U.S. Department
of Transportation

Federal Highway Administration

Federal Transit Administration

Maritime Administration

1995 Status of the Nation's Surface Transportation System:

Condition & Performance

REPORT TO CONGRESS

A Summary

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Introduction

This pamphlet provides a summary of the *1995 Status of the Nation's Surface Transportation System: Condition and Performance Report to Congress* (C&P Report). It is the latest in a series of biennial reports that track changes in transportation physical and operating characteristics, finance, and usage patterns. Also included are estimates of capital investment required from all sources to meet specified levels of system performance in future years. The current report combines information about our highway, bridge, transit, and maritime systems.

This report is the second in the C&P Report series that combines documents satisfying statutory requirements for the Department of Transportation to provide Congress with information on the condition, performance, and capital investment requirements of the Nation's highway and transit systems. For the first time in the report series history, information is provided on maritime infrastructure. Maritime reports are not, however, statutorily required.

This report is in keeping with the Department's commitment to a truly intermodal perspective of the Nation's transport system. Combining modal information provides a valuable intermodal perspective as we seek to make the best use of each mode in satisfying our Nation's needs. We will continue the expansion of modal coverage in this report series to provide the breadth of information needed to deal with our increasingly complex transport requirements.

The report finds that personal and freight transport demands on our systems are at an all time high and are expected to increase with population and economic growth, but at a slower rate than experienced in past decades. While the U.S. population has increased 1.16 percent annually since 1980, the number of trips per person and miles per trip have increased about three times as fast. Reasons for the per capita increases include changes in trends related to employment; the number, size, makeup, and location of households; the number of licensed drivers; and the number of household vehicles.

The physical condition of the surface transportation system has generally been stable, with States and local governments investing at rates approximately equal to the cost of maintaining the physical plant. Improved highway conditions have, to some extent, resulted in a significant decline in highway fatality rates over the past decade.

In contrast, highway system performance has been declining; this is reflected in various measures of congestion. The quality of transit performance has improved with increases in average speed, reductions in wait times and number of transfers as well as reductions in trip times.

Although all units of government and private industry are currently investing at record levels to maintain transport services and efficiency, demands continue to outpace investment. In 1994, an estimated $57.2 billion in capital investment would have been required from all sources just to maintain 1993 conditions and performance on our Nation's highway, bridge, and transit systems. In 1993, all levels of government actually invested $40.5 billion in these systems.

An estimated $80.0 billion would have been required in 1994 to provide a higher level of service by correcting existing and accruing deficient highway, bridge and transit conditions. The highway component of this estimate is based on a new procedure that focuses on the services that the system provides to the users rather than on the physical condition of the infrastructure. All highway improvements included in this estimate generate direct user and agency benefits in excess of the initial cost of the improvement.

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Document Organization

This document provides a summary of the *1995 Status of the Nation's Surface Transportation System: Conditions and Performance Report to Congress.* It is presented in two parts. The first contains material on highway and transit facilities, the second covers the maritime industry.

Part I begins with a discussion of highway and transit system and user characteristics:

- *Who uses the system?*
- *Why do they use it?*
- *What does the system need in order to meet current and future personal transportation requirements?*
- *What does the system look like?*

The second chapter provides information on highway and transit finance:

- *Who pays for the system?*
- *Where do the revenues come from?*
- *How are highway and transit funds spent?*

The third chapter provides an indication of how well the highway and transit systems are working:

- *In what physical condition are the Nation's highway and transit systems?*
- *How much congestion are highway users facing?*
- *How has the transit system been performing?*
- *How safe is the highway system?*
- *What has been the impact of highway transportation on the quality of our environment?*

The next chapter provides estimates of the investment required, by all units of government, to either maintain or improve the condition and performance of the highway and transit systems over the next 20 years. These estimates are expressed as average annual requirements, that is the 20-year investment total divided by 20 years. The final chapter in Part I provides a linkage between the 20-year investment estimates and actual recent capital outlays by all units of government for highway, bridge, and transit capital improvements.

Part II summarizes information describing the maritime system. Material is also provided on system condition and performance. This section does not provide estimates of future investment requirements.

Readers will note that this summary contains a number of boxes labeled "Drawing Conclusions." This convention is intended as a vehicle for providing background information that may be useful in interpreting the report's statistical information.

Part I

Highway and Transit

1993 System Report Card

Highway

System Characteristics

Highway **vehicle miles traveled** reached 2.3 trillion (up 2.2 percent per year since 1989); **highway passenger miles** reached 3.9 trillion (an increase of 2.3 percent per year since 1989).

The extent of **rural center-line mileage** declined since 1983 due primarily to the expansion of Federal-aid urban area boundaries based on the periodic census.

Conditions and Performance

Pavement **condition** improved throughout the 1980's and continued to do so into the early 1990's. However, because the States are transitioning to a new method of rating pavements, it is impossible to determine if overall pavement condition changed in 1993 relative to prior years.

The **severity of congestion** (as measured by the percent of travel congested in the peak hour) increased through most of the 1980's, but stabilized between 1989 and 1991. The 1993 data indicates that the severity of congestion has continued to remain relatively constant. However, the change in urban area boundaries shifted a number of formerly rural highway sections into the urban category—diluting congested urban mileage. In urban areas, the **extent and duration of congestion** has increased steadily since 1983.

Highway **safety** has improved since 1983; the overall highway fatality rate has declined steadily from 2.58 fatalities per 100 million vehicle miles traveled (VMT) in 1983 to 1.75 per 100 million VMT in 1993, with the Interstate system continuing to be, by far, the safest system.

Since 1990, the percent of deficient **bridges** has decreased. In 1994, bridges classified as either structurally or functionally deficient accounted for 24 percent of Interstate bridges, 28 percent of other arterial system bridges, and 28 percent of collector system bridges.

Finance and Investment Requirements

All levels of government provided **$88.5 billion for highway programs**. The Federal Government provided $18.2 billion; the States, $46.9 billion; and counties, cities, and other local government entities funded the remaining $23.4 billion.

The $88.5 billion provided for highway programs was distributed as follows:

- *Capital investment: $39.0 billion*
- *Noncapital expenses: $41.9 billion*
- *Debt retirement: $5.2 billion*
- *Reserve: $2.4 billion*

Of the $39.0 billion invested in **capital improvements,** $34.8 billion was for projects intended to improve the physical condition or performance of the system. The remaining $4.2 billion was spent on improvements that were not triggered by condition or performance deficiencies (e.g., environmental mitigation and expenditures for economic development).

Federal funds accounted for $17.1 billion of the $39.0 billion in capital outlay, or 44 percent.

In 1994, an estimated **$49.9 billion** in highway and bridge capital investment would have been required from all sources just to **maintain 1993 conditions and performance**. Actual capital investment in 1993 (the latest year for which expenditure data is available) was 70 percent of what was required to maintain conditions.

An estimated **$68.2 billion would have been required in 1994 to provide a higher quality of service** on highway and bridge systems. Not all existing and accruing highway deficiencies would have been eliminated, but those highway improvements that generated direct benefits in excess of the initial cost would have been made.

1993 System Report Card

Transit

System Characteristics

A total of 508 local public **transit operators** provided transit services in 316 urbanized areas. An additional 5,010 local and regional organizations provided publicly accessible transit services in rural and small urban areas.

On rail, **transit patronage** was 17.9 billion passenger miles (up 0.7 percent per year since 1983); on bus systems, transit patronage was 18.4 billion passenger miles (down by 0.5 percent per year since 1983).

Conditions and Performance

Between 1984 and 1992, the percent of transit **maintenance yards**, **maintenance buildings**, **stations,** and **bridges** in good or better condition improved significantly. However, one-third or more remain in less than good condition. As of 1992, 76 percent of rail cars were in good or better condition.

The perception of **quality** among customers and potential customers is an important determinant of transit use, often more important than the fare levels:

- *Since 1984, the passenger-mile-weighted **average speed** improved by about 10 percent.*
- *Well over half of all riders reported **wait times** of 5 minutes or less. About 80 percent of riders wait no longer than 10 minutes. Fifty-one percent of transit trips involve one or more **transfers**.*
- *Twenty-nine percent of transit trips involve **standing** for at least part of the trip.*
- *About 25 percent of all transit users report **trip times** of 10 minutes or less, and nearly 76 percent of transit trips were reported to take less than half an hour.*

Finance and Investment Requirements

Total **transit revenue**, from all sources, was $22.6 billion. Public funding for transit was $15.5 billion. The Federal share of this support was $3.3 billion, the State and local share was $12.1 billion. **Fares** and other system-generated revenue accounted for $7.1 billion.

Of the $22.6 billion in funding provided for transit, $21.7 billion was expended for **capital investment and operating requirements**. Capital investment accounted for $5.7 billion and $16.0 billion was spent to satisfy operating costs (the remainder was placed in reserve).

Overall, **Federal funds** contributed only 6 percent to meeting transit operating costs, while contributing just under 42 percent of transit capital expenditures.

In 1994, an estimated **$7.3 billion** in transit capital investment would have been required from all sources just to **maintain 1993 conditions and performance**. This level of investment included a $5.1 billion requirement in system preservation and $2.2 billion to expand capacity. Capital investment in 1993 was $5.7 billion, or 78 percent of what was required.

An estimated **$11.8 billion was required in 1994 to provide a higher quality of service** on transit systems. Of the $11.8 billion investment requirement, $7.1 billion would have been spent on system preservation and $4.7 billion would have been used to correct capacity deficiencies.

Highway and Transit

Chapter 1

System Description and Usage Characteristics

The United States enjoys an extensive surface transportation system that includes 3.9 million miles of roads, 576,000 bridges, and over 166,000 route miles of transit.

In 1993, the number of vehicle miles traveled on highways reached 2.3 trillion, up 3.4 percent per year since 1983. On rail, transit patronage was 17.9 billion passenger miles in 1993, up at an annual rate of 0.7 percent from 1983. On bus systems, transit patronage was 18.4 billion in 1993, down by 0.5 percent per year since 1983. In 1993, total highway passenger miles traveled (PMT) reached 3.9 trillion, up at an annual rate of 2.3 percent since 1989 (the first year that highway PMT statistics were available).

The interaction of complex societal forces over the last two decades has resulted in important changes in the Nation's travel trends. These changes will place new demands on our transportation system in the future.

A major trend noted is the transition to a service economy and the associated increase in the flexible labor force. Commuter trips will be increasingly spread over a longer day, with a sizable minority of travelers having variable work schedules.

A number of important demographic trends may also impact future travel patterns and service requirements. For example, the significant growth in the number of married women who work outside the home suggests large numbers of commuters who may need to drive alone due to their need to balance multiple responsibilities such as dropping children at daycare on the way to work or grocery shopping on the way home.

Finally, rapid suburbanization of the population and employment has important transportation implications. In general, the lower the density of a community, the fewer concentrated origins and destinations and the fewer corridors of high density demand. These kinds of patterns require decentralized transportation facilities and services.

Classification by Function

Highway

The 3.9 million miles of 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. Exhibit 1-1 provides an overview of the system and displays mileage and travel shares by functional classification.

Exhibit 1-1
Center-Line Highway Miles and Vehicle Miles of Travel (VMT) 1993

ALL U.S. ROADS 3,904,721 miles of highway 2,296,585 million vehicle miles traveled	
URBAN 21% of total miles 61% of total VMT	RURAL 79% of total miles 39% of total VMT
ARTERIALS 4% total miles 48% total VMT	ARTERIALS 7% total miles 24% total VMT
COLLECTORS 2% total miles 5% total VMT	COLLECTORS 18% total miles 10% total VMT
LOCAL 14% total miles 9% total VMT	LOCAL 54% total miles 4% total VMT

Arterials

The arterial system, which includes the Interstate as well as the recently designated National Highway System, provides the highest level of mobility, at the highest speed, for long uninterrupted distances. These facilities generally have higher design standards than other roads, often with multiple lanes and some degree of access control.

Collectors

Collectors provide 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. They provide the highest degree of mobility for a variety of local travel requirements.

Local Roads

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. These roads and streets provide a high level of access to abutting land but limited VMT.

Transit

All public transit services in the United States may be functionally classified according to the public policy purposes served by individual trips: low-cost mobility, congestion management, and supporting livable metropolitan areas. Exhibit 1-2 provides an organizational overview and displays trip shares by functional system.

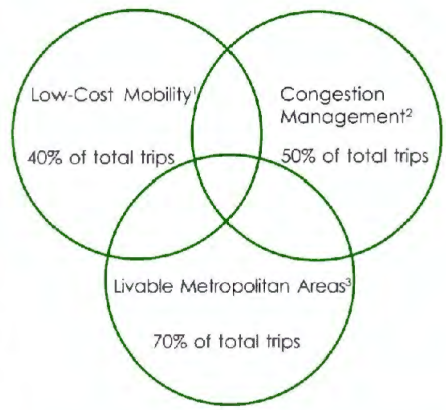
Low-Cost Mobility

All transit systems in the United States devote a portion of their services to providing low-cost mobility for people who, for reasons of low income, youth, old age, or disability, do not or cannot operate personal motorized transportation. The most important characteristic of such services is the provision of regular access to as many destinations in the service area as possible for a fare that passengers from low-income households can afford.

Congestion Management

Transit services that are competitive with the automobile most effectively serve the congestion mitigation function. The most distinctive characteristic of these transit services is consistently rapid door-to-door travel speeds encouraging a large proportion of people who own automobiles to choose transit thereby avoiding the unreliability and delays of congested highways.

Exhibit 1-2
Transit Functional Classification



Note: Since the services performing these functions overlap (e.g., congestion management by transit includes trips that also represent low-cost mobility), their sum exceeds 100 percent.

1/The low-cost mobility group consists of all trips made by people with household incomes below the poverty level plus nonwork trips in bus-only transit systems.

2/All work trips are classified as congestion management related.

3/Livable metropolitan areas are defined as urbanized areas with more than 55 annual transit trips per capita or significant transit rail service.

Livable Metropolitan Areas

Transit services that provide motorized access to and from pedestrian oriented and multiple purpose central business districts and communities serve the function of supporting livable metropolitan areas. The most distinctive characteristic of these services is design for pedestrian access rather than access by automobile. Transit's role in supporting a livable metropolitan area is strongest where pedestrian access to transit and to other services via transit enable households and businesses to function with reduced use of automotive transport. Although most such areas are very large cities, communities with very large college campuses exhibit similar characteristics.

Exhibit 1-3
Highway Center-Line Miles by Functional System
1983-1993

Functional System	1983	1993	Percent Change
Rural Highway Miles			
Interstate	32,788	32,652	(0.4)
Arterials	228,770	234,129	2.3
Collectors	734,338	715,036	(2.6)
Local	2,221,392	2,119,826	(4.6)
Subtotal	3,217,288	3,101,643	(3.6)
Urban Highway Miles			
Interstate	10,240	12,878	25.8
Other Arterials	123,462	147,514	19.5
Collectors	72,513	85,378	17.7
Local	456,135	557,308	22.2
Subtotal	662,350	803,078	21.2
Total Highway Miles	3,879,638	3,904,721	0.6

System Extent and Capacity

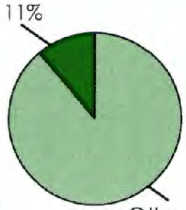
Extent

Highway

In 1993, total National public road and street mileage was 3.9 million miles. Exhibit 1-3 compares current (1993) mileage with 1983 mileage. The share of total miles in rural areas decreased slightly, from 83 percent to 79 percent (see Drawing Conclusions, right).

Highway Mileage

by Urban/Rural



by Functional Class

Bridge

In 1994, there were more than 576,000 bridges on our Nation's highways, compared to about 573,000 bridges in 1984.

Transit

In 1993, 508 local public transit operators provided transit services in 316 urbanized areas. An additional 5,010 local and regional organizations provided publicly accessible transit services in rural and small urban areas. In 1993, there were 129,317 total transit vehicles, 7,439 miles of rail track, 2,271 rail stations, and 1,172 maintenance facilities. Route miles of transit rail grew 15.7 percent from 1983 to 1993, or 1.5 percent per year. Nonrail transit includes buses, ferry boats, vans, and other conveyances, which in 1993 reached 158,799 route miles, an annual increase of 2.0 percent since 1983.

Drawing Conclusions

Timeseries Comparisons

Comparison of previous year data with the 1993 data used in the current C&P Report has the following difficulties:

- Expansion of the urban area boundaries as a result of the 1990 census resulted in reclassification of certain rural highway facilities to urban, causing miles and travel to shift from rural to urban classification.
- The States have reclassified certain U.S. Forest Service roadways to nonpublic roadways (which are not included in the National statistics).
- As a prelude to designation of the National Highway System, the States functionally reclassified their roads and streets in order to establish an updated principal arterial system.

Capacity

Highway and transit capacity comparisons are found in Exhibit 1-4. In 1993, there were 8.1 million lane miles of highways in the Nation. Over the 10-year period from 1983 to 1993, lane mileage increased 0.2 percent annually (see Drawing Conclusions, page 7).

Transit rail and bus capacity is defined as the average number of miles traveled by each vehicle multiplied by the number of vehicles, expressed as standardized "bus equivalent vehicles." In 1993, transit rail capacity consisted of 15,945 rail passenger vehicles providing 1,564 million bus equivalent vehicle miles, an annual increase of 2.2 percent since 1983. Transit bus capacity, from 1983 to 1993, increased 1.5 percent annually.

Exhibit 1-4
Highway Lane Miles by Functional System and Transit System Equivalent Lane Miles
1983-1993

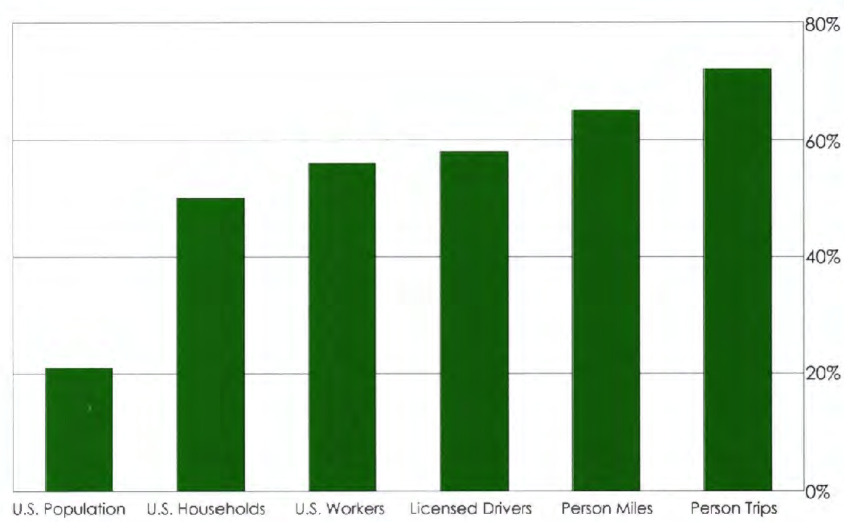
Functional System	1983	1993	Percent Change
Rural Highway Lane Miles			
Interstate	131,976	132,239	0.2
Arterials	510,448	524,621	2.8
Collectors	1,442,103	1,435,411	(0.5)
Local	4,442,784	4,239,652	(4.6)
Subtotal Rural	6,527,311	6,331,923	(3.0)
Urban Highway Lane Miles			
Interstate	53,386	69,135	29.5
Other Arterials	354,104	432,473	22.1
Collectors	153,118	181,035	18.2
Local	912,270	1,114,616	22.2
Subtotal Urban	1,472,878	1,797,259	22.0
Total Highway Lane Miles	8,000,189	8,129,182	1.6
Transit Capacity Equivalent Miles (thousands)			
Rail	1,256,316	1,564,354	24.5
Nonrail	1,423,827	1,658,679	16.5
Total Transit Equivalent Miles	2,680,143	3,223,033	20.2

Aggregate and Per Capita Travel Growth

The 1990 Nationwide Personal Transportation Survey shows that in 1990 Americans made 250 billion personal trips in a car or truck, or by bus, train, subway, or airplane, or by walking, biking, or riding a motorcycle. In 1990, Americans took over 91 percent of work trips and over 87 percent of all trips in a car or truck or other personal vehicle and only 2 percent to 4 percent of all trips in a bus, subway, or train. However, the transit share is much higher in urban areas, particularly the largest areas.

In 1990, Americans made 72 percent more person trips and traveled 65 percent more person miles than they had in 1969. This remarkable growth in travel is a function of aggregate travel growth and per capita growth.

Exhibit 1-5
Percent Increase in Various Factors Linked to Travel
1969-1990



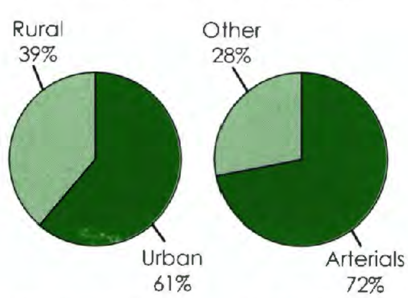
Aggregate travel growth is related to total growth in the U.S. population; as the population increases the aggregate number of trips made and miles traveled increases, even if no one person takes more trips or travels farther than before. However, as shown in Exhibit 1-5, from 1969 through 1990 the total number of trips taken by all Americans increased over three times as fast as the population. It is clear that other factors, in addition to population growth, account for much of the increase in total trips.

In 1990, the average trip length for all purposes was 9.4 miles compared to 8.7 miles in 1983, while the average commute increased to 10.7 miles from 8.5 miles, or a 26 percent increase.

Highway Vehicle Miles Traveled (VMT)

Highway VMT comparisons are found in Exhibit 1-6. In 1993, total highway VMT reached 2.3 trillion. For the 10-year period from 1983 to 1993, total travel increased at a compound annual rate of 3.4 percent. Travel growth in urban areas outpaced rural areas. However, as noted earlier, part of this growth is the result of expanding urban boundaries, i.e., rural travel becoming urban travel (see Drawing Conclusions, page 7).

1993 Highway Travel (VMT)



by Urban/Rural   by Functional Class

Exhibit 1-6
Highway Vehicle Miles of Travel
1983-1993
(millions of miles)

Functional System	1983	1993	Percent Change
Rural Highway Vehicle Miles			
Interstate	144,733	208,021	43.7
Other Arterials	273,383	348,754	27.6
Collectors	200,592	226,995	13.2
Local	81,825	103,176	26.1
Subtotal Rural	700,533	886,946	26.6
Urban Highway Vehicle Miles			
Interstate	191,149	315,837	65.2
Other Arterials	530,584	774,302	45.9
Collectors	86,593	121,214	40.0
Local	140,247	198,286	41.4
Subtotal Urban	948,573	1,409,639	48.6
Total Highway Vehicle Miles	1,649,106	2,296,585	39.3

Exhibit 1-7
Highway and Transit Person Miles of Travel
1989-1993
(millions of miles)

	1989	1991	1993
Highway	3,543,011	3,670,765	3,881,229
Transit	38,221	37,473	36,220

Highway and Transit Personal Miles Traveled

On rail, transit patronage was 17.9 billion passenger miles in 1993, up at an annual rate of 0.7 percent from 1983. On bus systems, transit patronage was 18.4 billion in 1993, down by 0.5 percent per year since 1983.

In 1993, total highway passenger miles reached 3.9 trillion, up at an annual rate of 2.3 percent since 1989 (the first year that PMT statistics were available). Person miles of travel trends are provided in Exhibit 1-7.

Personal Travel Characteristics

While almost all indicators of travel are up, there is substantial diversity within aggregate travel trends. There are important differences in the travel patterns of men and women, the young and the old, those in urban and rural areas, and among those of different racial and ethnic backgrounds.

Changes in travel patterns during the last two decades result from the interaction of complex societal forces that constrain and shape how American households organize all aspects of their lives. In order to recognize the demands that will be made on the Nation's transportation systems in the future, we must recognize how American households respond to the pressures created by these linked forces, and how their responses lead to wide variations in individual and aggregate travel patterns.

Economic Trends

In the next decade most job growth will be in service rather than production industries. Retail trade will soon replace manufacturing as the second largest source of total U.S. employment, generating over 5 million jobs by 2005.

A key component of the service sector is the flexible labor force, which contains as much as one-fourth of all American workers. The flexible labor force is characterized by temporary employment, variable work schedules, workers with multiple employers, and work weeks of less than 40 hours.

In addition, the change to a service industry has brought deconcentration of employment sites, creating a wide variety of dispersed work destinations. Industries do not need to be near one another or in a central area, average firm size is smaller, and firms are less likely to locate along heavily traveled corridors.

These changes have substantially altered the trip patterns of many workers, who are now traveling at different hours, along different routes, and on different days of the week than comparable people two decades earlier. Commuter trips are now spread over a longer day, with a sizable minority of travelers having variable work schedules.

Demographic Trends

The major societal trends highlighted in Exhibit 1-5 appear to have affected certain groups in society differentially.

Ethnic Diversity

Large and growing numbers of the U.S. population are from different cultural, racial, or ethnic backgrounds. For reasons ranging from differing cultural norms to varying employment opportunities and income levels, these groups appear to have distinct travel patterns.

The Elderly

American society is rapidly aging. In 1990, more than one-fourth of the entire population was over age 60. By the first decade of the next century almost half of all elderly people will be over age 75, and almost 5 percent of the entire U.S. population will be over age 80.

A number of factors related to the aging of society have profound implications for our Nation's transportation system. First, there are larger numbers of elderly drivers today. Between 1983 and 1993 the increase in licensing among both older men and women was substantial. As a result the elderly are driving far more than they did two decades ago (see Exhibit 1-8).

Second, the travel patterns of older people are strongly influenced by residential patterns. Because most older people age in the places they lived while working, elderly people are concentrated in low density or rural areas, where alternatives to automobile transportation are limited.

Third, there are central city concentrations of older people with special needs. Those elderly people who live in the central cities of metropolitan areas are more likely to be members of ethnic or racial minorities or women living alone.

One of the major implications of the aging of society is that there will be fewer younger workers available to pay for, or to directly provide, services for the rapidly growing number of seniors who require assistance. The overall level of care required by our aging population is much more physically and psychologically demanding than that needed four decades ago, in part because of the increased number of cognitive diseases among the growing number of people older than age 80.

Exhibit 1-8
Average Annual Miles Driven by Driver Age
1969-1990

	Year			
	1969	**1977**	**1983**	**1990**
All Ages	8,685	10,006	10,588	13,181
60-64	8,112	8,002	8,568	10,314
65-69	5,850	6,277	6,804	8,347
70+	4,644	4,828	4,348	6,138

Source: *Travel by the Elderly*, Sandra Rosenbloom.

Women

Today women account for close to half of those in paid employment. There has been significant growth in the number of married women who work outside the home as well as the participation of women with children, many with very young children.

The ways in which salaried women balance their domestic and employment responsibilities impact the modes they choose, the hours they travel, the routes they take, and how they organize and combine their out-of-home activities. For example, because they retain multiple responsibilities when they enter the paid labor force, women often "link" trips together, dropping children at daycare on the way to work or going grocery shopping on the way home.

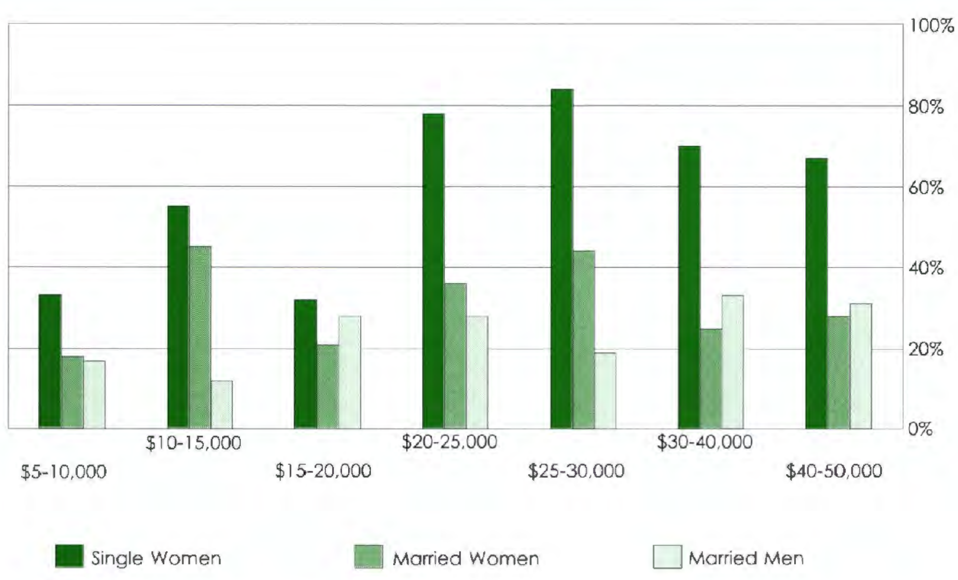
Women with children often have to make trips solely to meet the needs of their children and therefore may be less able to use alternative modes. Many workers report that they must drive alone because they need access to a car immediately before and after work to accomplish their child care needs and are concerned that they might be faced with a family emergency during the middle of the work day (see Exhibit 1-9).

Population Movements and Land Use Patterns

Over the last three decades, the United States has experienced large shifts in employment and population that have resulted in rapid suburbanization of the population and employment as well as concentration of poverty in central cities. At the same time, local land use regulations have interacted with these factors to continue to increase the expansion of single purpose neighborhoods and low density communities.

These patterns all have strong implications for how, where, and how often people travel. The majority of Americans today live and work in metropolitan areas with low density land use and housing patterns. In general, the lower the density of a community the fewer concentrated origins and destinations and the fewer corridors of high density demand. These kinds of patterns require decentralized transportation facilities and services.

Exhibit 1-9
Percent of Parents with Children Under Age 6 Who Link Trips Home from Work
Urban Areas, 1990



Source: Unpublished data from the *1990 Nationwide Personal Transportation Survey.*

Highway and Transit

Chapter 2

Financing

All levels of government provided $88.5 billion for highway programs. The Federal Government accounted for 21 percent; the States 53 percent; and counties, cities, and other local government entities funded the remaining 26 percent.

In the past two decades (since 1973), the Federal share of highway funding has gradually dropped from 28 percent to 21 percent. Alternatively, the percentage of highway receipts contributed by local governments has steadily increased during the same period, increasing from 19 percent in 1973 to 26 percent in 1993.

The $88.5 billion in highway revenues does not include revenues collected from highway users but used to finance transit and other nonhighway activities. For example, State highway user revenues from motor fuel taxes, motor vehicle fees, and tolls actually generated $46.1 billion in revenues in 1993, but only $36.7 billion was actually used to fund highways.

The $88.5 billion provided for highway programs was distributed as follows:

- *Capital investment: $39.0 billion*
- *Noncapital expenses: $41.9 billion*
- *Debt retirement: $5.2 billion*
- *Reserve: $2.4 billion*

During the past two decades, in constant (1970) cents per unit of travel, total expenditures have dropped from 1.88 cents per vehicle mile of travel (VMT) in 1970 to 1.12 cents per VMT in 1993, a 40 percent reduction.

Total transit revenue, from all sources, was $22.6 billion. Public funding accounted for slightly over two-thirds and system-generated revenue (e.g., fares, advertising, etc.) accounted for almost one-third.

Of the $22.6 billion in funding provided for transit, $21.7 billion was expended for capital investment and operating requirements. Capital investment accounted for $5.7 billion and $16.0 billion was spent to satisfy operating costs.

Funding by Level of Government

Highway

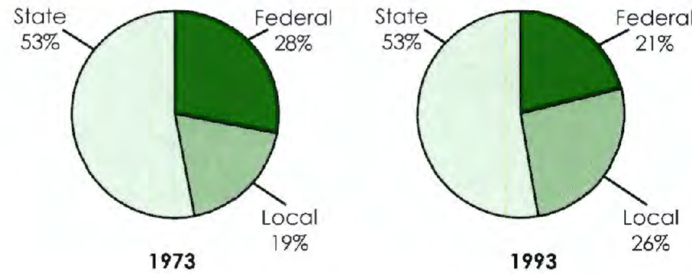
In 1993, all levels of government provided $88.5 billion for highway programs. The Federal Government funded $18.2 billion; the States, $46.9 billion; and counties, cities, and other local government entities funded the remaining $23.4 billion.

The Federal share of funding for highways increased dramatically between 1956 and 1960 following passage of the Federal-Aid Highway Act of 1956 and the establishment of the Highway Trust Fund. However, since 1960 there has been a gradual trend downward in the Federal share of funding.

The percentage of highway receipts contributed by local governments has been steadily increasing over the past several decades. For example, as illustrated in Exhibit 2-1, the local share of highway funding has increased from 19 percent in 1973 to 26 percent in 1993.

While the Federal Government provided 21 percent of the funding for highways in 1993, its direct share of actual total expenditures was only $0.9 billion, or less than 1 percent. This is because almost all of the funds that the Federal Government provides for highways are transferred to the States under the Federal-Aid Highway Program for State and local governments to expend. Most of the remainder is spent on Federally owned roads and research.

Exhibit 2-1
Highway Receipts by Governmental Unit
1973 Versus 1993



Billions of Dollars

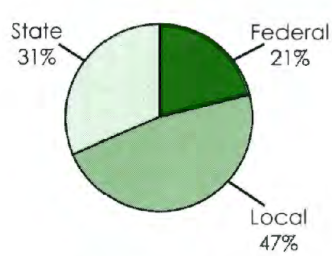
	1973	1993
Local	$5.0	$23.4
State	$14.3	$46.9
Federal	$7.4	$18.2
Total	$26.6	$88.5

Transit

Public funding for transit in 1993 was $15.4 billion. The Federal share of this support was $3.3 billion, remaining at about the same level in current dollar terms since 1985. The State and local share was $12.1 billion in 1993.

The state and local share of transit assistance has climbed steadily since reaching a low of 45 percent in 1980. This is due to a reduction in Federal operating assistance in the 1980s, an increase in State and local assistance over the same period, and a continued increase in transit service provided.

1993 Transit Funding
by Level of Government



Total = $15.4 billion

Sources of Public Sector Financing

Highway

The $88.5 billion provided for highway programs in 1993 came from a number of sources including highway user charges, property taxes and assessments, general funds, investment income, other taxes, miscellaneous fees, and bond issues. Exactions, development fees, and special district assessments provided additional revenue (see Exhibit 2-2).

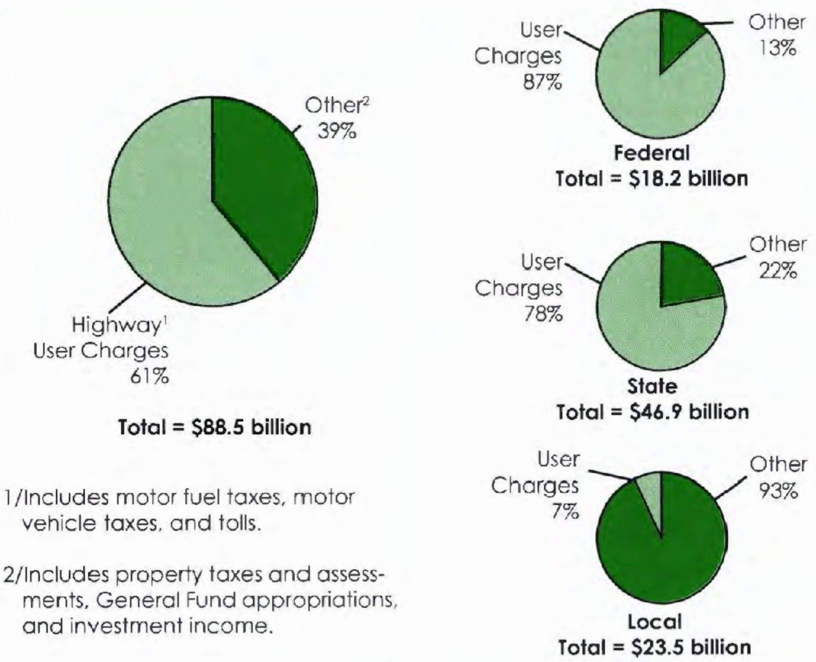
At the Federal level, motor fuel and motor vehicle taxes are the primary source of funds for highways. Motor fuel and motor vehicle taxes also provide the largest share, 72 percent, of highway funds at the State level.

Drawing Conclusions

Funds Collected for Highways but Spent for Nonhighway Purposes

The highway revenues cited in this report do not include revenues collected from highway users but used to finance transit and other nonhighway activities. For example, State highway user revenues from motor fuel taxes, motor vehicle fees, and tolls actually generated $46.1 billion in revenues in 1993. However, only $36.7 billion was used to fund highways. Although local governments actually raised $2.4 billion from highway user taxation, only $1.7 billion was expended for roads and streets. The difference in highway user revenues went for a variety of nonhighway purposes.

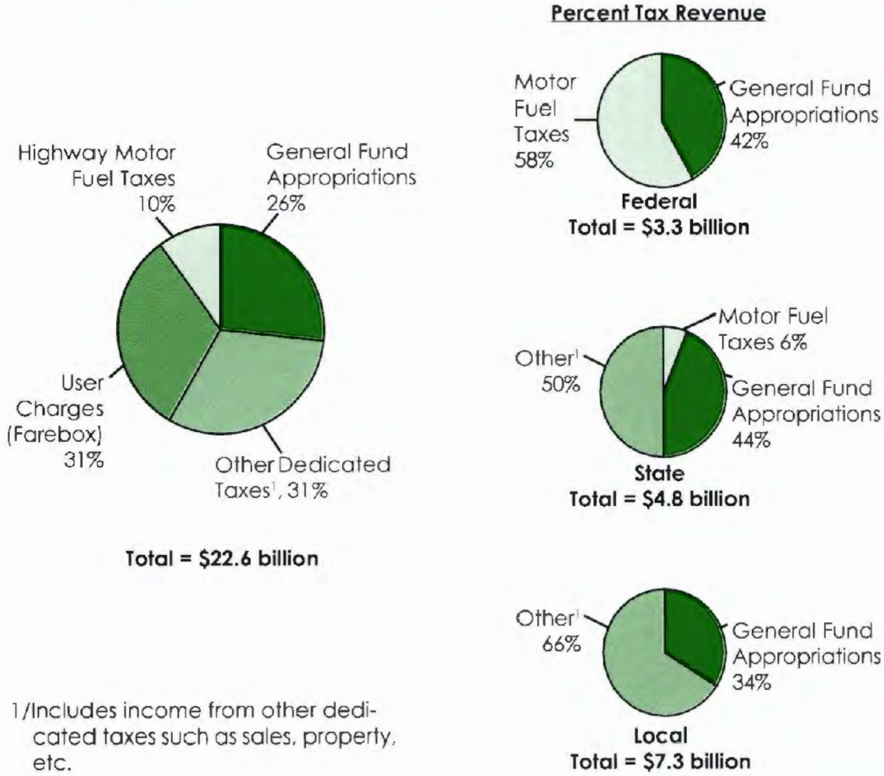
Exhibit 2-2
Sources of Public Sector Highway Financing
1993



1/Includes motor fuel taxes, motor vehicle taxes, and tolls.

2/Includes property taxes and assessments, General Fund appropriations, and investment income.

Exhibit 2-3
Sources of Public Sector Transit Financing
1993



1/Includes income from other dedicated taxes such as sales, property, etc.

Over one-third (36 percent) of highway funding at the local level is provided through the General Fund. Investment income and bond issue proceeds account for 32 percent. Property taxes, assessments, and other fees contribute almost 24 percent. The remainder (7 percent) is provided by highway users (motor fuel taxes, motor vehicle taxes, and tolls).

Transit

Federal support for transit comes from two sources: the Mass Transit Account of the Highway Trust Fund and the General Fund. The Transit Account now receives 2.0 cents per gallon of Federal motor fuel tax receipts (see Exhibit 2-3).

Capital and Noncapital Expenditures

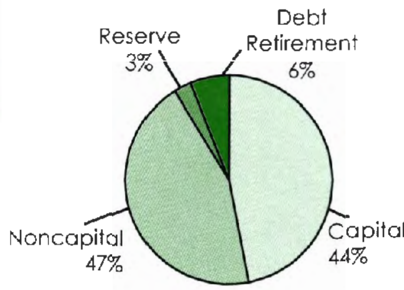
Summary of Expenditures

Of the $88.5 billion in funding provided for highways in 1993, $86.1 billion was expended for highway programs and $2.4 billion was placed in reserve. Of the total highway expenditures, $80.9 billion went for current expenditures and $5.2 billion was used for debt retirement.

In constant (1970) cents per unit of travel, total expenditures dropped from 1.88 cents per vehicle mile of travel (VMT) in 1970 to 1.12 cents per VMT in 1993 (see Exhibit 2-4).

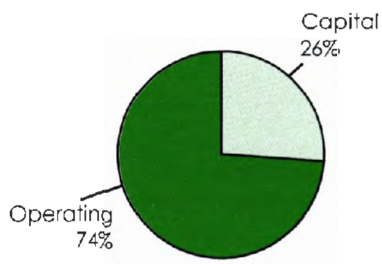
Of the $21.7 billion expended for transit in 1993, $5.7 billion was expended for capital and $16.0 billion was for operating costs.

1993 Highway Expenditures
by Type of Expenditure



Total = $88.5 billion

1993 Transit Expenditures
by Type of Expenditure



Total = $21.7 billion

Capital Expenditures

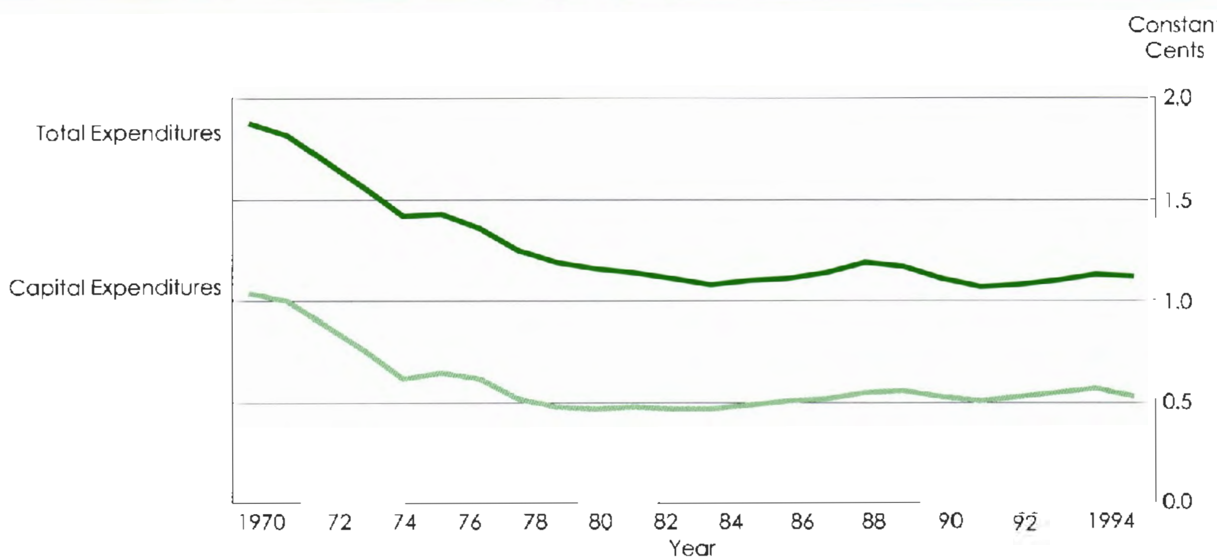
Highway

All levels of government spent over $39.0 billion on highway capital improvements (see Defining Terms, page 17). Of total expenditures, capital outlay represented 53 percent in 1973 and 48 percent in 1993. In constant (1970) cents per unit of travel, capital outlay dropped from 1.04 cents per VMT in 1970 to 0.56 cents per VMT in 1993, a 46 percent decline (see Exhibit 2-4).

Of the $39.0 billion spent on capital outlay in 1993, State and local governments spent $38.7 billion, including $17.1 billion in Federal funds. Federal direct expenditures were $0.3 billion. Federal funds accounted for 44 percent of total highway capital outlay in 1993, down from a high of 56 percent in 1980.

State and local governments supplied 55 percent of all funds for highway capital improvements in 1993. With the exception of the

Exhibit 2-4
Highway Expenditures
per Vehicle Mile of Travel
1970-1993



period from 1976 to 1986, the State and local government share has been consistently more than 50 percent.

Exhibit 2-5 summarizes the distribution of highway capital outlay by improvement type and functional system for nonlocal roads.

Capital outlay on all local roads was $7.1 billion in 1993. Local roads have the highest level of spending per unit of travel of all the functional systems. Improvement type data, however, are not available for this functional class.

Transit

While Federal capital assistance (see Defining Terms, below) has remained relatively stable between 1988 and 1993, the level of State and local contribution to transit capital assistance has grown. Thus, investment in transit capital assets, both for existing and new systems has increased from $4.1 billion in 1988 to $5.7 billion in 1993. Federal capital assistance levels in fiscal years 1994 and 1995 were substantially higher than in past years.

The largest single component of transit capital expenditures in 1993 was rail facilities, reflecting a general preponderance in capital investment for facilities. Rolling stock accounts for just 27 percent of transit capital expenditures. This is due primarily to the greater investment required for rail facilities, which includes the rights of way, track, and structure over which the service operates. Bus facilities, while far more numerous, can be much simpler and require less substantial investment.

Defining Terms
Capital Transit Spending

Expenditures for the design, engineering, construction, and reconstruction of fixed transit assets (e.g., bus garages) and rolling stock (e.g., railcars).

Defining Terms
Capital Highway Spending

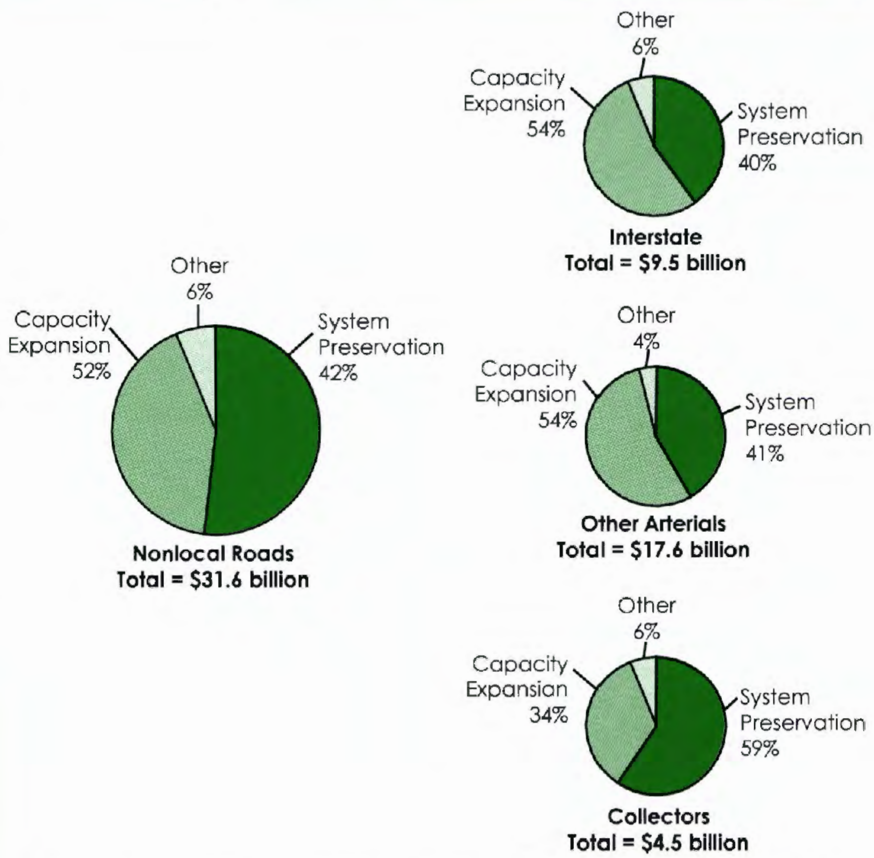
System preservation (e.g., minor widening, resurfacing, rehabilitation, restoration).

Capacity additions through adding lanes to existing facilities or constructing new roads and bridges.

Other spending, such as that for

- safety enhancements,
- traffic operations improvements,
- environmentally related improvements, and
- improvements to reduce vehicle use (e.g., designated High Occupancy Vehicle lanes).

Exhibit 2-5
Distribution of Highway Capital Outlay by Improvement Type* 1993



* Note: The capacity expansion category includes some improvements that would have been made to correct condition deficiencies even in the absence of a capacity deficiency.

Noncapital Expenditures

Highway

Since 1956, in both current and constant dollars, spending for noncapital highway expenditures has increased. The noncapital share of expenditures for highways was $41.9 billion in 1993, or 52 percent of highway expenditures.

Constant dollar growth from 1960 through 1993 for the noncapital category of expenditures was 122 percent compared to a 60 percent growth in total expenditures for both the capital and noncapital categories. In constant dollars, 1993 maintenance and traffic services expenditures were 78 percent higher than in 1960.

Exhibit 2-6 demonstrates the increase in the proportion of total highway expenditures directed toward noncapital requirements.

A total of $22.9 billion was spent by State and local governments in 1993 to keep all highways, roads, and streets in serviceable condition. The maintenance and traffic services share of total expenditures was 26 percent in 1960 and 28 percent in 1993.

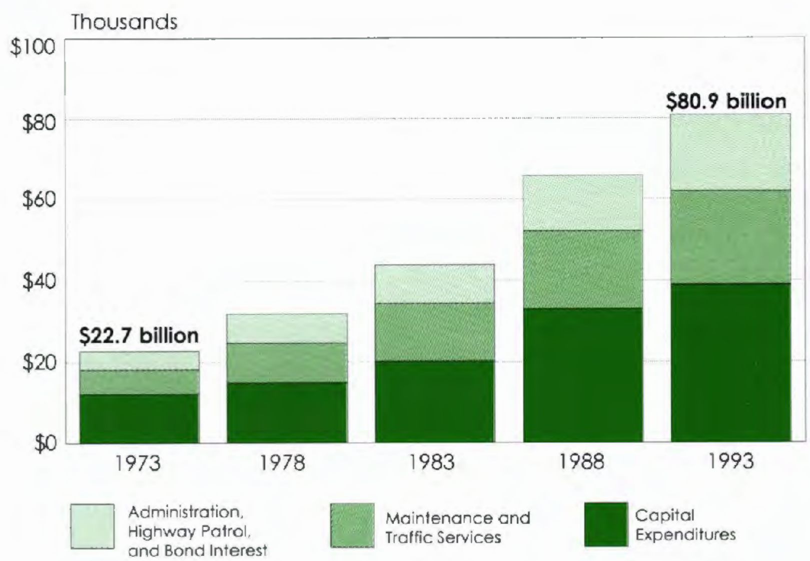
Other noncapital highway expenditures include administration, highway law enforcement and safety, and interest on highway debt. The relative share of these other noncapital expenditures to total expenditures has increased from 12 percent in 1960 to 24 percent in 1993. In constant dollars this category of spending has increased dramatically (216 percent) since 1960.

Defining Terms

Noncapital Highway Spending

- Maintenance (e.g., patching and bridge repairs)
- Traffic Services (e.g., snow and ice removal)
- Administration
- Highway Law Enforcement
- Safety
- Interest on Highway Debt

Exhibit 2-6
Highway Expenditures by Function
1973-1993



Transit

Operating (noncapital) expenditures (see Defining Terms, below) increased significantly between 1983 and 1992, from $8.4 billion to $16.0 billion. Most of the percentage increase took place between 1983 and 1986. From 1987 to 1993, the annual increase in operating expenses, in real terms, was less than 1 percent. The earlier increases result, largely, from more complete reporting of costs, particularly in the rail transit sector as well as from significant increases in service supplied.

Although real operating costs per unit of service have remained relatively stable in recent years, expenditures per unit of travel have increased due to a decline in the rate of service utilization. Specifically, real operating costs per passenger mile increased 31 percent from 1983 to 1993, an average annual increase of 3 percent. The decline in service utilization rates can largely be explained by the increase in real fares of 41 percent during this period, an annual rate of 4 percent.

Defining Terms

Transit Operating (Noncapital) Expenditures

- Wages
- Salaries
- Fuel
- Spare Parts
- Support Services and Leases

Highway and Transit

Chapter 3

Conditions and Performance

Because of investment targeted to system preservation, our highways, bridges, and transit systems are in better physical shape than they were a few years ago, and they are safer than ever:

- *The number of structurally deficient bridges has dropped.*
- *The amount of pavement in poor condition has stabilized at a manageable level.*
- *The percent of transit fixed facilities and rolling stock in good condition has improved.*
- *The overall highway fatality rate has declined steadily from 2.58 fatalities per 100 million vehicle miles traveled (VMT) in 1983 to 1.75 per 100 million VMT in 1993, with the Interstate system continuing to be, by far, the safest system.*

However, highway congestion continues to worsen. More travelers, in more areas, during more hours are facing high levels of congestion and delay than at any point in the history of the country. This means we are more susceptible to massive traffic backups as a result of accidents and even minor incidents.

The quality of transit service has improved:

- *Since 1984, the passenger-mile weighted average speed improved by about 10 percent.*
- *Well over half of all riders report wait times of 5 minutes or less. Fifty-one percent of transit trips involve one or more transfers.*
- *Less than one-third of all transit trips involve standing for at least part of the trip.*
- *About 25 percent of all transit users report trip times of 10 minutes or less.*

System Performance

Highway Performance

Highway performance refers to the quality of service provided to system users. Highway operating performance, on a given facility or system, is a function of the quality of traffic flow.

"Congestion" is a term often used to describe poor highway performance (see Drawing Conclusions, below). There are substantial costs to the economy of the Nation as a result of congestion. A report by the Texas Transportation Institute, *Roadway Congestion Estimates and Trends—1990*, March 1993, estimated the total cost of congestion for the 50 urban areas studied at $43.2 billion. Delay accounted for approximately 85 percent of this amount, while excess fuel consumption accounted for 15 percent. Eight of the top ten urban areas had total congestion costs exceeding $1 billion.

While there is no widely accepted definition of congestion, congestion has three attributes: severity, duration, and extent. These three attributes affect system reliability.

The *severity* of congestion refers to the magnitude of the problem, measured primarily by the average overall travel speed, travel time delay, or the maximum length of a queue behind a bottleneck.

The *extent* of congestion is defined by the geographic area, the portion of the population, or the portion of total travel affected. The *duration* of congestion is the length of time that the traffic is congested.

This report presents an assessment of severity. However, data to quantify the duration and extent of congestion are currently unavailable. A discussion of daily vehicle travel per lane mile is provided to give the reader a sense of travel density.

Peak-Hour Severity

The volume to service flow ratio (V/SF) may be used as a measure of severity. The V/SF is the ratio between the volume of traffic actually using a highway facility during the peak hour and the theoretical capacity of that facility to accommodate the traffic (see Drawing Conclusions, page 21).

A V/SF of greater than 0.80 indicates the beginning condition of congestion. This level is a cost-effective level of operation, but small increases in traffic beyond this point will generally cause operational problems.

Beyond a V/SF of 0.80, delay increases rapidly and system reliability is impaired because of an increase in nonrecurring delay (see Drawing Conclusions, above). In general, as the traffic flow and density increase, any interruption is increasingly likely to cause disruption to the smooth flow and create a stop-and-go situation, resulting in lower throughput.

Drawing Conclusions

Congestion

"Congestion" is a term often used to describe poor highway performance. However, there is no widely accepted specific definition. It results from the inability of an individual highway section or system to accommodate adequately the volume of traffic that attempts to use the facility or system.

The results of congestion are interruptions in the traffic flow, delay, increased travel time, increased fuel consumption, increased vehicle emissions and reduced air quality, increased user costs, increased cost of goods transport with resultant increased costs to the consumer, increased aggravation to the driver, and other effects.

The perception of what constitutes congestion varies from place to place. What may be perceived as congestion in a city of 300,000 population may not be considered congestion in a city of 3 million. For that reason, this report does not attempt to specifically define congestion. Instead, it looks at the peak-hour volume of traffic relative to the calculated capacity.

Drawing Conclusions

Nonrecurring Delay

Incidents such as vehicle breakdowns and accidents, including minor fender benders, have the potential to create nonrecurring delay. Where congestion levels exceed volume to service flows of 0.80, the likelihood of nonrecurring delay increases significantly. High levels of nonrecurring delay result in system unreliability and are the economic reason that high levels of congestion should be avoided.

Questionable system reliability can severely restrict the adoption of advanced production and distribution techniques. Just-in-time delivery is only one example of many innovative practices that depend on the efficiency and reliability of highways. Although the absolute amount of time taken for a trip is important, what is more important is the assurance that the time for the trip will not be outside a specified range.

A V/SF of 0.95 or higher indicates the onset of severe congestion. Vehicle operating costs, fuel consumption, emission, and aggravation increase dramatically. Commuting time increases, worker productivity is lost, and trip quality declines.

The percentage of daily peak-hour urban travel in 1993 occurring under congested or highly congested (near stop-and-go) conditions is presented in Exhibit 3-1. It is noteworthy that of the peak-hour travel on Interstates and other freeways and expressways that is congested to some extent, 77 percent is occurring under severely congested conditions.

Due to changes in urban area boundaries and reclassification of some rural facilities, it is difficult to assess trends related to peak-hour congestion (see Drawing Conclusions, page 7). However, the percent of peak-hour travel on urban Interstates with V/SF ratios greater than 0.80 increased from about 55 percent to about 70 percent between 1983 and 1989, and has remained relatively constant since that time.

Drawing Conclusions

Highway and Bridge Data Sources

The highway information on condition and performance is based on data supplied by State highway agencies via the Highway Performance Monitoring System (HPMS) and the National Bridge Inventory (NBI) databases. The HPMS data is updated annually and includes information about pavement, roadway cross-section, alignment, and usage for more than 110,000 sample sections of arterial and collector highways nationwide. The NBI contains records on each of approximately 575,000 bridges and is updated continuously.

Drawing Conclusions

Calculating Capacity

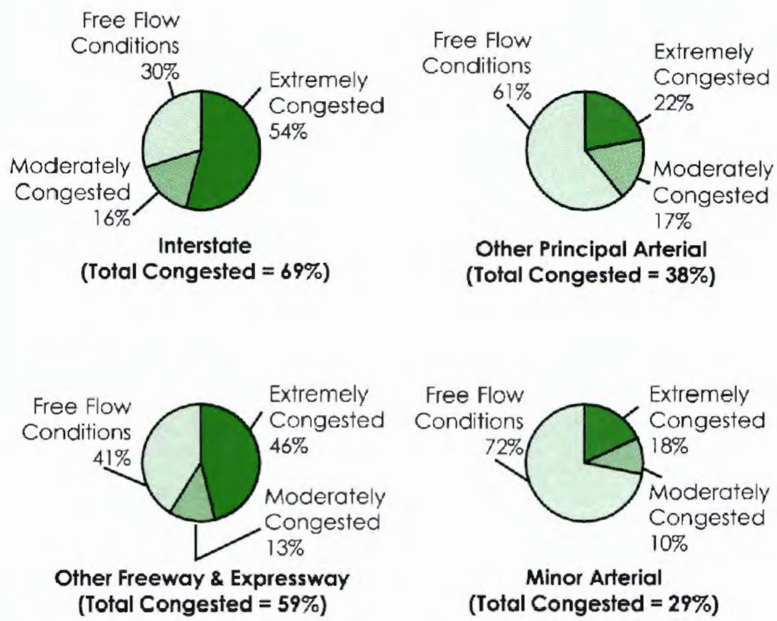
The volume to service flow ratios (V/SFs) reported in the current 1995 C&P Report are consistent with the capacity calculation procedures presented in the 1985 Highway Capacity Manual (HCM), Special Report 209 of the Transportation Research Board.

The 1985 HCM was revised in 1994 to reflect the increased volumes of traffic that are now being accommodated by freeways and, to a lesser extent, by other roads. Current research shows that more traffic can move through a freeway lane per hour than ever before because drivers have become willing to travel at closer headways (less than 2-second intervals) and at higher speeds at higher rates of flow than previously.

The new HCM suggests a capacity increase of 10 percent to 15 percent on freeways and means that less highway mileage and travel will be reported as occurring under congested conditions than is currently reported using the old procedure.

It is anticipated that the 1995 HPMS data furnished by the States and reported in the 1997 C&P Report will reflect the new capacity calculation procedures.

Exhibit 3-1
Percent Congested Urban Highway Travel in the Peak Hour
1993



Daily Vehicle Miles of Travel per Lane Mile (DVMT)

There has been a consistent increase in travel relative to the capacity of the highway system to accommodate the travel. Exhibits 3-2 and 3-3 illustrate the changes in DVMT per lane mile for each functional system, from 1983 to 1993.

These exhibits demonstrate the continuing increase in travel density on the higher functional systems, particularly the Interstate. DVMT per lane mile on the rural Interstates increased an average of 3.6 percent annually. On the urban Interstates, travel per lane mile increased 2.6 percent annually.

This increase in travel relative to the slower increase in supply of highway capacity suggests increasing congestion on the higher functional systems in the urbanized areas. Rural travel has not yet saturated the facilities to the degree that has occurred in the large urbanized areas. The greatest extent of congestion on highways in the rural category often occurs on those highways adjacent to urban areas or on facilities with heavy recreational travel.

Exhibit 3-2
Daily Vehicle Miles of Travel (DVMT) per Lane Mile - Rural
1983-1993

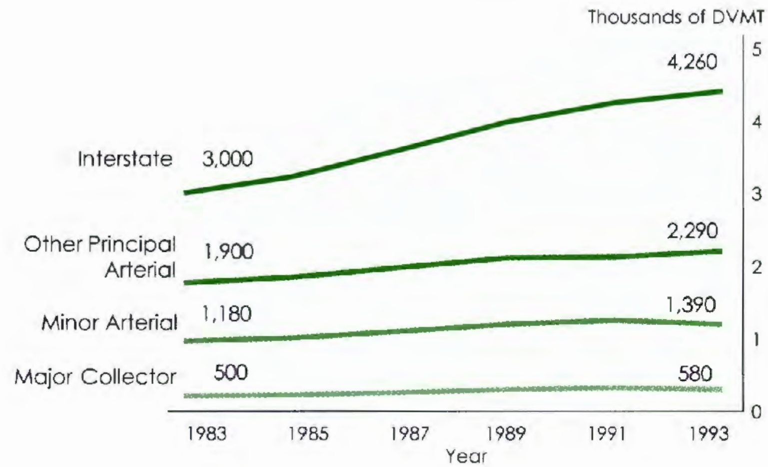
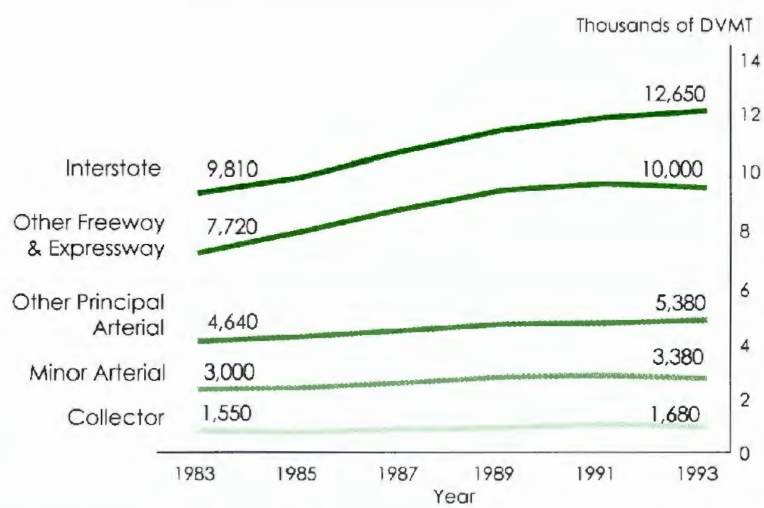


Exhibit 3-3
Daily Vehicle Miles of Travel (DVMT) per Lane Mile - Urban
1983-1993



Transit Performance

The perception of quality among customers and potential customers is an important determinant of transit use, often more important than the fare levels.

User Travel Speed

One of the most important dimensions of transit performance is speed of service, as perceived by the user. Overall speeds have improved since 1984 for both rail and bus service. Average rail speed improved from 24.8 miles per hour in 1984 to 26.3 miles per hour in 1993. Bus speed, on average, was 12.9 miles per hour in 1984 and 13.7 miles per hour in 1993.

Transfers and Waiting Times

The latest data (1990) indicates that the majority of transit users do not spend much time waiting for service. Well 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 need to transfer between transit vehicles en route to one's travel destination also influences transit patronage. Fifty-one percent of transit trips involve one or more transfers. In addition, approximately 17 percent of transit trips involve a transfer from a private vehicle, e.g., park-and-ride situations.

Available Seats

The presence of standees, even one or two, tends to convey a sense of crowding. This is especially true from the perspective of those who must stand. Passengers often consider a vehicle to be crowded when it is operating with a load factor above seated capacity but still significantly below full capacity. As shown in Exhibit 3-4, 29 percent of transit trips involve standing for at least part of the trip.

Travel Times

According to data collected in 1990, 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.

Exhibit 3-4
Percentage of Transit Riders with Available Transit Seat by Transit Function
1990

	Seat Availability		
	Entire Trip	Part of Trip	Not Available
Livable Metropolitan Areas	67	8	23
Low-Cost Basic Mobility	78	7	13
Congestion Management	67	9	23
System Average	71	9	20

System Condition

Highway Conditions

Highways

Highway physical condition is a function of pavement condition, lane width, alignment, drainage adequacy, and other measures that relate to the road's physical integrity or level of safety. Pavement conditions degrade because of normal use and weathering, increases in traffic or vehicle sizes and weights, as well as levels of maintenance and capital spending.

Pavement rated as poor usually requires vehicles to travel more slowly than the posted speed limit, with more acceleration and deceleration to avoid potholes or other sections of bad pavement. Vehicle slowdown and rough pavement driving reduces fuel efficiency, wears out brakes and shock absorbers more quickly, and can lead to more frequent front end alignments.

Exhibit 3-5 shows the 1993 mileage and travel distribution by category of pavement condition as well as the percent of unpaved mileage.

Pavement in poor condition requires immediate improvement, usually reconstruction, to restore

Exhibit 3-5
Percent Mileage and Travel by Pavement Condition Category*
1993

	Pavement Condition											
	Poor		Mediocre		Fair		Good		Very Good		Unpaved	
Functional System	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel
Rural												
Interstate	6.9	5.6	24.0	20.2	18.4	17.6	34.4	36.0	16.3	20.6	0.0	0.0
Other Principal Arterial	9.3	6.6	26.5	22.8	23.8	23.7	26.0	29.2	14.3	17.6	0.0	0.0
Minor Arterial	11.0	8.4	22.0	19.6	29.1	31.6	23.0	23.3	14.9	17.2	0.0	0.0
Major Collector	6.8	5.7	12.4	11.8	37.7	38.4	16.3	21.2	15.9	21.8	10.9	1.1
Urban												
Interstate	9.5	8.9	24.9	24.7	20.3	20.5	27.0	25.0	18.3	20.8	0.0	0.0
Other Freeway & Expressway	9.9	9.6	30.2	27.1	21.9	24.8	22.1	22.7	15.8	15.9	0.0	0.0
Other Principal Arterial	15.0	15.8	26.4	24.0	23.5	22.4	19.9	22.5	15.3	15.3	0.0	0.0
Minor Arterial	7.9	7.6	13.8	12.9	40.2	40.7	18.4	18.4	19.4	20.3	0.4	0.1
Collector	10.6	8.9	16.8	16.0	40.0	39.7	16.1	18.3	15.5	16.8	1.0	0.3

* Note: Pavement condition reflects both Pavement Serviceability Ratings and International Roughness Ratings.

Drawing Conclusions

Assessing Pavement Condition

Pavement condition evaluations have in the past been based on the Present Serviceability Rating (PSR) system. However, a transition is being made to ratings based on the International Roughness Index (IRI). This change from PSR to IRI invalidates any comparison of 1993 pavement condition data with that of preceding years. Several years of measurements using the IRI procedure are needed to define a trend.

IRI is an objective measure of pavement roughness developed by the World Bank, and is accepted as a standard in the pavement evaluation community. It has been adopted as the measurement of pavement roughness by FHWA because (1) it uses a standard procedure and can be replicated, (2) it provides a consistent measure across jurisdictional lines and diverse functional systems, (3) it is an objective measurement, and (4) it is consistent with accepted worldwide pavement roughness measurement procedures.

The PSR measure is more subjective, and its application was subject to variation among jurisdictions and over time in the same jurisdiction, so it was difficult to compare accurately the trends in pavement condition.

serviceability. Reconstruction involves removing and replacing paving material down to (and perhaps including) the subbase.

Mediocre pavement is expected to need improvement in the near future, generally within the next 5 years, depending on pavement design, environmental factors, and traffic loading. Pavement rated as mediocre can be improved by pavement management programs. The life of the highway surface for these pavements can be prolonged with lower cost, 3R types of pavement improvements (resurfacing, restoration, and rehabilitation).

Pavement in fair condition will likely need improvement in the 5- to 10-year horizon. The pavement in good condition will not likely need improvement for 10 years to 15 years or more.

The pavement information for the higher functional systems is, for most States, based on the International Roughness Index (IRI) pavement rating system (see Drawing Conclusions, above). Ratings for the lower order functional systems reflect, for the most part, Pavement Serviceability Rating (PSR)-based assessments. However, to some extent, the distribution of pavements by condition rating reflects a mixture in each functional system of the PSR and IRI procedures.

Bridge

The proportions of bridges that are classified as being structurally or functionally deficient are found in Exhibit 3-6. In general, the higher functional systems have fewer deficient bridges.

A structurally deficient bridge is not necessarily unsafe or one that requires special posting for speed or weight limitations. It is a bridge that is designated as needing significant maintenance attention, rehabilitation, or sometimes replacement. Some of these bridges are load-posted so that heavier trucks will be required to take an alternate, longer route.

Functionally deficient bridges are those that do not have the lane widths, shoulder widths, or vertical clearances adequate to serve the traffic demand; or the waterway of the bridge may be inadequate and therefore allow occasional flooding of the roadway.

Exhibit 3-6
Bridge Deficiencies
1990-1994

	1990		1994	
	Number	Percent	Number	Percent
Interstate				
Deficient Bridges	15,208	28.6	13,262	24.2
Structurally Deficient	3,848	7.2	3,303	6.0
Functionally Deficient	11,360	21.4	9,959	18.2
Other Arterial				
Deficient Bridges	39,491	31.7	36,199	28.0
Structurally Deficient	15,989	12.8	14,161	10.9
Functionally Deficient	23,502	18.9	22,038	17.0
Collector				
Deficient Bridges	56,622	34.5	45,330	27.9
Structurally Deficient	33,056	20.1	26,060	16.1
Functionally Deficient	23,566	14.3	19,270	11.9

Transit Conditions

Bus and Paratransit

Vehicle age is used as a surrogate for condition and provides the basis for evaluating bus and paratransit fleet conditions.

Exhibit 3-7 displays urban bus and paratransit vehicle conditions, in terms of the percentage of fleet in excess of the Federal Transit Administration (FTA) guideline age (see Drawing Conclusions, below), for each type of vehicle.

Exhibit 3-7
Percent Overage Vehicles in Urban Transit Fleet
1994

	Total Fleet	Portion Overage
Articulated Buses	1,807	16%
Full-Size Buses	46,824	20%
Medium-Size Buses	3,598	24%
Small Buses	4,064	13%
Vans	8,353	22%

Exhibit 3-8
Percent Overage Vehicles in Rural Transit Fleet
1994

	Rural Operators (Section 18)		Special Service Operators (Section 16)	
	Total Fleet	Portion Overage	Total Fleet	Portion Overage
Medium-Size Buses	740	51%	310	19%
Small Buses	3,660	24%	5,250	18%
Vans and Other	8,050	44%	23,770	43%

There is a significant number of overage vehicles of all types in the rural Section 16 and Section 18 fleets. The Section 16 fleet includes all vehicles owned by private nonprofit human service agencies that are recipients of Section 16 funds, not just those acquired with FTA funds.

Bus Maintenance Facilities

According to transit operators, more than half (57 percent) of urban bus support facilities are in "good or better" condition for their current mission. The remaining facilities are categorized as "adequate" (18 percent), "substandard" (14 percent), and "poor" (10 percent).

Of those facilities owned by rural operators, 74 percent are reported to be of adequate size and 68 percent adequately equipped. Of leased facilities, 61 percent are reported to be of adequate size and 55 percent are considered to be adequately equipped.

Rail

The areas reported to be in most need of improvement in 1984 have improved significantly. Maintenance yards went from only 17 percent in good or better condition to 64 percent, and maintenance buildings went from only 28 percent to 52 percent. Also, stations improved significantly from 29 percent to 66 percent, and bridges from 33 percent to 61 percent.

A substantial portion of rail infrastructure is still in need of investment to return it to good condition. Most significantly, over 73 percent of elevated structures need major investments. In addition, overhead (43 percent), third rail (41 percent), and maintenance facilities (48 percent) also have significant shares in less than good condition, requiring major investments.

Drawing Conclusions

Minimum Transit Asset Age Requirements

For the purpose of managing the Federal investment in transit, the Federal Transit Administration (FTA) has established minimum requirements for the period of time an asset must remain in mass transit service before it will be considered eligible for funding of a replacement. These guidelines are based on such factors as industry practices, manufacturer recommendations, and studies of the trade-off between capital investments and operating costs. On this basis, the following are the minimum useful life guidelines for vehicles used in bus and paratransit service:

- Standard Full Size Transit Bus: 12 years
- Medium Duty Transit Bus: 10 years
- Small Transit Bus: 7 years
- Urban Paratransit Van: 4 years

Highway Safety

A significant improvement in highway safety occurred during the period from 1983 through 1993 (see Exhibits 3-9 and 3-10). The overall highway fatality rate declined steadily from 2.58 fatalities per 100 million in 1983 to 1.75 fatalities per 100 million in 1993.

Accident and fatality rates are affected by many factors other than highway condition and performance, including weather conditions, occupant protection use, number of intoxicated drivers, extent of police exposure, law enforcement, vehicle speed variations, and driver performance.

Selected Highway Environmental Indicators

The environmental consequences of transportation arise from both construction and usage. Indices of performance pose both conceptual and practical challenges. However, an initial set of categories has been identified and includes air quality, water quality, wetlands, energy, noise, land use and open space, threatened and endangered species, and community impacts.

Progress is being made in each of these categories. As an example, there has been significant progress in reducing the overall levels of four major transportation-related air pollutants over the last decade (see Exhibit 3-11).

Transportation sources are credited with most of the emissions reductions during the decade, even though travel increased by 33 percent. Improvements in air quality are attributed to Federal limits on gasoline volatility; replacement of older cars with newer, less polluting ones; and increased usage of unleaded gasoline.

Exhibit 3-9
Rural Highway Fatality Rates
1983-1993

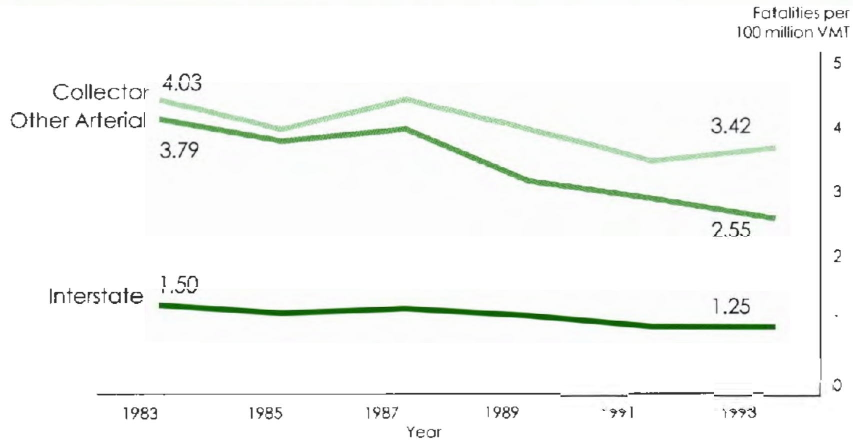


Exhibit 3-10
Urban Highway Fatality Rates
1983-1993

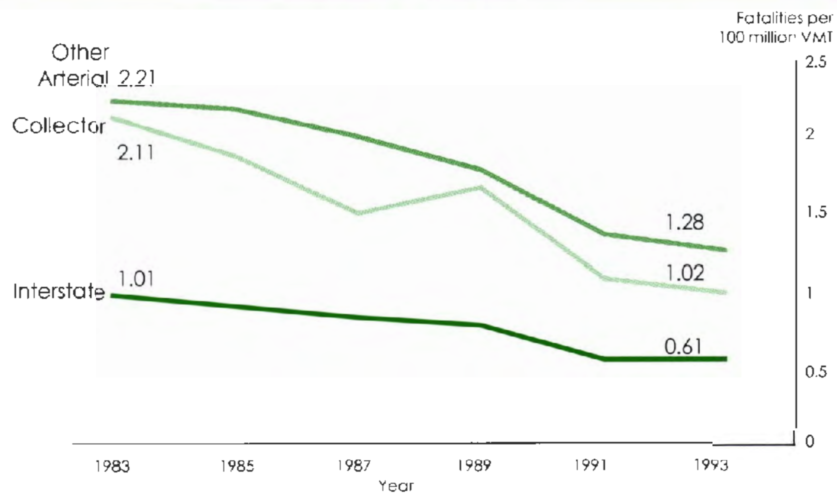


Exhibit 3-11
Reduction in Highway Vehicle Emissions
1984-1993

	Carbon Monoxide	Lead	Nitrogen Dioxide	Ozone (smog)
Ambient Air Quality	37%	89%	12%	12%
Emission Reductions				**Hydrocarbons**
All Sources	15%	88%	(1%)	9%
Highways	24%	96%	11%	35%

Highway and Transit

Chapter 4

Investment Requirements

Investment requirement estimates are developed for two scenarios. The **Cost to Maintain** conditions and performance provides the cost to keep the system functioning at its current level. The **Cost to Improve** conditions and performance provides the cost to bring the system up to a specified level of condition and performance.

The average annual **Cost to Maintain** overall 1993 highway, bridge, and transit conditions and performance, for the period 1994 through 2013 is estimated at $62.7 billion. The average annual **Cost to Improve** highway, bridge, and transit conditions and performance is $86.8 billion over the same period.

Seventy percent of the highway and bridge investment reported as necessary to either maintain or improve conditions and performance would be required in urban areas where about 55 percent of the cost would be directed to capacity expansion.

Somewhat over half of the investment necessary to either maintain or improve transit conditions and performance would be required to correct rail deficiencies; the remainder would be directed to the bus system. A significant portion (85 percent) of total transit investment requirements would be spent in areas having populations greater than 1 million.

The investment requirements provided above reflect the adoption of policies, within the most populous urbanized areas, to locally manage and satisfy future travel demand given environmental, fiscal, and social constraints.

The highway component of the **Cost to Improve** scenario was developed using a new simulation model, the Highway Economic Requirements System. This procedure uses marginal benefit/cost analysis to optimize highway investment. All highway improvements selected for implementation generate direct user and agency benefits in excess of the initial cost of the improvement.

Analytical Overview

Investment Scenarios

Total capital investment required from all sources to achieve certain specified levels of overall condition and performance on the Nation's highway, bridge, and transit systems is provided for two scenarios: (1) the **Cost to Maintain** current conditions and performance and (2) the **Cost to Improve** current conditions and performance.

Both scenarios are implemented over a 20-year time horizon, beginning in 1994 and include the cost to selectively repair pavement, bridge, and transit deficiencies; eliminate unsafe conditions; and add capacity.

Under the **Cost to Maintain** scenario, some facilities will get better and some will get worse but overall system condition and performance will stay the same throughout the analysis period. In contrast, under the **Cost to Improve** scenario, overall system performance is improved by correcting existing and accruing system deficiencies.

Methodology

The centerpiece of the highway investment requirements estimation procedure is the Highway Performance Monitoring System (HPMS), which includes a comprehensive national database and sophisticated investment/performance simulation models.

The HPMS database provides information describing the current state of the highway system in terms of condition and performance (see Drawing Conclusions, page 21).

Drawing Conclusions

Investment Requirements

Estimates of investment required to either maintain or improve the Nation's highway, bridge, and transit systems over the next 20 years are intended to serve as benchmarks for policy development.

The Cost to Improve highway, bridge, and transit conditions and performance suggest the upper limit of appropriate national investment, based on either engineering or economic criteria. Alternatively, the Cost to Maintain conditions and performance estimates provide a sense of the lowest reasonable level of investment; investment at levels less than the Cost to Maintain benchmark will result in system deterioration.

The investment scenarios do not represent comprehensive alternative national investment policies. No policy priorities have been assumed regarding either the strategic importance of individual facilities, classes of facilities, or mode of transportation. In actual practice, however, State and local transportation agencies do target selected facilities for improvement.

The coordinated simulation models—the Analytical Process (AP) and the Highway Economic Requirements System (HERS)—simulate investment decisions and estimate the resulting level of system condition and performance.

The AP was used to evaluate the **Cost to Maintain** scenario. This approach is founded on engineering principles. That is, engineering standards determine deficiency levels for various system attributes and potential improvement options are identified and considered for implementation based on engineering judgement and practice.

The HERS was used to evaluate the highway **Cost to Improve** scenario. This marks the beginning of a significant transition from the traditional engineering-based approach to one that incorporates economic considerations. The **Cost to Improve** investment requirements estimate now incorporates an economic efficiency test that each candidate improvement must pass before being selected for implementation.

The highway **Cost to Improve** scenario is now referred to as the **Economic Efficiency** scenario to highlight its economic component.

Where the traditional engineering-based analysis systematically implements all appropriate improvement options identified, regardless of economic merit, HERS evaluates each potential improvement to assure that direct user and agency benefits generated by the project will exceed the initial cost of the improvement.

Bridge investment requirements for both the **Cost to Improve** and **Cost to Maintain** scenarios are estimated using an engineering-based procedure, analogous to the HPMS AP. The bridge investment requirements do not reflect explicit benefit/cost considerations.

For both scenarios, the transit analysis is based on current infrastructure extent and condition and an estimate of the cost of system preservation and added transit capacity required to satisfy the objectives of each scenario. Explicit benefit/cost procedures are used to validate service level assumptions and certain unit costs.

Drawing Conclusions

The Highway Economic Requirements System (HERS)

An Overview

An important goal of highway capital investment is to reduce the total cost of transportation, including costs occasioned by public agencies as well as highway users. User costs vary according to highway physical conditions and system performance, and these factors are directly affected by the level of highway investment.

The HERS model estimates the national highway investment required to achieve a specified user cost level or the user cost level resulting from a given level of highway investment. Its simulation procedure assumes that project-level selection practices will optimize (given varying constraints) the relationship between public investment and direct user costs.

The HERS uses as input the HPMS database and employs benefit/cost analysis (BCA) to evaluate the attractiveness of potential highway improvements that have been identified to correct deficient prototype sections. The BCA decision rule is straightforward: invest only when benefits exceed costs.

In the current version of HERS, benefits include reductions in direct user and agency costs. Highway user benefits are defined as reductions in travel time costs, accidents, and vehicle operating costs. Agency benefits include reduced maintenance costs and the residual (salvage) value of a project. Costs refer to expenditures associated with implementing the project such as design, right-of-way acquisition, and construction.

For each alternative, a time stream of constant-dollar costs and benefits is estimated for the lifetime of the project. Future benefits are measured relative to the base, or do nothing alternative, and discounted to allow for the opportunity value of resources with respect to time.

When analyzing the **Economic Efficiency** investment scenario, the HERS corrects all system deficiencies having associated improvements that generate direct user and agency costs exceeding the initial cost. Investment beyond that indicated by the Economic Efficiency scenario includes projects having negative net benefits. Investment short of this point is a "second best" alternative because constraints, such as funding, exclude some projects having benefits greater than costs.

When funding is not available to achieve "optimal" spending levels, HERS will prioritize economically worthwhile potential improvement options according to relative merit (that is, benefit/cost ratios) and select the best set of projects. Subsequent editions of the C&P Report series will include the results of such analysis.

Limitations

An intensive, independent review of HERS in 1994 indicated that, while the model was fundamentally sound, it could be improved by consideration of a number of issues.

<u>Static System</u>. The current version of the model does not consider network interactions, new construction on new alignment, traffic diversion, or induced travel. Many of these limitations are a function of the database, which consists of statistically sampled discrete highway sections.

<u>Inefficient Pricing of Facilities.</u> Because highways (and transportation in general) are not efficiently priced, highway users do not consider the marginal costs—increased travel times—they impose on all other drivers using the facility. Future versions of HERS will have the capability of simulating the impact of alternative pricing strategies.

<u>Direct User Costs.</u> While the direct benefits included in the current version of HERS constitute the major impacts of highway improvements, the HERS accounting is not comprehensive. Most significantly, externalities (e.g., changes in air quality) and "real" (as opposed to pecuniary) productivity improvements (e.g., benefits from improved system reliability) arising from system improvements are not addressed. Work is underway to incorporate externalities into the HERS framework.

<u>Uncertain Value of Travel Time.</u> One of the most significant benefits associated with many highway improvements is travel time savings. Although much research has been conducted in this area, there is still disagreement on the proper values that should be applied to the various types of travel: commercial, commuting to work, and personal. Future editions of the C&P Report will include detailed results of sensitivity analysis.

Exhibit 4-1
33 Most Populous Urbanized Areas
Daily Vehicle Miles of Travel (DVMT)
1980-2012

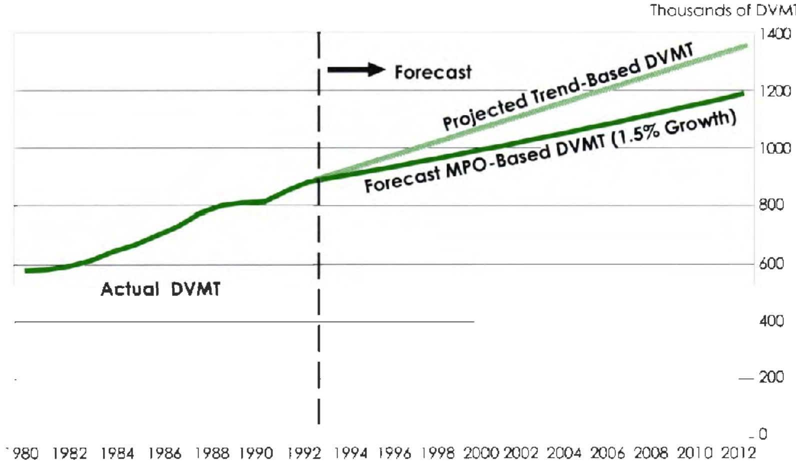
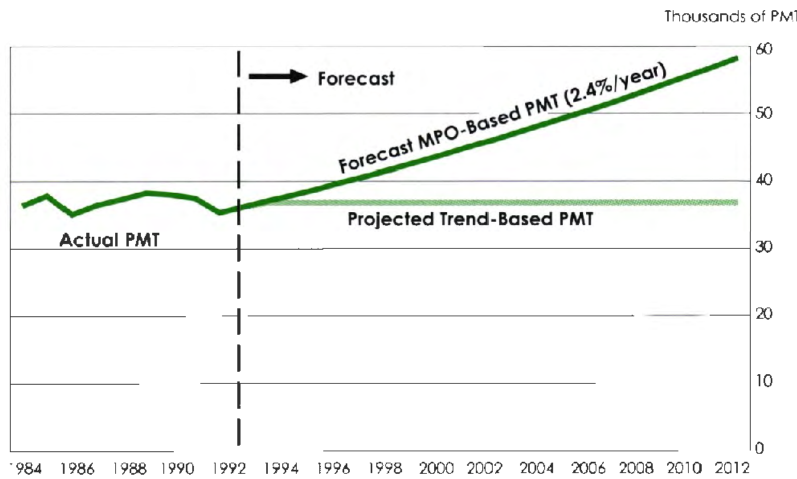


Exhibit 4-2
33 Most Populous Urbanized Areas
Annual Transit Passenger Miles of Travel (PMT)
1984-2012



Travel Growth Assumptions

For the current 1995 C&P Report, the travel forecasts underlying the highway and transit investment requirements for the 33 most populous urbanized areas (UZAs) are derived from the Metropolitan Planning Organization (MPO) planning process. Highway travel growth projections for facilities outside these areas are based on state-supplied, facility-specific forecasts as provided in the HPMS database.

Social, fiscal, and environmental concerns are most pronounced in these areas and transportation modal alternatives are more prevalent as well. For example, approximately 90 percent of transit ridership occurs in the 33 most populous UZAs.

The MPO highway and travel forecasts must be in conformance with Clean Air Act requirements and consistent with the fiscal capability of the area to implement the proposed transportation investments.

Exhibits 4-1 and 4-2 illustrate the divergence from historical patterns implied by adoption of MPO travel growth assumptions. Highway travel is projected to increase at a dampened rate (1.5 percent annually) relative to past experience. (The growth rate would naturally decline in the future as the VMT base grows; however, the MPO forecast implies a sudden shift to a lower rate.)

Alternatively, transit travel growth trends are assumed to shift from a continually constant level of travel to one in which travel will grow at a compound annual rate of 2.4 percent. These trends are consistent with MPO plans that seek to reduce highway travel through various demand- and supply-oriented measures that encourage higher transit use.

However, without significant and widespread demand-shaping policies, which have yet to be implemented in any American city, it is not likely that the MPO forecasts will be achieved. To the extent that actual future experience exceeds the highway travel forecasts, the resulting investment requirement estimates may be understated. Analogously, the degree to which the transit travel forecasts are not realized, the estimates of future transit investment requirements may be overstated.

Additional Assumptions and Procedural Improvements

The database, as well as the associated models are under continuous review. Procedures are routinely developed, external to the models, to keep the investment requirement estimation procedures consistent with current information. Efforts to incorporate these external procedures into the model structure are underway but may take several years to complete.

Exhibit 4-3 provides an overview of the external revisions to the model inputs and outputs that were implemented for the current report.

Investment Requirements

Cost to Maintain Conditions and Performance

Highway and Bridge

The average annual **Cost to Maintain** overall 1993 highway and bridge conditions and performance on existing arterial, collector, and local systems through 2013 is estimated at $54.8 billion (see Exhibit 4-4).

Under this strategy, the overall miles of roadway in poor or mediocre condition would remain essentially unchanged over the analysis period. System performance would be maintained at its current level on most rural and many urban miles.

The current total number of structurally deficient and functionally obsolete bridges would also remain about the same.

Transit

The average annual **Cost to Maintain** current transit conditions and performance, for the period 1994 through 2013, is estimated at $7.9 billion (see Exhibit 4-5).

This level of investment would maintain facilities and equipment in their current state of repair and expand service to meet the demand increase forecasted by the MPOs.

At this level of investment, 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. Transit operators would meet the requirements of the Americans with Disabilities Act (ADA) and the Clean Air Act Amendments (CAAA).

Cost to Improve Conditions and Performance

Highway (Economic Efficiency)

Under this scenario, system deficiencies are identified and any investment that creates positive net benefits is considered worthwhile. Implementation of this scenario resulted in an average BCR of greater than 2.6. Some improvements resulted in BCRs significantly higher than 2.6 and some were lower; no improvement was implemented that had a BCR of less than 1.0 (see Drawing Conclusions, page 29).

The average annual **Cost to Improve** highway conditions and performance for the period 1994 through 2013 is, given **Economic Efficiency** standards, $65.1 billion (see Exhibit 4-6).

Bridge

The **Cost to Improve** bridge conditions scenario provides cost estimates for achieving and maintaining predefined Minimum Condition Standards for physical conditions on bridges that are currently deficient or expected to become deficient at some point during the analysis period. This scenario represents a significant improvement in nationwide bridge conditions.

The modeling procedure used to develop the investment estimates for this scenario does not employ economic considerations in the evaluation of potential improvements.

The **Cost to Improve** bridge conditions for the period 1994 through 2013 is $8.9 billion annually (see Exhibit 4-6).

Transit

The average annual **Cost to Improve** transit conditions and performance is estimated at $12.9 billion for the analysis period (see Exhibit 4-7).

Of the total annual investment requirements, $7.9 billion represents the **Cost to Maintain** current conditions and performance, $2.0 billion to correct existing deficiencies, and $3.0 billion to improve transit service levels in terms of system speed, comfort, and convenience. These estimates reflect investment requirements imposed by the CAAA and the ADA.

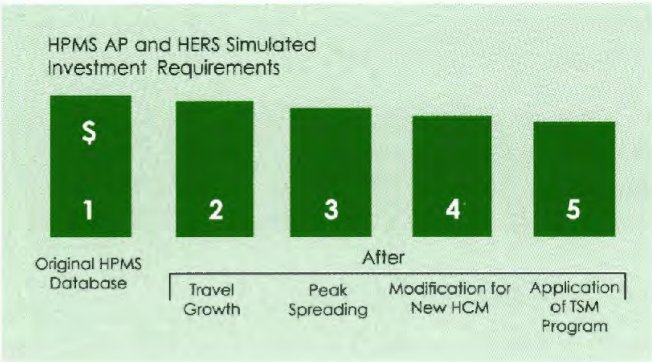
At this investment level, sufficient capacity would be available to provide transit patrons with seats for all but those trips occurring at the peak of rush hours. In addition, wait times and the need to transfer would be reduced. Finally, the backlog of deferred rail and bus modernization and rehabilitation requirements would be eliminated.

Exhibit 4-3
Schematic: Development of Highway Investment Requirements

Adjustments to the Highway Performance Monitoring System Analytical Process and Highway Economic Requirements System Simulated Investment Requirements

1. The analysis of 1994-2013 highway and bridge investment requirements began with an assessment of the 1993 Highway Performance Monitoring System (HPMS) database (see Drawing Conclusions, page 21). The States provide section-specific estimates of future travel at the end of the analysis period.

2. The first major adjustment was to revise the HPMS State-supplied travel forecasts in the 33 most populous urbanized areas to reflect MPO planning considerations. This adjustment resulted in less highway travel being projected over the 20-year analysis period and therefore lowered capacity requirements, especially in the most populous urbanized areas.



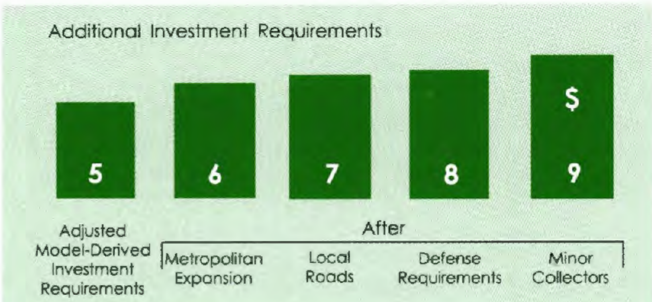
3. In the face of increasing congestion, many drivers will adjust their schedules to make more intensive and efficient use of available highway capacity. Therefore, peak travel periods will extend for longer periods of time and in more locations. To reflect this phenomenon a spreading of the peak was simulated, resulting in lower capacity requirements.

4. The model-based results were adjusted to reflect the latest edition of the Highway Capacity Manual (HCM) (see Drawing Conclusions, page 21), which assumes a larger number of vehicles per lane per hour are now being accommodated than in the past (effectively increasing capacity). The impact of this adjustment was a reduction in projected capacity requirements.

5. Where appropriate, capacity enhancements other than constructing additional lanes were simulated. Such enhancements include freeway surveillance and control, High Occupancy Vehicle facilities, ramp metering, incident management, signalization improvements, traffic channeling, and restriping existing pavement. The impact of implementing an aggressive Transportation System Management program reduces the requirement for additional lane miles of capacity.

Investment Requirements Added to the Model-Based Estimates

6. To incorporote the basic infrastructure requirements in expanding suburban areas, the expected population growth in and around urbanized areas is translated into basic network infrastructure. Incremental metropolitan expansion requirements are estimated at $8.5 billion per year (beyond estimates for increased demand on existing facilities).



7. The HPMS database does not contain condition and performance information for the approximately 2.7 million miles of roads functionally classified as local. Local road investment requirements are estimated at $1.0 billion per year, based on a Department of Agriculture study.

8. The military relies on the highway system for peacetime movement of military shipments, as well as for wartime or emergency mobilization and deployment of military units. For these purposes, a subset of Interstate and other principal arterial systems has been accorded certain design specificotions in order to accommodate large and heavy military vehicles. Capital requirements necessary to achieve these specifications, above and beyond what would normally be required to accommodate nonmilitary traffic, are estimated at $30 million annually.

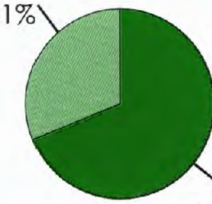
9. In their HPMS submittal, the States are no longer required to provide information on rural minor collectors. The investment analysis of rural minor collectors was based on information included in the 1992 HPMS database.

Exhibit 4-4
Cost to Maintain Condition and Performance, 1994-2013
Highway and Bridge

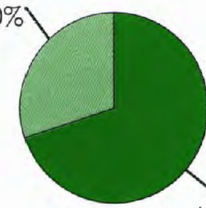
Annualized Investment Requirements 1994-2013*
(billions of 1993 dollars)

Functional System	Highway (Engineering)	Bridge (Engineering)	Total
Rural			
Interstate	$2.8	$0.4	$3.2
Other Arterials	5.1	0.4	5.5
Collectors	6.6	0.2	6.8
Local	0.5	0.5	1.0
Total Rural	$15.0	$1.5	$16.5
Urban			
Interstate	$7.3	$2.0	$9.3
Other Arterials	18.5	1.4	19.9
Collectors	4.6	0.0	4.6
Local	4.4	0.1	4.5
Total Urban	$34.7	$3.6	$38.3
Total	$49.7	$5.1	$54.8

*Annualized investment requirement equals 20-year total divided by 20.

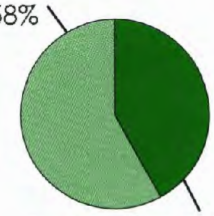


Functional System Distribution

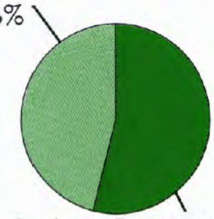


Rural Requirements Versus Urban Requirements

Rural



Urban



Total

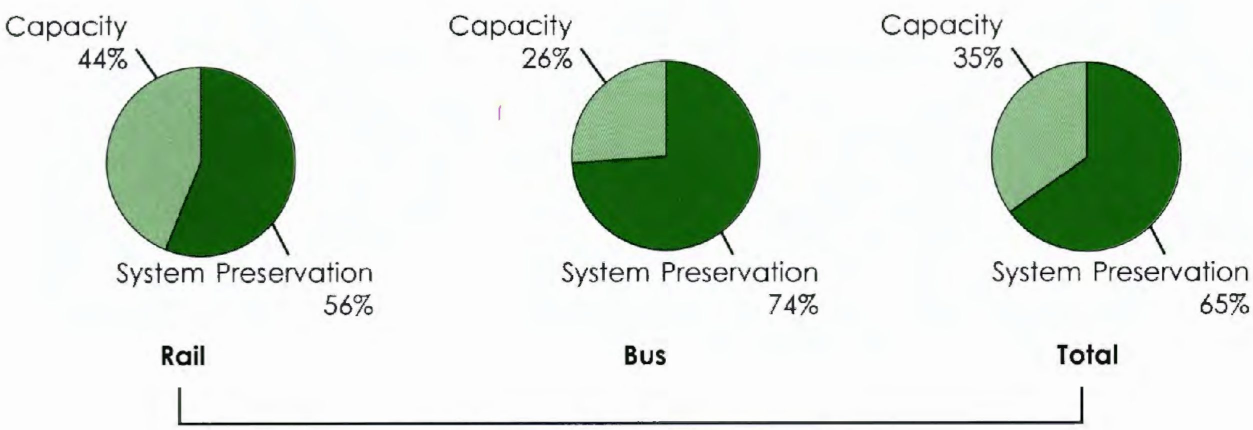
Capacity Versus System Preservation

Exhibit 4-5
Cost to Maintain Condition and Performance, 1994-2013
Transit

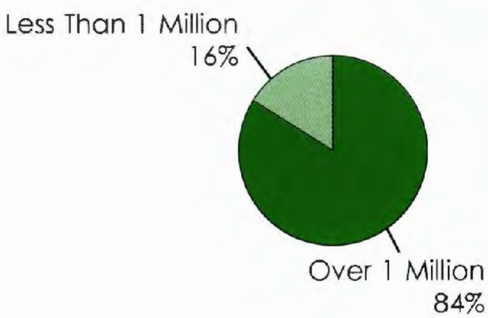
Annualized Investment Requirements
1994-2013*
(billions of 1993 dollars)

Bus	$3.6
Rail	4.2
Total	$7.9

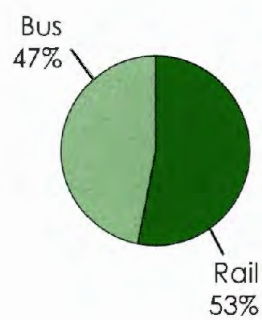
*Annualized investment requirement equals 20-year total divided by 20.



Capacity Versus System Preservation



Areas Over 1 Million Versus
Areas Under 1 Million



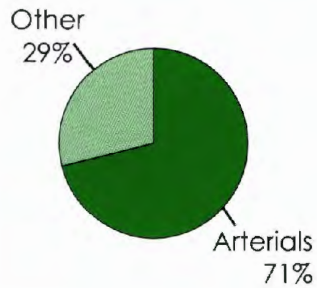
Bus Versus
Rail Requirements

Exhibit 4-6
Cost to Improve Condition and Performance, 1994-2013
Highway and Bridge

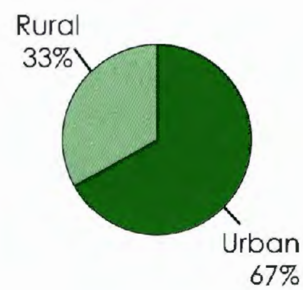
Annualized Investment Requirements 1994-2013*
(billions of 1993 dollars)

Functional System	Highway (Economic**)	Bridge (Engineering)	Total
Rural			
Interstate	$3.1	$0.9	$4.0
Other Arterials	7.9	1.0	8.9
Collectors	9.3	0.7	10.0
Local	0.7	0.6	1.3
Total Rural	$21.1	$3.1	$24.2
Urban			
Interstate	$9.4	$2.8	$12.2
Other Arterials	24.8	2.5	27.3
Collectors	5.4	0.2	5.6
Local	4.4	0.2	4.6
Total Urban	$44.0	$5.8	$49.8
Total	$65.1	$8.9	$74.0

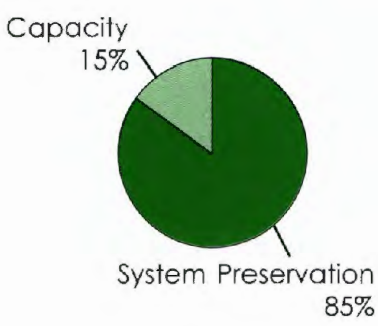
*Annualized investment requirement equals 20-year total divided by 20.
**Economic Efficiency Scenario



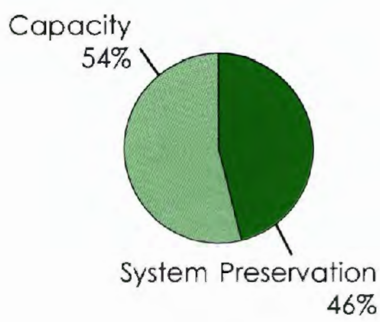
Functional System Distribution



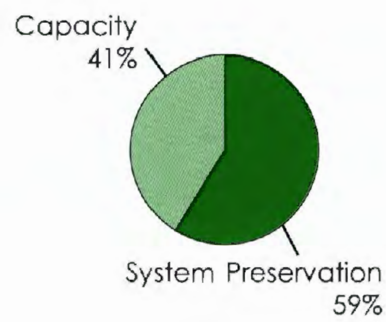
Rural Requirements Versus Urban Requirements



Rural



Urban



Total

Capacity Versus System Preservation

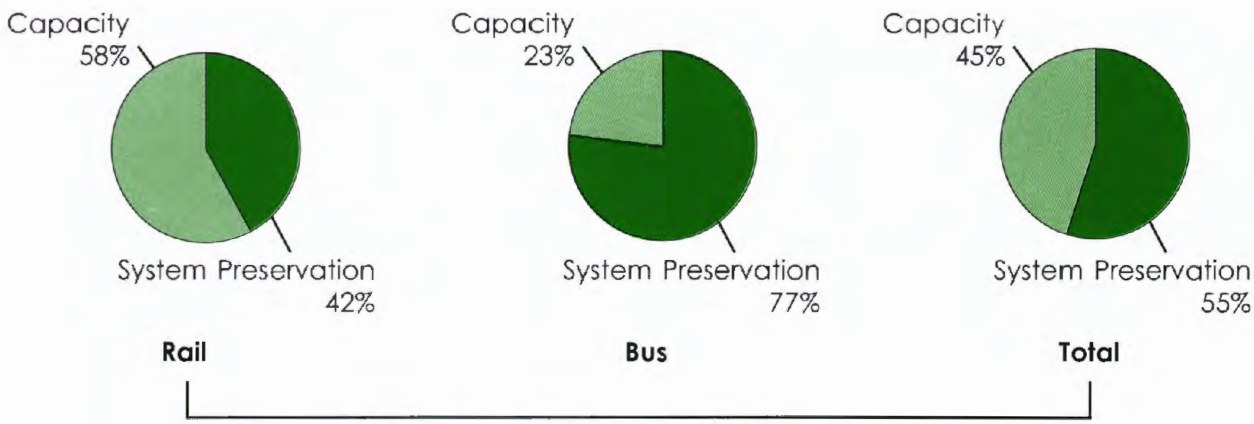
Exhibit 4-7
Cost to Improve Condition and Performance, 1994-2013
Transit

Annualized Investment Requirements 1994-2013*

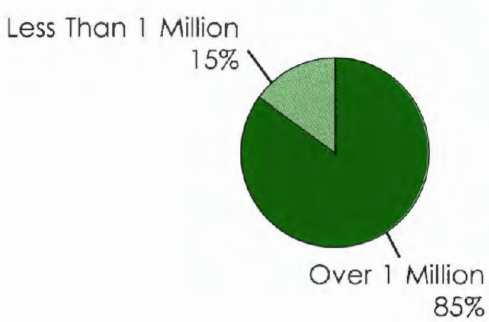
(billions of 1993 dollars)

Bus	$4.9
Rail	8.0
Total	$12.9

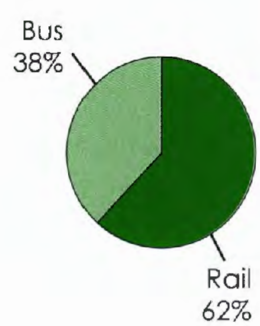
*Annualized investment requirement equals 20-year total divided by 20.



Capacity Versus System Preservation



Areas Over 1 Million Versus Areas Under 1 Million



Bus Versus Rail Requirements

Highway and Transit

Chapter 5

Investment Requirements Versus Capital Outlay

In 1994, $57.2 billion in capital investment would have been required, from all levels of government, just to maintain 1993 conditions and performance on our Nation's highways, bridges, and transit systems. This estimate includes $34.8 billion in system preservation and $22.4 billion to expand capacity to prevent increased congestion.

In 1994, $80 billion would have been required to provide a higher quality of service. This estimate includes $50.7 billion for system preservation and $29.3 billion for expanded capacity. Under this scenario, highway deficiencies would not be eliminated, but those highway improvements that generated a benefit/cost ratio of one or greater would be made.

Currently (1993), all levels of government spend $40.5 billion annually on highway and transit capital investment triggered by condition and/or performance deficiencies. Highway investment accounted for $34.8 billion and transit investment accounted for $5.7 billion.

Just to maintain current conditions on our highway and transit systems will require 41 percent higher funding than Federal, State, and local governments are currently investing. To improve conditions to optimal levels based on economic and engineering criteria would require us to double our current capital investment in highways and transit.

Investment by all units of government has never been sufficient to maintain overall system condition and performance. However, highway and transit systems have not fallen apart because the States are investing strategically so that the most important deficiencies are addressed. As a result of overall disinvestment, highway system performance continues to decline. Motorists now face more congestion, in more places, for longer periods of time, than at any point in history. Maintaining the highway and transit infrastructure at an acceptable level will become increasingly difficult unless adequate funding is provided.

Investment estimates are developed for a 20-year analysis period. To provide linkage between these 20-year investment estimates and actual current year investment, this section offers a comparison of 1994 investment requirements and actual recent capital outlays by all units of government.

This analysis requires that only 1993 disbursements related to condition and performance deficiencies (as opposed to total capital outlay) be compared to investment required in 1994 (in contrast to the average annual requirement).

It was reported earlier in this pamphlet that a total of $38.7 billion was spent by State and local governments on highway and bridge capital improvements in 1993 (see page 16). However, not all of this spending was occasioned by condition and performance deficiencies.

Of the $38.7 billion in capital expenditures, $34.8 billion was spent to correct condition and performance deficiencies. The balance was spent on capital improvements intended to satisfy other objectives such as environmental impact mitigation or economic development. Exhibit 5-1 provides a comparison of total capital outlay with that portion invested to correct condition and performance deficiencies.

Because of projected increases in highway and transit travel over the 20-year analysis period, the investment requirement estimate for any given year (except the midpoint) will be different than the average annual investment requirement reported in Section 4. Investment required for capacity expansion to maintain or improve system performance is assumed to grow at a rate equal to the rate of travel growth. Therefore, the investment required for each year during the first 10 years of the analysis period will be lower than the average annual; and the investment required for each year during the second half of the analysis period will be higher than the average annual.

Exhibit 5-2 compares the investment required in 1994 to maintain or improve highway, bridge, and transit conditions with the comparable 1993 capital outlay. Readers will note that the highway and transit investment required in 1994 is indeed lower than the average annual. Bridge investment is generally directed at system preservation and is therefore assumed to be insensitive to travel growth estimates.

Exhibit 5-1
Capital Outlay Related to Condition and Performance on All Roads and Bridges
1993

Functional Class	Total Capital Outlay (billions)	Condition and Performance Related Capital Outlay (billions)
Rural		
Interstate	$3.1	$2.7
Other Principal Arterial	4.7	4.2
Minor Arterial	3.0	2.7
Major Collector	2.7	2.5
Minor Collector	0.6	0.6
Total Rural	$14.1	$12.6
Urban		
Interstate	$6.3	$5.4
Other Freeway & Expressway	2.7	2.3
Other Principal Arterial	4.4	3.9
Minor Arterial	2.8	2.4
Collector	1.2	1.0
Total Urban	$17.4	$15.0
Subtotal, Rural and Urban, Nonlocal	$31.6	$27.7
Rural and Urban Local	$7.1	$7.1
Total, All Systems	$38.7	$34.8

Exhibit 5-2
1994 Investment Required for Highways, Bridges, and Transit Systems Versus 1993 Capital Outlay*

All Systems (Includes Local)
(billions of dollars)

Highway

1994 Cost to Maintain			1994 Economic Efficiency			1993 Capital Outlay*
Capacity Expansion	System Preservation	Total	Capacity Expansion	System Preservation	Total	
$20.2	$24.6	$44.8	$24.6	$34.7	$59.3	$28.8

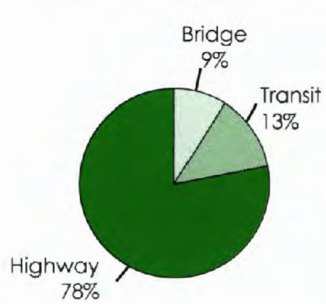
Bridge

1994 Cost to Maintain			1994 Cost to Improve			1993 Capital Outlay*
Capacity Expansion	System Preservation	Total	Capacity Expansion	System Preservation	Total	
-	$5.1	$5.1	-	$8.9	$8.9	$6.0

Transit

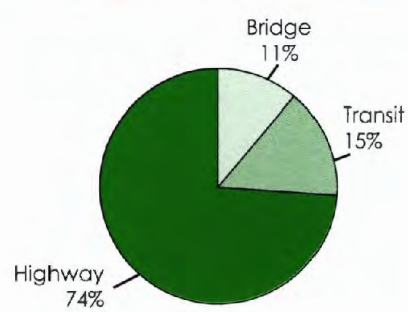
1994 Cost to Maintain			1994 Cost to Improve			1993 Capital Outlay*
Capacity Expansion	System Preservation	Total	Capacity Expansion	System Preservation	Total	
$2.2	$5.1	$7.3	$4.7	$7.1	$11.8	$5.7

1994 Cost to Maintain



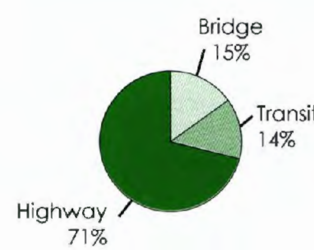
Total = $57.2 billion

1994 Cost to Improve



Total = $80.0 billion

1993 Capital Outlay



Total = $40.5 billion

*Capital outlay related to capital investment requirements.

Part II

M a r i t i m e

M a r i t i m e

Chapter 6

Waterborne Transportation

The U.S. waterborne transportation system serves the needs of both international and domestic commerce and also includes the port infrastructure and shipbuilding industry. Together its segments play a critical role in meeting national security requirements and contributing to economic growth.

The world merchant fleet amounts to over 25,000 vessels with a capacity of 686 million deadweight tons (DWT). The U.S. ranks tenth among countries of registry with 20 million DWT. The domestic fleet includes nearly 40,000 vessels with a cargo capacity of more than 67 million short tons.

The January 1, 1995, world orderbook for merchant vessels consisted of 1,527 vessels totaling 66.6 million DWT. The Major U.S. Shipbuilding and Repair Base is comprised of 101 private building and repair shipyards, and the U.S. ranks 26th among the world's shipbuilding nations.

U.S. oceanborne foreign trade amounted to 898 million long tons with a value of $566 billion in 1994 and is projected to grow 4.5 percent annually through 2005.

The cargo carried on U.S.-flag vessels increased steadily from 25.1 million long tons in 1970 to 35.2 million long tons in 1994, a 40 percent increase, reflecting the deployment of larger, more productive vessels.

Total domestic trade amounted to approximately 1.1 billion short tons annually during the 1987 through 1993 period.

There are 1,917 major U.S. seaport terminals, and 1,789 river terminal facilities located in 21 states on the 25,000-mile U.S. inland waterway system. Of the 343 ports that handled waterborne trade during 1993, the 50 leading coastal and inland ports accounted for 89 percent of the total traffic. In 1994, 44 percent of the world merchant fleet tonnage called at U.S. ports.

World oceanborne trade is projected to approach 5 billion tons by 2005. The demand for newbuildings worldwide will approximate $267 billion in current dollars over the next five years, $150 billion attributable to replacement requirements and $117 billion to trade growth.

Future investment in the U.S. waterborne transportation system will need to continue to be a blend of public and private money, as the industry remains essentially privately capitalized.

System Characteristics and Condition

The U.S. waterborne transportation system serves the needs of both international and domestic commerce. It includes the international liner (scheduled), nonliner (unscheduled dry cargo) and tanker segments, the domestic inland waterways, Great Lakes and ocean segments, the port infrastructure, and shipbuilding industry. Together these segments play an important role in both the global and domestic economy, and a critical role in meeting our national security requirements and contributing to economic growth.

World and U.S. Oceangoing Fleets

Characteristics

The world merchant fleet of oceangoing vessels 1,000 gross tons and over, as of January 1, 1995, amounted to just over 25,000 vessels with a capacity of 686 million deadweight tons (DWT). Only 15 nations have more than 10 million DWT registered under their flags, and together these 15 account for 75 percent of the world total. The five largest registry flags are Panama, Liberia, Greece, Cyprus, and the Bahamas, accounting for 46 percent of the total world fleet. The U.S. ranks tenth with 20 million DWT.

Tanker vessels make up the largest part of the world fleet, accounting for 5,994 vessels and 297 million DWT. Dry bulk carriers account for 5,291 vessels and 250 million DWT. The United States has a significant presence in the world intermodal fleet; its containership fleet ranks third in the world (see Exhibit 6-1).

Exhibit 6-1
World and U.S. Merchant Fleets
Thousands of Deadweight Tons
January 1, 1995

	U.S. Flag	All Flags
Containerships	2,853	38,868
Dry Bulk	880	250,472
Tanker	11,476	297,141
Roll-on/Roll-off	1,008	11,597
Cruise/Passenger	74	906
Other	3,643	86,772
Total	19,934	685,756

Condition

The U.S. oceangoing fleet is older and less fuel efficient than the overall world fleet.

U.S. Domestic Fleet

Characteristics

The domestic fleet includes nearly 40,000 vessels with a cargo capacity of more than 67 million short tons. The predominant vessel in the domestic fleet is the dry cargo barge, 87 percent of which operate on the inland waterways. Total capacity of the 26,953 dry cargo barge fleet is 39 million short tons (see Exhibit 6-2).

In 1993, the tank barge fleet consisted of 3,862 vessels with a capacity of nearly 11 million short tons. About 82 percent of these operated on the inland waterways.

The domestic towboat/tugboat fleet amounted to 5,224 vessels in 1993, 62 percent operating on the inland waterways. The self-propelled U.S.-flag Great Lakes fleet consists almost exclusively of dry bulk vessels, most of which carry ores. Ferries constitute a small segment of the domestic fleet, 150 in number, with a total passenger capacity of just over 87,000 (580 per vessel average).

Exhibit 6-2
U.S. Domestic Fleet
Selected Vessel Types
December 1993

	Vessels	Average Capacity
Dry Cargo Barge	26,953	1,446 short tons
Tank Barge	3,862	2,775 short tons
Tug/Towboat	5,224	1,723 horsepower
Ferry	150	580 passengers
Other*	2,919	
Total	39,108	

*Dry cargo vessels, tankers and rail car floats operated in coastal and Great Lakes trades.

Exhibit 6-3
U.S. Domestic Fleet, Age Distribution by Capacity Selected Vessel Types December 1993

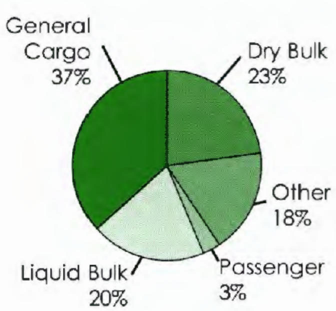
Fleet	Year Built					
	Before 1970	1970-1974	1975-1979	1980-1984	1985-1989	After 1989
Dry Cargo[1]	14%	18%	25%	26%	6%	11%
Tank Barge[1]	31%	19%	20%	19%	2%	8%
Tug/Towboat[2]	33%	17%	25%	20%	3%	2%
Ferries[3]	41%	8%	8%	26%	13%	3%

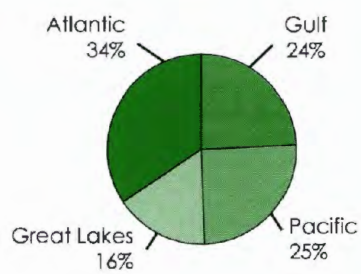
[1]Capacity expressed as Short Tons
[2]Capacity expressed as Engine Horsepower
[3]Capacity expressed as Passengers

Drawing Conclusions
Intermodal Transportation

Intermodal transportation uses sophisticated equipment (vessels, terminals, and inland delivery systems) linked through information technology to meet shippers' needs. Compared to traditional breakbulk services, intermodal transportation provides shippers with lower transportation costs, reduced inventory and warehousing costs, just-in-time logistics support, reduced damage and pilferoge, and increased market opportunities. U.S.-flag carriers pioneered the development of marine container terminals, double stack trains, and cargo and equipment tracking systems to provide the total logistics support required for an efficient transportation network.

Exhibit 6-4
U.S. Seaport Terminals by Berth Type and Berths by Region 1993





Total Berths = 3,173

Condition
An age profile of selected portions of the domestic fleet is shown in Exhibit 6-3.

Port Infrastructure
The U.S. port system is comprised of deep-draft seaport and Great Lakes port facilities and the inland waterway system. Each of these elements include both publicly and privately owned marine terminal facilities which are the interface between water and surface transportation modes.

There are in total 1,917 major U.S. seaport terminals comprising 3,173 berths. The general cargo class is the predominate berth type in all regions except the Great Lakes, where the majority of facilities are for dry bulk cargoes (see Exhibit 6-4).

There are 1,789 river terminal facilities located in 21 states on the 25,000-mile U.S. inland waterway system. The inland system is less concentrated geographically and provides almost limitless access points to the waterways.

U.S. Shipbuilding
The Major U.S. Shipbuilding and Repair Base is comprised of 101 private shipbuilding and repair shipyards—21 shipbuild-

Drawing Conclusions
U.S.-flag Shares

U.S.-flag vessels carried approximately 3.8 percent of U.S. waterborne foreign trade in 1994, down from 5.3 percent in 1970. However, the cargo carried on U.S.-flag vessels has increased steadily from 25.1 million long tons in 1970 to 35.2 million long tons in 1994, a 40 percent increase. This absolute increase in cargo carried on U.S.-flag vessels reflects the deployment of larger, more productive U.S.-flag vessels in the 1970s and 1980s.

ing yards, 32 major repair yards, and an additional 48 yards that are capable of performing topside work on large vessels.

System Performance

International Trade

In 1994, world oceanborne trade (imports) amounted to about 3.1 billion long tons, with the United States accounting for 18 percent. Total oceanborne U.S. foreign trade (exports and imports) in 1994 amounted to 898 million long tons with a value of $566 billion, an increase of 3.2 percent in tonnage and 12.8 percent in value from the previous year (see Exhibit 6-5).

U.S. liner trade expanded at an annual rate of 6.8 percent between 1985 and 1994. In 1994, approximately 78 percent of all U.S. liner cargoes (long tons) were containerized. Highly specialized line-haul/ feeder services, connecting carrier services and vessel-sharing arrangments have become the norm in these trades.

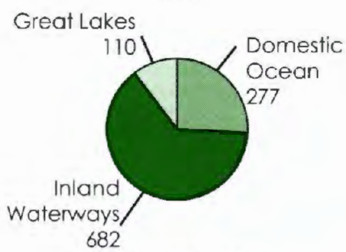
U.S. non-liner shipments declined at an annual rate of 1 percent between 1985 and 1994. The U.S. tanker trade grew at an average annual rate of 7 percent between 1985 and 1994, due largely to rising U.S. petroleum imports (occasioned in part by declining domestic crude oil production).

In 1994, 7,206 vessels, or 29 percent of the world merchant fleet, called at U.S. ports. In terms of capacity, these ships represented 44 percent of the deadweight tonnage in the world fleet.

U.S. Domestic Trade

Total domestic trade (inland waterways, Great Lakes, and domestic ocean services) amounted to approximately 1.1 billion short tons annually during the 1987 through 1993 period.

Domestic Waterborne Commerce
1993



Millions of Short Tons

The total volume of cargo carried on the Great Lakes has been quite stable over the last several years, and amounted to nearly 110 million tons in 1993. More than 90 percent of this traffic moved in dry bulk ships.

One out of every eight tons of goods transported domestically moves via the inland or intracoastal waterway systems, and more than half of U.S. states are tied to a waterway system.

Total cargo moving in the domestic ocean trades, which include Alaska, Hawaii and Puerto Rico, has been declining steadily for the past several years, reflecting the decline in Alaska North Slope crude oil shipments.

Port Traffic

The movement of domestic and foreign waterborne commerce through the U.S. port system is highly concentrated. A total of 343 ports handled waterborne trade during 1993. The tonnage handled by the 50 leading coastal and inland ports amounted to 89 percent of the total water-borne trade in that year. Despite the high degree of concentration, there were 145 ports that handled over 1 million short tons of cargo, which demonstrates the broad base on which the U.S. port system is built.

U.S. Port Calls by Vessel Type
1994

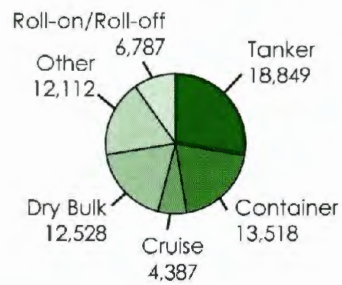


Exhibit 6-5
U.S. Oceanborne Foreign Trade by Type of Service
1994

	Thousands of Long Tons			Millions of Dollars		
	All Flags	U.S. Flag	Percent U.S. Flag	All Flags	U.S. Flag	Percent U.S. Flag
Liner	117,847	16,999	14	$419,427	$70,916	17
Tanker	448,250	9,841	2	57,301	1,315	2
Nonliner	331,612	8,394	2	88,907	4,786	5
Total	897,709	35,234	4	$565,635	$77,017	14

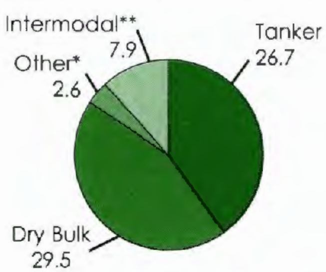
Container traffic through U.S. ports, which increased by 12 percent from 1993 to 1994, is also highly concentrated. The top 10 ports accounted for 79 percent of the total.

In terms of port calls, the top 20 ports accounted for approximately 75 percent of the vessel calls to all U.S. ports in 1994.

Shipyard Production

As of January 1, 1995, the world orderbook for merchant vessels 1,000 gross tons (GRT) and over consisted of 1,527 vessels totaling 66.6 million DWT. Japan and South Korea are by far the leading world merchant shipbuilders with a combined 64 percent share (based on DWT) of the January 1, 1995, orderbook. The United States ranks 26th among the world's shipbuilding nations.

Newbuilding Orderbook
by Type
January 1, 1995



Millions of Deadweight Tons

* Breakbulk ships, partial containers, refrigerated cargo ships, barge carriers, cruise/passenger, specialized cargo ships.

**Includes containerships and roll-on/roll-off vessels

The U.S. shipbuilding industry has a long history of commercial ship construction. However, as a result of the suspension of federal construction assistance, the U.S. shipbuilding industry's commercial orderbook fell from 77 vessels (approximately 4.7 million GRT) in the mid-1970's to zero by 1988. Since the enactment of the National Shipbuilding and Shipyard Conversion Act of 1993, U.S. shipyards have been aggressively competing for re-entry into the domestic and foreign commercial shipbuilding markets. The newly expanded federal mortgage guarantee program (Title XI) has been a major impetus to the shipyards.

National Security Aspects

In the past, the United States relied on a huge fleet of relatively small commercial ships to provide sealift support; now, that fleet has been superseded by an infinitely more sophisticated network of interrelated, intermodal equipment and large vessels. These assets, located throughout the world, serve both U.S. commercial and military requirements.

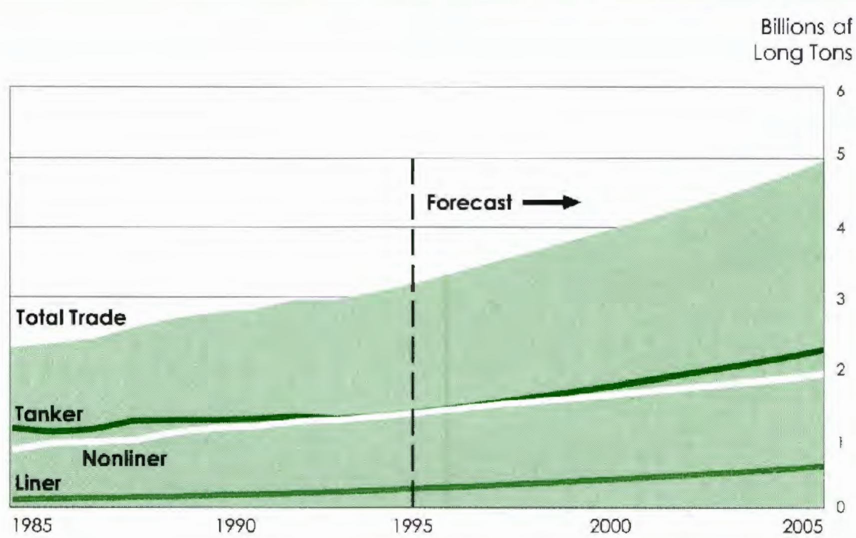
Demand for Water Transportation and Shipping Capacity

Oceanborne Trade

World oceanborne trade expanded from 2.3 billion long tons to 3.1 billion long tons between 1985 and 1994 (3.9 percent annually), and is projected to grow at 4.3 percent annually to approach 5 billion tons by 2005 (see Exhibit 6-6). U.S. oceanborne foreign trade grew at a slightly slower rate over the last ten years, but is projected to grow 4.5 percent annually through 2005.

Oceanborne trade is expected to grow at higher rates than gross domestic product due to reduction in trade barriers and advances in transportation and communications. Countries will be trading a larger share of what they produce.

Exhibit 6-6
World Oceanborne Trade
1985-2005



Demand for Ocean Shipping Capacity

Demand for shipping capacity is largely a function of world trade. However, given the age profiles of the existing world fleet, the principal newbuilding demand in the 1990's will come from the requirement to replace existing vessels. Thus, total shipbuilding demand has a replacement component and a trade-induced component. Since trade forecasts may vary widely, there is much more certainty associated with the replacement component, which reflects the physical deterioration of ships over time.

Exhibit 6-7 shows the world demand for newbuildings in the 1995-2000 period. Nearly two-thirds of the total demand for newbuilding through the year 2000 will be for replacement vessels. The demand for newbuildings worldwide will approximate $267 billion in current dollars over the next 5 years, $150 billion attributable to replacement requirements and $117 billion to trade growth.

Considering the high percentage of the world fleet that serves the U.S., this demand for newbuilding is important to the Nation, as both a shipbuilder and a consumer of transportation services.

System Investment Requirements

Future investment in the U.S. waterborne transportation system will need to continue to be a blend of public (Federal, State, and local) and private money, as the industry remains essentially privately capitalized.

Significant investment in replacement tonnage will be required. Where the replacements are built and what flag they fly will be largely a function of the level of Federal commitment to maintaining a U.S.-flag presence in international trade and a U.S. shipbuilding capability.

Federal funds invested in the maritime industry tend to be highly leveraged. Thus, an annual investment of $100 million in the proposed Maritime Security Program would maintain an operating liner fleet of 50 U.S.-flag ships operating in international trade (a small fraction of the total operating costs of such a fleet). Similarly, the Title XI ship financing program (which guarantees up to 87.5 percent of vessel cost) requires that only a small portion of the guarantee amount (5 percent to 10 percent) be held as a reserve against default.

Exhibit 6-7
Newbuilding Demand
1995-2000

	Replacement		Trade-Induced		Total	
	Number	DWT*	Number	DWT*	Number	DWT*
Containerships	187	5.3	632	17.9	819	23.2
Dry Bulk	970	62.4	701	45.1	1,671	107.5
Tanker	1,441	89.5	479	29.7	1,920	119.2
Roll-on/Roll-off	117	1.1	237	2.3	354	3.4
Cruise/Passenger	19	0.1	90	0.5	109	0.6
Other	4,740	32.9	2,001	13.9	6,741	46.8
Total	7,474	191.3	4,140	109.4	11,614	300.7

* Millions