 million miles across the continental U.S. This amount does not include the money spent on inventory, warehousing, and logistics services, nor does it include the international transportation networks used to reach or leave the U.S. mainland.

For business, freight transportation is a significant operating expense. Using 1994 gross national product numbers as a yardstick, freight transportation accounted for 6.3 percent of total expenditures. Another way to look at freight transportation's impact on the economy is to consider transport jobs and salaries. Of the nearly 4 million jobs directly attributable to transportation, roughly 75 percent—about 3 million—are freight related.

On a personal level, only housing, health care, and food have a larger share of our personal budgets. Americans spend more on transportation (freight and personal) than they do on clothing themselves, operating their households, enjoying recreation and travel, or contributing to religious and welfare activities. In short, transportation costs account for almost 11 percent of disposable personal income.

Exhibit 4-1
Freight Profile

Mode	Cargo Value	Cargo Volume	Service	Distance Traveled
Truck	Moderate to High	Loads of less than 50,000 pounds per vehicle. Higher weights with state permits.	Single driver can go 500/day. Team or relay driving can go further. On-time performance varies by carrier. Most better than 90% with some at 99% or better.	Varies by carrier type. Two-thirds of tonnage moves less than 100 miles. Interstate carriers average 416 miles.
Rail	Moderate to Low	Multiple Carloads. No weight restrictions.	Dedicated service can move goods cross-country by third morning. More normal times 4-7 days. On-time performance varies by carrier. Some meet 85% or better. Others 60%-70% range.	Average length of haul is 794 miles.
Intermodal	Moderate to High	Truck trailers by rail or water are most common haul of multiple carloads. No weight restrictions. Other combinations include air/truck, water/rail, and pipeline/truck or ship.	Matches to end of rail – third morning for cross country. Also uses more normal rail transits of 4-7 days On-time performance equal to or better than rail but not as good as truck generally.	No average length specified. However, distances normally range from 700 miles to 1,500 miles or more.
Air	High	Small. Most are less than 100 pounds.	Normally overnight or second day service.	Average distance is more than 1,300 miles.
Domestic Water	Moderate to Low	Normally bulk shipments totaling in the millions of tons.	Varies according to system segment. Competitive with rail on large dimension and bulk shipments.	Based on system segment, average distances range: from 356 to about 1,600.
Domestic Off-Shore Water	Moderate to Low	Container and general freight as well as bulk shipments.	Bulk service is slower than container. Container transits can occur within 7-10 days trans-Pacific and trans-Atlantic.	Distance varies based on the state, territory, possession being served.
International Water	High to Low w/ most moves moderate to Low	Bulk shipments similar to domestic. Container shipments similar to rail and truck.	Bulk service is slower than container. Container transits can occur within 7-10 days trans-Pacific and trans-Atlantic	Average distance is more than 2,300 miles
Pipeline	Low	Bulk shipments in the millions of tons or trillions of gallons.	Flow rates vary with consumer demand. Can range from 0 to 20 miles per hour.	Average distance for crude oil is 825 and 375 for finished products.

Exhibit 4-2
Modal Profiles

Transport Mode	Percent of U.S. Freight Bill	Percent Hauled Based on Value	Shipment Value ($/Lb.)	Percent Hauled Based on Volume	Average Length of Haul (Miles)
Truck	79	72.6	$0.35	52.6	416**
Rail	8	4.0	$0.08	12.7	794
Water	5	3.9	$0.06	17.2	2,300-maritime 1,650-domestic
Intermodal	*	10.4	$1.61#	1.7	***
Air Freight	4	2.4	$26.77	0.02	1,325
Pipeline	2	2.8	$0.09-$0.06	10.8	825-crude 375-product
Other	2	3.9	$0.20	5.0	unknown

* Percentage incorporated into underlying modal totals.

** Without local trucking operations, which would lower this intercity average. Two-thirds of domestic freight shipments by volume have a length of haul that is less than 100 miles.

*** Not specified. Generally, a minimum distance of 750 miles is needed, with best economies appearing when shipments distances are 1,000-1,500 miles or greater.

\# Average value. Package express has a value of $15/lb.; rail/truck intermodal $1.09/lb.; and, other intermodal $0.05/lb.

Source: 1993 Commodity Flow Survey: State Summaries, September 1996, U.S. Department of Transportation, Bureau of Transportation Statistics, Association of American Railroads and U.S. DOT's Maritime Administration

Freight is not a single industry or defined set of procedures. It is instead the dynamic interaction of many businesses focused on producing and distributing goods in commerce. It encompasses the public as well as the private sector and includes the Department of Defense, the Nation's largest shipper.

Of the $420 billion spent by the U.S. in 1994 to move its freight, trucking was the dominant mode, accounting for $331 billion, or 79 percent of the total freight bill. Railroads came in second, generating about $34 billion, or 8 percent of the total. International, inland, and coastwise water transportation was the next largest portion with $22 billion, or 5 percent. Air freight followed with about $17 billion, or 4 percent. Oil pipelines and miscellaneous modes each generated another 2 percentage points, or about $8 billion.

Motor Carriers

Trucking is the Nation's dominant form of freight transportation, accounting for almost 80 percent of the 1994 freight bill. A retailer of transportation services, the industry has increased market share over the last two decades by creating customized transportation services to meet specific commercial needs. Except in certain circumstances, such as the shipment of large quantities of bulk commodities, trucking dominates local and regional freight movements.

The trucking industry is specialized. Companies tend to segregate their services into distinct categories or industries: long distance versus regional or local, private versus for-hire, dry van versus tanker, and general versus specialized cargoes.

Exhibit 4-3
Motor Carrier Profile

Industry Segment	Percent of Total Truck Revenues
Private Local	27.3
For-Hire Local	11.4
Private Interstate and Intrastate	26.6
For-Hire Interstate	28.9
For-Hire Intrastate	3.4
For-Hire Exempt	2.4

America's Private Carriers: Who Are These Guys?, National Private Truck Council and Transportation Technical Services, 1995

Exhibit 4-4
Interstate Motor Carrier Profile

Interstate Carrier Type	Percent of For-Hire Industry	Percent of Carrier Revenues
Truckload	42.5	30.7
Less than Truckload	11.9	40.1
Household Goods	4.6	7.8
Bulk	5.2	4.9
Tank	10.6	5.7
Refrigerated	9.5	4.9
Other Specialized	15.7	6.0

Source: ATA Trucking Information Services, Motor Carrier Annual Report. Derived from reports filed with the U.S. DOT by carriers with $1 million or more in annual revenue

Although the popular image of the industry is of the tractor-semitrailer hauling goods long distances over Interstate highways, this is a misleading view. First, truck equipment is diverse and is dominated by smaller vehicles and a wide variety of equipment types. Second, most trucking operations are local, with 66 percent of truck tonnage moving distances of 100 miles or less.

Of the 353 billion miles traveled by trucks for business purposes in 1994, 57 percent was generated by vehicles weighing less than 10,000 pounds. Trucks weighing between 10,001 and 33,000 pounds accounted for another 15 percent. Medium to large combinations such as tractor-semitrailers weighing over 33,000 pounds generated only about 28 percent of the miles traveled. *[See Exhibit 4-5]*

Trucking is pervasive. It serves as the carrier of choice for most small businesses, especially the very smallest, which rely on package express carriers like Federal Express and United Parcel Service to meet their shipping needs. By revenue, food and food products, lumber and wood products, and petroleum and coal account for 34.8 percent of truck traffic.

Trucking's customer focus has played a key role in helping to create the logistics revolution of the past decade. The just-in-time revolution of the 1980s was spearheaded by trucks, with motor carriers and shippers the first to experiment with set times for pickup and delivery so that less inventory was needed in the overall production process.

Motor carriers face competition from air freight carriers for high-value commodities and from railroads for lower-value goods. On high-value goods, the competition pits traditional air freight services against package express or courier services as well as expedited carriers. Because transportation costs are a relatively small portion of the purchase price of these goods, firms are willing to pay premium rates. In this segment of the industry, delivery is predicated on strict time and service requirements. Air freight has an average value of $26 per

Exhibit 4-5
Relationship of Equipment and Revenue

Truck Body Type	Number of Units	Percent of Carrier Revenues
Light Duty (Pickups, Vans, Utilities, Station Wagons)	54,089,000	91.4%
Multi-Stop Step Van	408,000	0.7%
Platform and Flatbed	1,569,000	2.6%
Pole and Logging	54,000	0.1%
Dry Van	808,000	1.4%
Refrigerated Van	205,000	0.3%
Livestock Van	48,000	0.1%
Other Van	80,000	0.1%
Liquid/Gas Tank	232,000	0.4%
Dry Bulk Tank	34,000	0.1%
Dump Truck	612,000	1.0%
Grain Body	311,000	0.5%
Concrete Mixer	61,000	0.1%
All Other	690,000	1.2%
Total	**59,201,000**	**100.0%**

Source: 1992 Truck Inventory - U.S., U.S. Bureau of the Census
Note: Numbers may not total 100 percent due to rounding

pound and package express of $15 per pound, while general trucking's average shipment value is 35 cents per pound. Here carriers compete for commodities like computers and related goods, fresh flowers and foods, as well as letters and business documents.

On lower-value goods, trucks share a dual-natured relationship with railroads, cooperating in providing intermodal services but competing to capture market share in goods like automobiles and auto parts, food and food-related products, and intermodal shipments, with this competition being greatly affected by weight and distance. *[See Exhibit 4-8]*

Through the FHWA's Office of Motor Carriers and the National Highway Traffic Safety Administration, DOT oversees a wide variety of safety requirements encompassing vehicle operations such as braking and driver licensing standards, maximum driver work hours, and the overall safety fitness of interstate carriers. Few economic controls remain on the industry. Those that do are administered by the Surface Transportation Board.

The technology and information revolution has greatly improved the accuracy of shipping data and the speed with which this information can be shared, and it has helped reduce the amount of on-hand inventory needed for business operations. Like railroads, motor carriers are using technology to transmit timely, reliable information to assure the prompt movement of their goods. Just-in-time service cannot occur unless the pertinent shipping information arrives ahead of the load. Unlike the railroads who have decided to use a single technology for shipment location information—interactive tags and readers, the motor carrier industry is exploring multiple technologies for this function from GPS and low-orbit satellites to microwave and cellular technologies.

Railroads

Railroads are wholesalers of transportation services. They concentrate on hauling large quantity and bulk shipments over long distances. Based on volume, they haul 12.7 percent of the nation's goods.

railroads. In fact, many of them were created as the Class I companies downsized in the 1970s and 1980s and spun off their unprofitable and light-density lines. Because of lower operating costs, these smaller carriers have been able to create profitable, more customer-oriented operations that are not possible under the cost structure and expansive route system of a Class I carrier.

Of the 530 U.S. railroads, 487, or almost 92 percent, are local or short-line carriers. They are divided into two categories: linehaul and switching/terminal.

Exhibit 4-6
Railroad Carrier Profile

Mode	Percent of Industry (530 Total Carriers)	Percent of Freight Revenues	Percent of Road Miles Operated	Percent of Industry Employees
Class 1	2.3	90.4	73.1	88.8
Regional	6.0	5.3	11.8	5.0
Local ShortLine	51.2	2.5	10.7	2.8
Local Switching/ Terminal	40.5	1.8	4.5	3.3

Source: Railroad Ten-Year Trends 1985-1994, Volume No. 12, Economics, Policy and Statistics Department, Associations of American Railroads

As an industry, railroads are dominated by their largest companies. Of the 530 freight railroads in the U.S., the top 10, known as Class I's, own about 79 percent of the road miles and generate 94 percent of the revenue ton-miles and 90 percent of the freight revenues. They have almost 89 percent of the industry's employees and comprise 2.3 percent of all U.S. railroads.

Regional and local railroads often act as feeder services to the Class I

Linehaul railroads operate like Class I's but on a much smaller scale. They account for 51.2 percent of U.S. railroads.

Switching and terminal railroads operate in urban areas, facilitating the interchange of rail shipments among the railroads, usually Class I's, in their areas. It is not unusual for carriers of this type, which constitute 40.5 percent of the industry, to be owned by one or more Class I companies.

Exhibit 4-7
Top Rail Commodities

Commodity	Percent of Gross Freight Revenues	Percent of Tons Originated	Percent of Carloads Originated
Coal	21.7	39.1	24.5
All Others*	15.0	6.8	26.8
Chemicals & Allied Products	13.9	9.6	7.3
Farm Products	7.4	8.9	6.3
Transportation Equipment	10.0	2.0	6.2
Nonmetallic Materials	2.7	7.2	4.9
Food & Kindred Products	7.5	6.0	6.0

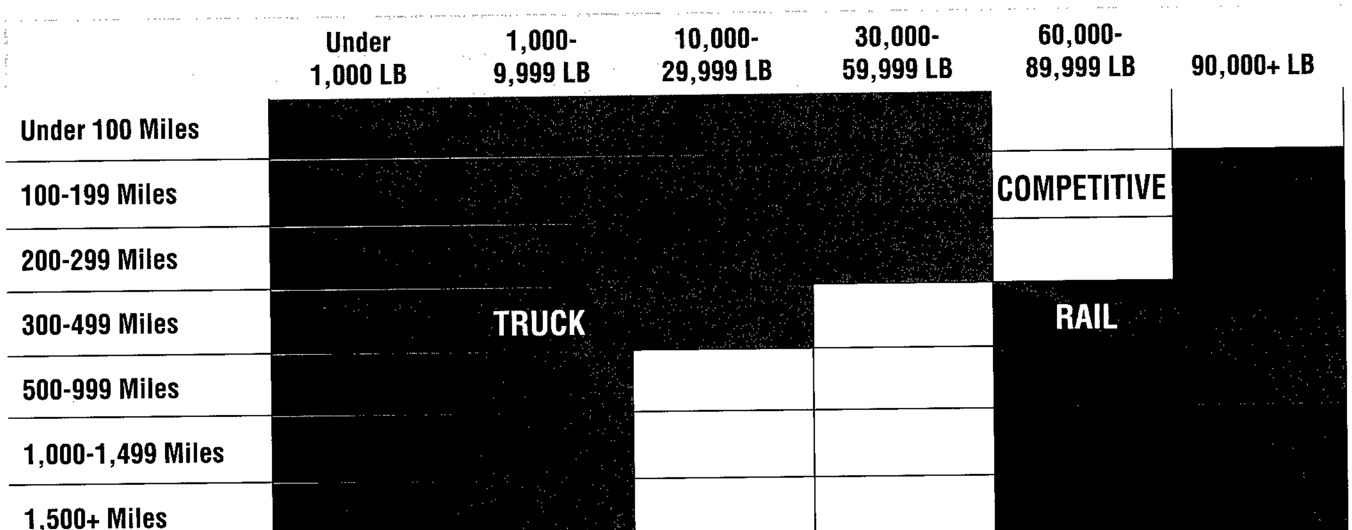
**Much of this category consists of intermodal traffic, although some of this traffic is dispersed in other commodity groups.*
Source: Railroad Ten-Year Trends 1985-1994, Nolume No. 12, Economics, Policy and Statistics Department, Associations of American Railroads

The remaining 32 railroads, accounting for 6 percent of the industry, are regional operators. They are substantially smaller than their Class I counterparts, but they operate almost as much mileage as the local short-line railroads. *[See Exhibits 4-6 and 4-7]*

The relationships of railroads with other modes of transportation range from virtually no interaction, as in the case of air freight, to the sometimes-uneasy customer/ competitor dichotomy that exists with trucking. The lack of interaction with air carriers is because of differing products and service needs. Air freight carriers handle high-value, lightweight shipments that must be moved within very short time frames, often as little as 24 hours, whereas railroads handle low-value, high-volume loads that rarely require completed service within a day. (The average value of goods moved by rail is eight cents per pound, while air freight's average value exceeds $25 per pound). *[See Exhibit 4-2]*

Railroads and ocean-going international or maritime carriers, by and large, have very cooperative relations. They regularly form partnerships to provide seamless transportation services for their bulk and intermodal customers. In fact, it was the cooperative efforts of railroads and U.S.-flag maritime

Exhibit 4-8
Truck and Rail Tonnage Distribution for Shipment Weight and Distance



Source: America's Private Carriers: Who Are These Guys?, National Private Truck Council and Transportation Technical Services, 1995 ship operators that created the doublestack train service—placing one shipping container atop another one on a rail car—that spurred the intermodal revolution.

Railroads face competition primarily from two sources—trucks and barges. Trucks provide competition on the railroad's higher-value shipments such as intermodal and finished vehicle transport, while barges compete on the more traditional low-value goods such as coal and grains. Barge competition is essentially limited to commodities moving in the central portions of the U.S., where there are navigable waterways such as the Mississippi, Ohio, and Missouri Rivers.

The relationship between railroads and truck lines is probably more complicated than the relationship between any of the other transportation modes because trucks have the ability both to generate freight for the railroads and to take it away from them. Railroads and trucks are business partners in providing intermodal services. Trucks provide the short-haul connections between the firms sending the freight and the railroads as well as between the railroads and the customers receiving the freight, with trains providing the interim long-haul service. When trucks and trains compete, it is mostly for goods that give the railroads most of their revenues—intermodal shipments, transportation equipment such as automobiles and assembly supplies, chemicals, and food products. *[See Exhibit 4-1]*

The Surface Transportation Board, an independent unit within the Department of Transportation, administers the economic regulations governing the railroads—essentially those imposed by the 1980 Staggers Rail Act—that remain following the sunsetting of the Interstate Commerce Commission in 1995. Federal rail safety regulations and the programs they generate are administered by DOT's Federal Railroad Administration.

The technology and information revolution has greatly improved the accuracy of shipping data and the speed with which this information can be shared. These innovations, in turn, are allowing information to reduce the amount of on-hand inventory needed for operations. The railroad industry has been a leader in creating standardized systems for tracking and monitoring equipment as it moves over the Nation's rail systems. Through RAILINC, a for-profit subsidiary of the Association of American Railroads (AAR) established in 1982, U.S. rail carriers maintain a centralized information service using computer and other telecommunications technology to locate shipments, access bill of lading information, and conduct other electronic business. Individual carriers as well as the AAR have developed systems for the tracking and monitoring of individual shipments.

Domestic and International Water Carriers and Ports

Significant volumes of goods move over the Nation's rivers and waterways as well as through its ports. Overall, about 17 percent

Exhibit 4-9

Commodities Moved by Water in Domestic Trade

Commodity	Percent of Total Domestic Tonnage	Percent of Internal Tonnage	Percent of Coastwise Tonnage	Percent of Lakewise Tonnage	Percent of Intraport Tonnage	Percent of Intraterritorial Tonnage
Petroleum	38.3	26.0	75.5	1.8	52.1	95.0
Coal	21.0	29.5	4.2	20.2	16.4	Negligible
Crude Materials	20.1	17.5	5.8	74.3	13.4	0.6
Food and Farm Products	8.5	13.5	3.1	0.4	0.5	0.3
Chemicals and Related Products	7.1	8.5	5.8	0.1	11.8	1.8
Total	**95.0**	**95.0**	**94.4**	**96.8**	**94.2**	**97.7**

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1994, Part 5 of the Nation's freight tonnage is moved by water. This tonnage accounts for between 3 and 5 percent of total freight value. Of the roughly 2 billion tons of domestic and international commodities moved by water, low-value, high-volume raw materials clearly dominate. Bulk commodities account for 90 percent of water commerce, with general commodities making up the remaining 10 percent of the trade. The average shipment value of goods moved by water is six cents per pound.

Ownership of the port system is more complicated than that of other modes, since there are both publicly and privately owned ports. Within public ports, there are publicly and privately owned terminals. An estimated 90 percent of inland shallow-draft terminals and 66 percent of deep-draft terminals are privately owned. Of the 204 public ports in the U.S., most of the Nation's international commerce moves through the 25 largest. [See Exhibit 4-10]

The Nation's domestic waterway system is made up of more than 25,000 miles of navigable waterways. These waterways are critical links in the movement of dry and liquid bulk commodities. Half of the Nation's export grain, 20 percent of its coal, and 30 percent of its petroleum products use our river system to get to market. [See Exhibit 4-11]

Barges haul large quantities of freight. They carry mostly dry bulk goods but can also handle liquid bulk shipments. Barges, which are found largely on inland river systems, compete with railroads for commodities like coal and grain.

Tankers are used to carry bulk shipments, most often petroleum and chemicals. They operate mostly along the Gulf Intracoastal Waterway and on the Gulf of Mexico. They also operate along the east and west coasts. While liquid cargoes can be moved by rail, the competition between tankers and trains is less intense than between barges and railroads.

Exhibit 4-10
Commodities Moved by Water in International Trade

Commodity	Percent of Total Foreign Tonnage	Percent of Import Tonnage	Percent of Export Tonnage
Petroleum	48.4	67.8	13.2
Food and Farm Products	14.6	3.7	34.3
Crude Materials	13.2	11.5	16.6
Coal	7.4	1.5	18.2
Chemicals and Related Products	6.1	3.2	11.3
Total	**89.7**	**87.7**	**93.6**

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1994, Part 5

About 59 percent of 1994 international freight tonnage was imports and 41 percent exports. The largest source of imports—67.8 percent—was petroleum and petroleum products. The largest U.S. exports were food and farm products at 34.3 percent, coal at 18.2 percent, and crude materials at 16.6 percent.

Based on value, the top five U.S. ports for international traffic are Long Beach, Los Angeles, New York/New Jersey, Seattle, and Houston. Based on volume, the top five are South Louisiana, Houston, New Orleans, Hampton Roads, and New York/New Jersey.

For international bulk cargoes, dry bulk ships are used to move commodities like grain, scrap iron, and waste paper, while tankers move goods like petroleum and chemicals. General cargo carriers use liner ships to move containers. Break bulk ships are used to move other general cargoes as well as for noncontainerized freight and for loads that mix containerized and noncontainerized freight. *[See Exhibit 4-10]*

Overall, there is substantial Federal involvement in and oversight of waterborne commerce. The U.S. Army Corps of Engineers builds and maintains the locks and dams of the Nation's inland river systems as well as the support structures needed for the intracoastal waterways. The only exception is the St. Lawrence Seaway, which is maintained by the St. Lawrence Seaway Development Corporation, part of DOT. Where needed, the Corps dredges our ocean and Great Lakes ports.

The U.S. Coast Guard, also part of DOT, provides the navigational markings for inland and intracoastal channels as well as for U.S. ocean ports. It also provides safety inspections and emergency response for all waterborne commerce. DOT's Maritime Administration oversees financial support programs for U.S. shipyards and the U.S. -flag fleet.

For international operations, the Federal Maritime Commission allows U.S.-and foreign-flag carriers to engage in collective ratemaking, subject to certain restrictions.

In addition, U.S. law requires that all ships operating in domestic commerce or between the U.S. mainland and U.S. possessions and territories to be registered in the U.S., be built in the U.S., be U.S.-owned, and their crews be U.S. citizens with some exceptions. These requirements are known as the Jones Act. Similar laws also apply to airline operations. However, they do not apply to international maritime commerce, where U.S.-flag carriers carry less than 4 percent of U.S. bulk cargoes and about 16 percent of the higher-value liner goods.

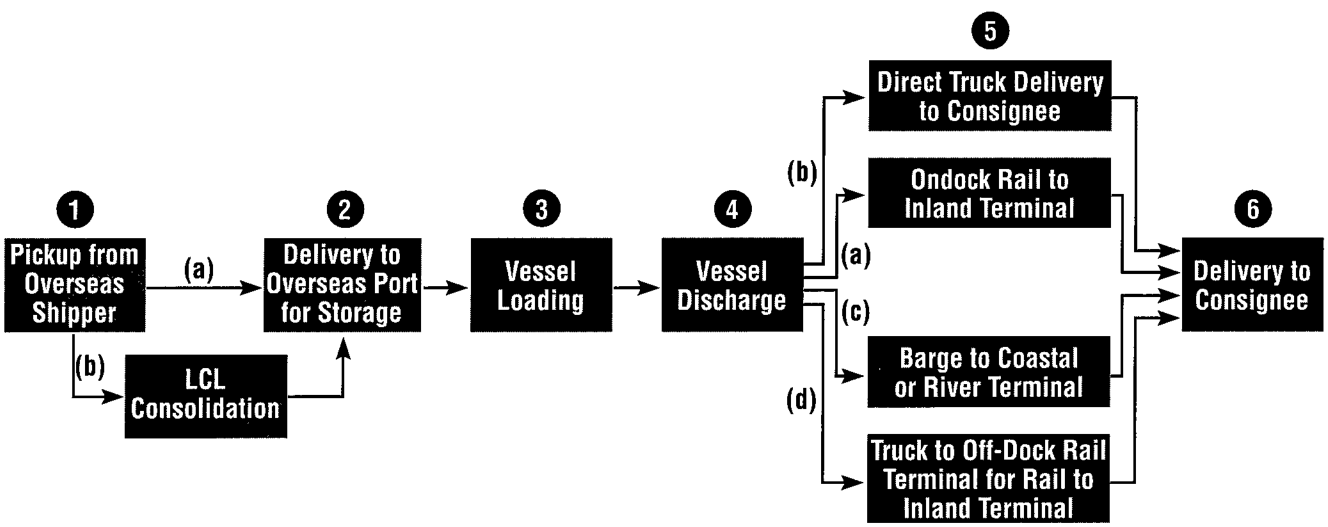
Technology plays a very important role in water commerce. In addition to the use of sonar, global positioning satellites, and other technologies for navigation and weather conditions, computers play an important role in the efficient routing and processing of freight. For international freight, especially the higher-value containerized freight, the communications systems developed by the Customs Service and carriers' land-based interchange partners also allow goods to move more efficiently. In addition, there are voluntary public and private organizations, such as Terminal Operator and Port Authority Subcommittee (TOPAS), that create electronic data interchange (EDI) guidelines to help standardize waterside electronic communications.

Intermodal

Intermodal is not a mode. Rather, it is the process of offering freight services by two or more modes so that the efficiencies of each participating carrier are maximized. As a result, customers receive more efficient service and carriers profit from business opportunities that would not exist under their more traditional service structures. The economic deregulation initiatives of the 1980s, especially the right to contract, are key factors in its success.

Based on the value of goods shipped, intermodal shipments account for 12.7 percent of the freight industry. These figures include rail-truck combinations, small package express carriers, postal shipments and courier movements, and other combinations such as rail-water, truck-water, air freight–truck, and truck-pipeline. *[See Exhibit 4-13]*

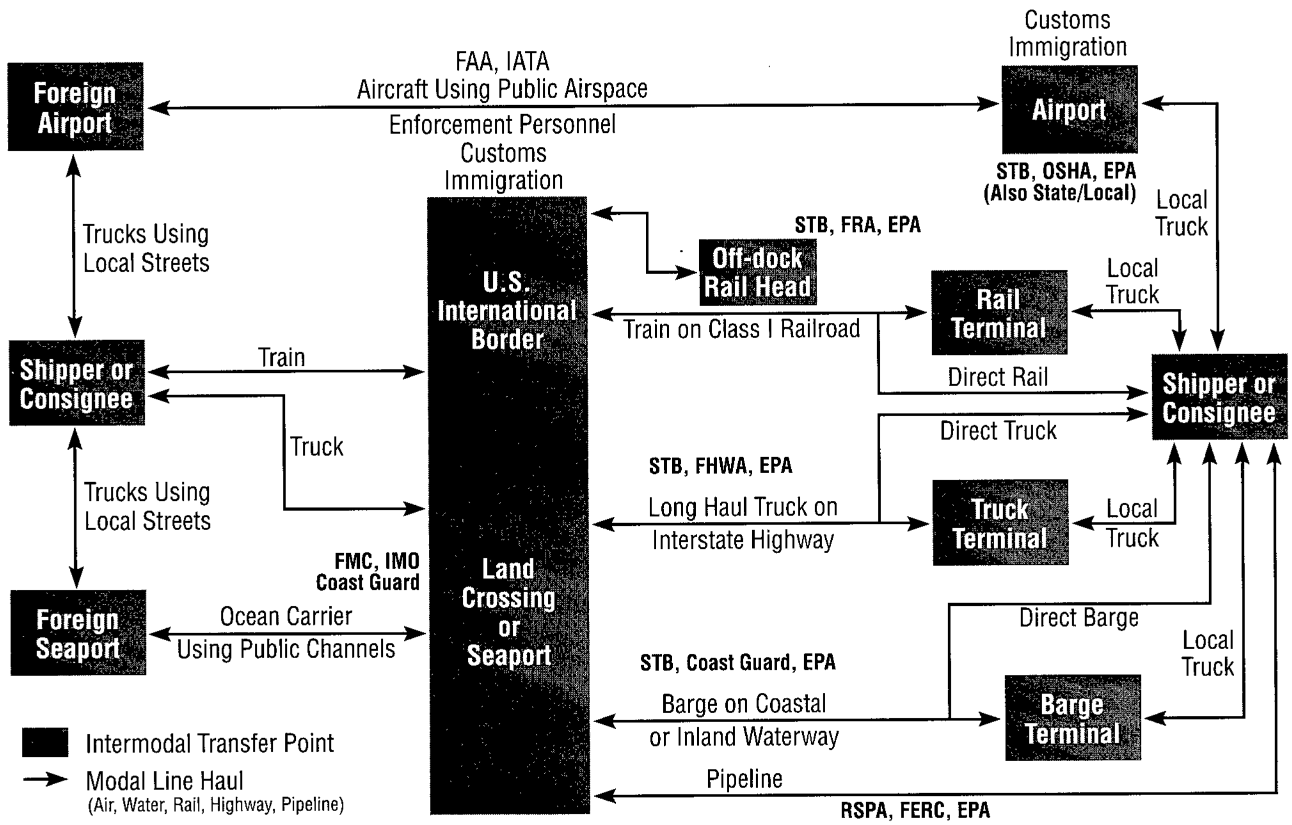
Exhibit 4-11
Sequence of an International Intermodal Freight Movement



Source: Intelligent Transportation Systems and Intermodal Freight Transportation, Joint Program Office, Federal Highway Administration, November 1996

Exhibit 4-12

An Overview of the International Intermodal Freight Transportation System and Its Regulators



Source: Intelligent Transportation Systems and Intermodal Freight Transportation, Joint Program Office, Federal Highway Administration, November 1996

In developing a profile of intermodal freight, distance is a factor. Because the interchange of freight equipment between carriers is costly, intermodal service is chosen only in those instances where the economies of scale for changing modes outweighs the expense of doing so. This is why rail/truck intermodal shipments require a minimum distance of about 750 miles and have such a substantial market share at distances of more than 1,000 miles. This is why rail/truck intermodal shipments require a minimum distance of about 750 miles, and have such a substantial market share at distances of more than 1,000 miles.

Exhibit 4-13

Profile: Modal Combinations

Intermodal Segment	Percent of Freight Industry Value	Percent of Freight Industry Tonnage	Shipment Value-Per/LB
All	12.70	2.00	$1.61
Small Package Express	9.30	0.20	$15.08
Rail/Truck	1.40	0.40	$1.09
Rail/Water	0.10	0.70	**
Truck/Air	1.80	0.02	*
Truck/Water	0.10	0.70	**
Truck/Pipeline	0.01	0.03	**

* For all air freight shipments, per-pound value is $26.77.
** The per-pound value of intermodal shipments other than package express and rail/truck has been estimated at $0.05.

Source: National Transportation Statistics 1996, Bureau of Transportation Statistics, U.S. Department of Transportation

Having timely, reliable shipment information is crucial to the success of intermodal service because of the number of parties to an intermodal transaction—two or more carriers as well as the shipper, receiver, and possibly others. There are more opportunities to lose or misdirect shipments in this environment than there are in single-mode hauls where the goods are under the control of a single carrier for the entire trip. As a result, intermodal carriers have been leaders in creating the technology and computer systems needed to assure that freight flows seamlessly. *[See Exhibit 4-9]*

Third Parties and Warehousing

Increasingly, the firms that arrange and manage the shipment of goods own neither the equipment nor the freight. These entities are known as third parties. Third-party firms are the fastest-growing segment of the freight industry, accounting for about 20 percent of the freight shipments and, depending on the industry, experiencing growth rates greater than 10 percent a year. Firms in this category include:

- Intermodal marketing companies (IMCs), also known as intermodal management companies. Firms in this category are essentially wholesalers of rail/truck intermodal services. They then retail these intermodal or piggyback services to freight shippers. Their services range from arranging the transportation of a customer-owned container or trailer to supplying the customer with both equipment and transport services.
- Third-party logistics firms. Like IMCs, they arrange transportation services for their customers, but unlike IMCs, they normally offer a full range of services that can be single mode or intermodal. In addition, they perform the functions of in-house transportation departments.
- Transportation property brokers are independent contractors who match freight with carriers, frequently truckers. They work either on behalf of shippers looking for equipment or carriers looking for shipments.
- Domestic or surface freight forwarders. They were once subject to control of the Interstate Commerce Commission and could only offer a very defined type of service to the public. After the industry was freed from Federal economic regulatory controls in the late 1980s, forwarders began offering a variety of rail/service packages. One common characteristic is that forwarders normally deal in shipment sizes that require assembly and, distribution of the freight, like less-than-truckload lots. They also act as carriers and assume the responsibilities of a common carrier when arranging freight transportation.
- Domestic airfreight coordinators. These companies were originally licensed by the Civil Aeronautics Board to pick up, deliver, consolidate, and containerize freight moving by plane. With the elimination of Federal economic regulatory controls in the mid-1970s, the industry now provides a full range of intermodal air-related services. Because of marketplace forces, there are few clear distinctions among the different players in the U.S. air freight industry—forwarders, cargo agents, and cargo consolidators.
- International airfreight forwarders. Accredited by the International Air Transport Association, they provide a wide range of services on international shipments, including supplying the necessary U.S. and foreign documentation; arranging rates, routing, storage, and warehousing; meeting hazardous materials requirements and special packaging and handling needs; and complying with any other licensing and regulatory rules.
- Ocean freight forwarders. Licensed by the Federal Maritime Commission, they provide a wide variety of services on international shipments including supplying U.S. and foreign documentation; arranging rates, routing, storage, and warehousing; and meeting hazardous materials requirements, special packaging and handling needs, and licensing and regulatory rules.
- Non-vessel-owning common carriers (NVOCCs). They arrange intermodal services for domestic or international shipments whose transportation involves the use of bulk or liner water carriers. They perform services like a carrier, such as billing and processing of loss and damage claims, but do not own the equipment they use. Unlike ocean freight forwarders, they are not licensed by the Federal Maritime Commission. However, they must obey any tariff filing requirements or other economic controls imposed by the agency.

- Customshouse or customs brokers. Licensed by the Treasury Department to handle international shipments, they prepare customs entries, determine the applicable customs tariff rates and shipment values, and file other necessary customs documentation. They are also familiar with the requirements of the more than 40 other government agencies that administer the Nation's nontariff requirements. They handle more than 90 percent of all U.S. imports and also often arrange for the transportation of these shipments.
- Shipper associations. They function like freight forwarders or consolidators, putting together a number of small shipments. The greater volume allows them to obtain better price and service packages than would be available for any individual shipments. However, unlike freight forwarders and consolidators, their services are limited only to members of their association. They buy single-mode as well as intermodal services and can handle international as well as domestic shipments. International shipments require a business letter from the Justice Department.
- Export management companies. They not only arrange international transport services for their clients but also offer a broad range of other services, including the creation of foreign sales and distribution networks. They often specialize either in particular markets or commodity types.
- Freight consolidators. They take less-than-truckload or containerload shipments and create full-size shipments for transport. They also break down full-size loads for distribution to various destinations. They offer a fixed range of services, normally with limited liability, and include brokers, warehouse operators, and others.
- Warehousing. This refers to the storage of goods. Warehouses are owned by shippers, carriers, receivers, intermediaries, and independent third parties as well as firms whose sole function is to provide warehouse space and services. They are an important part of the manufacturing and distribution process, and increasingly they have been asked to perform value-added services like pricing and repackaging consumer goods before they reach the stores.

Air Cargo

Because of the cost, freight is generally sent by air only when it is extremely valuable or time sensitive. As previously noted, air freight has an average shipment value of about $26 a pound. Air service is used for such goods as overnight business letters, computers and other electronic equipment, foods, and fresh flowers.

At present, the air freight industry accounts for about 2.4 percent of the Nation's freight bill by value and about 0.02 percent by volume. Its revenue ton-miles have almost tripled, from 7.9 billion in 1980 to 21.5 billion in 1994. If truck/intermodal package express services are included in these totals, the air cargo industry's market share by value has increased from 1.9 percent in 1980 to 4 percent in 1994.

There are several ways to categorize air freight. Services can be divided into express, mail, charter, and scheduled. Operations also can be sorted by expedited and nonexpedited shipments that can be transported by integrated and nonintegrated entities. The second method essentially divides air freight into two categories: package express, which covers the expedited cargoes moved by integrated carriers; and more traditional air freight shipments, which are nonexpedited hauls by nonintegrated carriers. Nonintegrated operations often involve a variety of parties, such as carriers and third parties, to complete the transportation.

As the air cargo industry increasingly sells second- and third-day delivery of goods, an interesting anomaly is developing for certain markets. Operating costs dictate that most of these goods will "fly" to their destinations in trucks operating on the Nation's highways. To illustrate, on a 350-mile route, a high cube truck pulling a 53-foot trailer can haul about 40,000 pounds of cargo for about $1.25 per mile, or $437.50. To move a 41,000-pound payload in a 727-100F airplane the same distance, the transport cost jumps to about $15 per mile, or $5,250. Even overnight shipments on certain short-distance traffic lanes move by road. Over the past 20 years, the number of "truck flights" has increased from about 400 per week to almost 16,000 per week.

In certain market segments, air cargo operators "fly" 10 percent or more of their cargoes by truck.

As it does for passenger service, the Federal Government regulates safety for air cargo operations. In addition to DOT's Federal Aviation Administration, the International Air Transport Association and the International Civil Aviation Association have issued operating and other standards that must be followed.

Technology and information systems have played a critical role in this industry. Because of the premium placed on service as well as the timeliness of information, the air cargo industry has been a pioneer in using EDI and other technologies to track and quickly move shipments. Like the maritime industry, air cargo carriers, their customers, and third parties have developed information-sharing data bases that improve the industry's ability to move goods quickly through the supply chain.

Pipelines

Pipelines are an important but often overlooked part of the U.S. transportation system. They are important because of the significant quantities they move: more than 16 percent of total ton-miles. They are overlooked because the goods they move are mostly low value and energy related. Pipeline commodities have a value of between 6 and 9 cents per pound and account for less than 3 percent of the Nation's freight bill. Pipelines generally transmit natural gas, crude oil, and petroleum products. Some hazardous liquids such as anhydrous ammonia and carbon dioxide also are moved. Like the railroads, pipeline rights-of-way are privately owned and operated.

The U.S. pipeline network is extensive—about 2 million miles. The network of interstate natural gas pipelines spans about 250,000 miles, while the crude oil and petroleum product system totals about 200,000. The interstate gas network is supported by 100,000 miles of intrastate pipelines and 1.4 million miles of gathering, distribution, and storage lines. Crude oil gathering and trunk lines total 112,990 miles, while finished product trunk lines account for 86,033.

Pipelines are subject to safety and economic regulatory controls. Safety oversight is performed by DOT's Office of Pipeline Safety, which is part of the Research and Special Programs Administration. These safety controls encompass both construction and operation standards. An effort has been made to make these controls more performance oriented. The Federal Energy Regulatory Commission administers the industry's regulatory controls, which are being loosened to allow greater competition among energy suppliers. This increase in competition is allowing companies to create varied price and service options.

As in other modes, information technology plays a very important role in the monitoring and transmission of commodities shipped by pipeline. The industry has invested heavily in computer technology because of the safety issues associated with the movement of oil, chemicals, and gases. Increasing customer sophistication about energy demands and use is another factor driving industry investment in computer and other information technologies.

Forces of Change

One of the key agents of change in today's marketplace is the integration of transportation with the production process, necessitating partnerships between carriers, third parties, and customers. When the "just in time" revolution was launched in the mid-1980s, the focus was on improving individual business processes, without much consideration of the impact of these processes on other entities. Today's reengineering efforts, however, are focused on integrating all partners' processes to generate new savings.

These efforts are reshaping the ways goods are moved and changing the notions of what an efficient, effective transportation system should deliver. Perhaps the greatest changes involve the new emphasis on system reliability, reduced shipment sizes, and the diminishing need for excess capacity.

When the just-in-time revolution began in the 1980s, it was considered revolutionary if a factory had two to three hours' worth of inventory. At the beginning of the 1990s, the state-of-the-art margin was 15 minutes. Today, cutting-edge factories are operating with only 10 minutes of inventory on hand, and the pressure for even better performance continues.

This continuing reduction in inventory levels means that businesses will be generating more orders of smaller-sized shipments at greater frequency. As a result, freight interests will make greater use of the transportation infrastructure, including already stressed areas such as those in urban and suburban population centers.

In choosing to retain or build manufacturing sites, a major consideration will be the ability of goods to move predictably and damage-free. As a Nation, we have not built our public transportation infrastructure to accommodate this business need, nor do the owners and planners of our public transportation system measure performance in this way. However, system reliability and the needs of the freight community are beginning to become a public as well as a private concern.

Local business development groups and others are beginning to work with public planning officials to develop the transportation infrastructure needed to help the Nation's economy stay competitive in an increasingly global marketplace. Examples of these new public-private partnerships can be found in Columbus, Ohio, Kansas City, Missouri, and many other cities across the Nation.

Another key factor is the change in the structure of inventory systems from "push" to "pull." The traditional push system assumes levels of demand and distributes goods based on those assumptions, so inventory is pushed through the distribution system. The pull system allows market demand to determine production levels so that inventory is pulled through the distribution system. The pull system seeks only to produce goods for which actual market demand is known. Industry's ability to predict more precisely inventory needs will be an increasingly important factor in assuring that our transportation infrastructure keeps pace with the demands placed on it by business and industry as they compete in a global economy. Other forces shaping the freight industry include population increases and the processes and financing of infrastructure improvements.

Exhibit 4-14
Present and Future Forces of Change

General Trends	Infrastructure	Operational	Regulatory	Institutional
Today	Increasing levels of congestion in ever larger areas of the country. Less infrastructure purchased for each dollar invested. Continued deterioration of physical plant with a replenishment rate that does not meet current or future needs.	Increasing demands for goods and services under tighter performance standards in more difficult operating environments. Greater emphasis on seamless services and shipment's ability to move efficiently regardless of mode.	Changing emphasis from economic regulatory controls to safety and environmental regulations. Increasing interest in negotiated rulemaking and consensus solutions to problems.	Greater government interest in funding flexibility and performance standards as an alternative to more traditional financing and control measures. Greater interest in intermodalism and other solutions that will allow public sector transport investments to provide the greatest return in terms of overall system mobility.
Tomorrow	Less mobility within increasingly sprawled urban/suburban areas. Increasing costs for facility and longer time-lines/stricter standards for completion of projects. Greater use of information technology to reduce demand for additional capacity.	Continued integration of transportation and supporting information systems into production processes under increasingly strict performance standards. Greater use of information technology to manage and improve logistics systems.	Greater government and industry interest in multinational standards and requirements to facilitate international trade and meet other social goals. Increased emphasis on seeking cooperative solutions to problems.	More coordination among public and private sector interests. Ongoing efforts to reinvent government at all levels and to create efficient public/private partnerships to enhance U.S. role in global commerce.

Until the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, there was no clear Federal mandate to link surface transportation investments to freight needs. Private sector investments are driven by corporate needs that generally are not integrated into public processes. This occurs because the strongest private-public links in developing the private transportation infrastructure often are local and State rules governing land use and economic development, not transportation.

Since ISTEA, government investment policy has begun to focus on the overall mobility of the National transportation system as well as on facilitating freight's ability to flow seamlessly across transportation systems. While some progress has been made, a better understanding by each side of the dynamic forces governing the public and private sectors is needed, as well as more work on actual infrastructure and regulations.

Looking to the future, technology will take on an ever-increasing importance in ensuring that the Nation's transportation needs are met. Information technology will have a prominent role as firms seek to minimize inventory and infrastructure requirements. Since it is unlikely that new major public infrastructure initiatives will be undertaken to improve transport performance times, companies will seek to fine-tune transportation services as they are being delivered, aided by private sector tracking and tracing systems as well as the global information and intelligent transportation systems (ITS) being deployed across the Nation by the public sector. ITS technology in particular will play an important role in developing long-term strategies for maximizing the productivity of the existing infrastructure.

Keeping America an economy in motion will take even greater levels of private and public cooperation as we face even tougher challenges from increased freight volumes and constrained public resources. However, it is a challenge that DOT and all of us address as we move into the next century.

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16. Abstract

This is third edition of the *Status of the Nation's Surface Transportation System* report that was submitted by the Secretary of Transportation to the United States Congress. The report provides updated information on highway, bridges, and transit conditions, performance, finance, and investment requirements from all sources to meet the anticipated demands in both highway travel and transit ridership. It offers a comprehensive, factual background to support development and evaluation of legislative, program, and budget options at all levels of government and also serves as a primary source of information for national and international news media, transportation associations, and industry. Maintain and improve scenarios for highways, bridges, and transit are clearly portrayed, based on the Highway Economic Requirements System (HERS), and the Transit Economic Requirements Model (TERM). Organizationally, this report has two sections: (1) a bulleted summary covering conditions and performance, finance, and investment requirements for highways, bridges, and transit; and (2) a series of relevant questions and answers about these topics. New sections are included on system performance and investment requirements of the National Highway System and the Nation's freight industry. Also included are names and addresses of key contacts in the U.S. Department of Transportation for further information on the report. The electronic version of this report can be found on the FHWA and FTA Home Pages (http://www.fhwa.dot.gov and http://www.fta.dot.gov).

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