Chapter 7

Capital Investment Requirements

Summary

Exhibit 7-1 compares the 20-year average annual investment requirements in this report with those presented in the 1999 C&P report. The first column shows the projection for 1998-2017 based on 1997 data shown in the 1999 C&P report, stated in 1997 dollars. The second column restates these highway and transit values in 2000 dollars, to offset the effect of inflation. The third column shows new average annual investment requirement projections for 2001-2020 based on 2000 data.

Results for highways, bridges, and transit are presented for two key scenarios, one in which the status of the current system is maintained, and one in which it is improved. However, the exact specifications of the scenarios differ for each mode. Investment requirements for highways and bridges are drawn from the Highway Economic Requirements System (HERS), which estimates highway preservation and highway and bridge capacity expansion investment; the National Bridge Investment Analysis System (NBIAS), which estimates future bridge preservation requirements; and external adjustments to reflect functional classes and improvement types not directly modeled. Transit investment requirements, with the exception of those for rural and special service transit, are estimated by the Transit Economic Requirements Model (TERM). Requirements for rural and special services are estimated separately based on the number of vehicles, percentage of overage vehicles and vehicle replacement costs.

Exhibit 7-1

Highway, Bridge and Transit Investment Requirement Projections Compared With Data from the 1999 C&P Report

STATISTIC	1998-2017 PROJECTION (BASED ON 1997 DATA): 1999 REPORT	1998-2017 PROJECTION (BASED ON 1997 DATA): ADJUSTED FOR INFLATION	2001-2020 PROJECTION (BASED ON 2000 DATA)
Average Annual Investment Requirements	**1997 $**	**2000 $**	**2000 $**
Cost to Improve			
Highways and Bridges	$94.0 bil	$104.8 bil	$106.9 bil
Transit	$16.0 bil	$16.8 bil	$20.6 bil
Cost to Maintain			
Highways and Bridges	$56.6 bil	$63.1 bil	$75.9 bil
Transit	$10.8 bil	$11.3 bil	$14.8 bil

Background information on the development of the future investment requirements estimates, and the motivation for using economic analysis as the basis for the estimates, is presented in the introduction to Part II. That section also discusses uncertainty in the investment requirement modeling process. More information on the methodology used to develop the investment projections, including recent changes to the methodology, is contained in Appendices A, B, and C.

Both the highway and transit analyses depend heavily on forecasts of future demand. Chapter 10 explores the effects that varying demand forecasts and some of the other key underlying assumptions in the highway and transit investment requirement analytical processes would have on the projections identified in Exhibit 7-1. Highway travel growth forecasts are also discussed in Chapter 9.

Highways and Bridges

The average annual **Cost to Improve** highways and bridges is projected to be $106.9 billion for 2001-2020. This figure represents an "investment ceiling" above which it would not be cost-beneficial to invest. Accounting for inflation (using the FHWA Construction Bid Price Index), this estimate is 2.0 percent greater than the Cost to Improve for 1998-2017 reported in the 1999 C&P report. The average annual **Cost to Maintain** highways and bridges is projected to be $75.9 billion for 2001-2020, which is 20.3 percent larger than the estimate in the 1999 C&P report for 1998-2017, again accounting for inflation. At this level of investment, future conditions and performance of the Nation's highway system would be maintained at a level sufficient to keep average highway user costs from rising above their 2000 levels.

Q. What is the Federal share of the highway and transit investment requirements identified in this report?

A. The investment requirements identified in this report represent the projected levels of total capital investment that would be necessary to obtain certain outcomes. The question of what portion should be funded by the Federal government, State governments, local governments, or the private sector is outside the scope of this report.

Chapter 6 includes information oh historic trends in public funding for highways and transit by different levels of government.

The changes in projected investment requirements from the 1999 report are due both to changes in the underlying characteristics, conditions, and performance of the highway system as reported in the available data sources, and to changes in the methodology and models used to generate the estimates. The Cost to Maintain scenario in this report incorporates a more ambitious goal of maintaining overall conditions and performance as measured by their impact on average highway user costs, while the values in the 1999 C&P report focused on maintaining the physical condition of the highway and bridge infrastructure. This change represents a return to the general approach used in earlier C&P reports.

While a Maintain User Costs figure derived from HERS was presented in the 1999 C&P report as a supplementary benchmark, it is not directly comparable to the value shown in this report. As described in Chapter 4, since the transmittal of the 1999 C&P report, new measures of congestion have been adopted in the annual FHWA performance plans that better quantify declines in the overall operational performance of the highway system. The HERS model has been modified in a comparable fashion, and is now equipped to consider delay due to incidents and the premium that travelers place on travel time reliability as part of its analysis of highway user costs. Factoring in these additional components of congestion into the analysis increases the level of investment required to stop user costs from rising. Further information on these methodological changes are presented later in this chapter, as well as in Appendix A.

The increase in the Cost to Improve highways and bridges relative to the last report is not unexpected. Capital investment by all levels of government between 1997 and 2000 remained below the Cost to Maintain level. Consequently, the overall performance of the system declined, which increased the number of potentially cost-beneficial highway and bridge investments that would address these performance problems.

The NBIAS was introduced in the 1999 C&P report, but this edition of the report is the first to use it as the primary model for estimating future investment requirements for bridge preservation. NBIAS includes a benefit cost screen in its evaluation of potential bridge improvements, which has the effect of reducing the bridge component of the Cost to Improve Highways and Bridges. However, NBIAS is also better at evaluating the condition of the subcomponents of the Nation's bridges, and in assessing the value of routine repair and rehabilitation of bridge elements as part of a comprehensive asset management approach to avoid costly replacements in the future. Consequently, it projects higher investment requirements to maintain the backlog of bridge deficiencies than the model it replaced. Further information on NBIAS is presented later in this chapter, as well as in Appendix B.

This chapter focuses on the estimated investment requirements for the Improve and Maintain scenarios noted in Exhibit 7-1. Chapter 9 includes an analysis of the projected impacts of these and other future investment levels on conditions and performance. Chapter 10 includes a sensitivity analysis, showing how the estimated investment requirements would change under different assumptions about the values of key model parameters. Appendices A and B include more discussion of the methodological changes in this report.

Transit

The average annual **Cost to Improve** both the physical condition of transit assets and transit operational performance to targeted levels by 2020 is estimated to be $20.6 billion in 2000 dollars, a 22.8 percent increase over the inflation adjusted amount reported for 1997 in the 1999 C&P report. The estimated average annual **Cost to Maintain** transit asset conditions and operating performance is estimated to be $14.8 billion, 30.7 percent higher than the 1997 amount. More than 90 percent of transit investment requirements will be in urban areas with populations of over 1 million, reflecting the fact that 90 percent of the Nation's passenger miles are currently in these areas.

These increased investment requirements reflect an enlarged transit infrastructure base and an increase in the absolute amount of overage transit infrastructure. They also reflect an updating of capital cost estimates for vehicles based on information that FTA maintains on the actual costs paid by transit operators for new vehicles. These costs are somewhat higher than those used to estimate investment requirements in the 1999 Report.

In the case of rail, a high proportion of fixed guideway elements, which account for slightly more 40 percent of the total value of the existing U.S. transit asset base, are currently not in acceptable condition. Rail systems (substations, overhead wire, and third rail), estimated to comprise about 10 percent of the value of the transit asset base, will also require significant investments. Although a large percentage of these rail systems is in adequate or better condition, they have an average useful life of around half that for other non-vehicle assets and require an accelerated replacement schedule. Rail facilities and stations will require the smallest levels of investment. The largest incremental investments needed to Maintain Performance through the expansion of the asset base will be for guideway elements and vehicles. To Improve Performance, significant investment will be required in system design and rights-of-way acquisition.

The purchase of vehicles accounts for the largest component of non-rail investment requirements. Guideway elements and facilities will also account for considerable proportions (20 percent each) of future non-rail asset expansion.

Highway and Bridge Investment Requirements

This section presents the projected investment requirements for highways and bridges for two primary performance targets. The **Cost to Maintain Highways and Bridges** represents the annual investment necessary to maintain the current level of highway system performance. The **Cost to Improve Highways and Bridges** identifies the level of investment that would be required to significantly improve system performance in an economically justifiable manner. The impacts of a wider range of alternative investment levels on various measures of system performance are shown in Chapter 9. Chapter 9 also explores recent trends in highway expenditures compared to recent changes in system performance.

The combined highway and bridge investment requirements are drawn from the separately estimated scenarios for highways and for bridges, and from external adjustments to the two models. These scenarios are defined differently, due to the different natures of the models used to develop them. However, it is useful to combine them in order to show combined investment. This is particularly helpful when trying to compare these scenarios to current or projected investment levels, since amounts commonly referred to as "total highway spending" or "total highway capital outlay," include expenditures for both highways and bridges. Chapter 8 compares current highway and bridge spending with the investment requirements outlined in this section.

The average annual investment required to **Improve Highways and Bridges** over the 20-year period 2001-2020 is projected to be **$106.9 billion** in 2000 dollars. The average annual **Cost to Maintain Highways and Bridges** is projected to be **$75.9 billion** (also in 2000 dollars).

Cost to Improve Highways and Bridges

The average annual Cost to Improve Highways and Bridges is broken down by functional class and type of improvement in Exhibit 7-2. The estimated investment requirements for urban arterials and collectors total $61.3 billion, or 57.3 percent of the total average annual Cost to Improve Highways and Bridges. Investment requirements on rural arterials and collectors are $23.8 billion or 22.3 percent of the total, while the investment requirements for rural and urban local roads and streets total $21.8 billion (20.4 percent).

The **Cost to Improve Highways and Bridges** scenario combines the **Maximum Economic Investment** scenario from the Highway Economic Requirements System (HERS) and the **Eliminate Deficiencies** scenario from National Bridge Investment Analysis System (NBIAS) with external adjustments to the two models.

Cost to Maintain Highways and Bridges

Exhibit 7-3 shows the average annual Cost to Maintain Highways and Bridges by type of improvement and functional class. The estimated investment requirements for urban arterials and collectors under this scenario total $43.2 billion, or 56.9 percent of the average annual Cost to Maintain Highways and Bridges. Investment requirements for rural arterials and collectors total $17.3 billion (22.7 percent), while the investment requirements for rural and urban local roads and streets total $15.5 billion (20.4 percent).

The **Cost to Maintain Highways and Bridges** scenario combines the **Maintain User Costs** scenario from HERS and the **Maintain Backlog** scenario from NBIAS with external adjustments to the two models.

Exhibit 7-2

Average Annual Investment Required to Improve Highways and Bridges, (Billions of 2000 Dollars)

FUNCTIONAL CLASS	SYSTEM PRESERVATION HIGHWAY	SYSTEM PRESERVATION BRIDGE	SYSTEM PRESERVATION TOTAL	SYSTEM EXPANSION	SYSTEM ENHANCEMENTS	TOTAL
Rural Arterials & Collectors						
Interstate	$3.0	$0.6	$3.6	$1.9	$0.4	$5.8
Other Principal Arterial	$3.2	$0.6	$3.8	$1.5	$0.6	$5.9
Minor Arterial	$2.8	$0.6	$3.4	$0.9	$0.5	$4.7
Major Collector	$3.3	$1.2	$4.6	$0.3	$0.4	$5.3
Minor Collector	$1.0	$0.6	$1.5	$0.4	$0.2	$2.1
Subtotal	**$13.3**	**$3.5**	**$16.8**	**$4.9**	**$2.1**	**$23.8**
Urban Arterials & Collectors						
Interstate	$5.5	$1.3	$6.8	$13.2	$1.2	$21.1
Other Freeway & Expressway	$2.2	$0.5	$2.7	$5.7	$0.5	$8.9
Other Principal Arterial	$4.0	$0.6	$4.6	$8.8	$1.5	$14.9
Minor Arterial	$3.2	$0.4	$3.6	$6.3	$1.0	$11.0
Collector	$2.2	$0.2	$2.4	$2.4	$0.5	$5.3
Subtotal	**$17.2**	**$3.0**	**$20.2**	**$36.4**	**$4.6**	**$61.3**
Subtotal Rural and Urban						
Rural and Urban Local	$8.6	$2.8	$11.5	$8.6	$1.7	$21.8
Total	**$39.1**	**$9.4**	**$48.5**	**$49.9**	**$8.4**	**$106.9**

Source: Highway Economic Requirements System and National Bridge Investment Analysis System.

Investment Requirements by Improvement Type

Exhibits 7-2 and 7-3 also show investment requirements by type of improvement. The investment requirements are classified into three categories: system preservation, system expansion, and system enhancement, which are defined in Chapter 6. System preservation, as defined in this report, consists of the *capital* investment required to preserve the condition of the pavement and bridge infrastructure. This includes the costs of resurfacing, rehabilitation, and reconstruction, but does not include routine maintenance costs. System expansion includes the costs related to increasing system capacity by widening existing facilities or adding new roads and bridges. System enhancements include safety enhancements, traffic operations improvements, and environmental improvements. Appendix A describes how the investment requirements modeled by HERS and NBIAS were allocated among the three types of improvements.

Exhibit 7-4 displays investment requirements by improvement type for rural and urban areas, for each scenario.

System Preservation

Average annual system preservation investment requirements are estimated to be $48.5 billion under the Cost to Improve scenario and $37.1 billion under the Cost to Maintain scenario. These totals comprise constitute 45.4 and 48.8 percent, respectively, of the totals for the two scenarios. Figures 7-2 and 7-3 also indicate that bridge preservation investments represent about one-fifth of total preservation investment requirements

Exhibit 7-3

Average Annual Investment Required to Maintain Highways and Bridges, (Billions of 2000 Dollars)

FUNCTIONAL CLASS	SYSTEM PRESERVATION HIGHWAY	BRIDGE	TOTAL	SYSTEM EXPANSION	SYSTEM ENHANCEMENTS	TOTAL
Rural Arterials & Collectors						
Interstate	$2.1	$0.5	$2.6	$1.6	$0.3	$4.5
Other Principal Arterial	$2.5	$0.5	$3.0	$0.9	$0.4	$4.3
Minor Arterial	$2.2	$0.5	$2.7	$0.3	$0.3	$3.3
Major Collector	$2.1	$1.0	$3.1	$0.2	$0.3	$3.6
Minor Collector	$0.7	$0.4	$1.1	$0.3	$0.2	$1.5
Subtotal	**$9.6**	**$2.9**	**$12.5**	**$3.3**	**$1.5**	**$17.3**
Urban Arterials & Collectors						
Interstate	$5.2	$1.0	$6.2	$11.3	$0.8	$18.4
Other Freeway & Expressway	$1.9	$0.4	$2.3	$4.2	$0.3	$6.8
Other Principal Arterial	$3.1	$0.5	$3.6	$4.0	$1.0	$8.7
Minor Arterial	$2.3	$0.4	$2.6	$2.8	$0.7	$6.1
Collector	$1.6	$0.2	$1.7	$1.1	$0.4	$3.2
Subtotal	**$14.0**	**$2.4**	**$16.4**	**$23.5**	**$3.3**	**$43.2**
Subtotal Rural and Urban						
Rural and Urban Local	$6.1	$2.0	$8.1	$6.1	$1.2	$15.5
Total	**$29.7**	**$7.3**	**$37.1**	**$32.9**	**$6.0**	**$75.9**

Source: Highway Economic Requirements System and National Bridge Investment Analysis System.

under each scenario. As shown in Exhibit 7-4, system preservation makes up a much larger share of total investment requirements in rural areas than in urban areas.

System Expansion

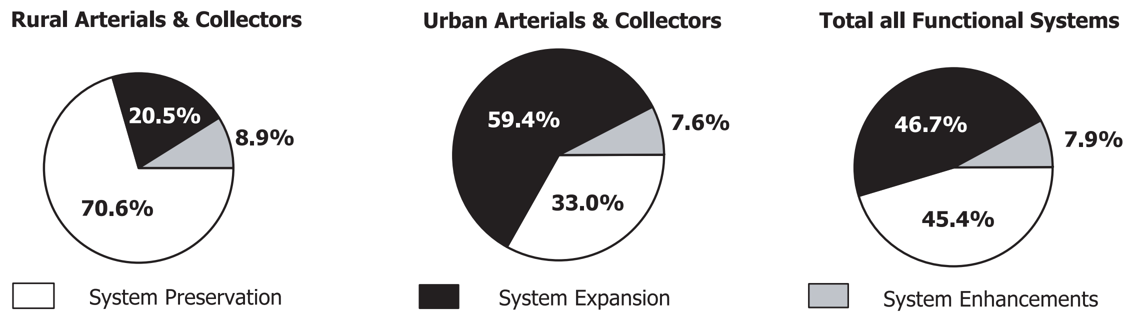
The $49.9 billion in average annual investment requirements for system expansion represent 46.7 percent of the total Cost to Improve Highways and Bridges. Comparable figures for the Cost to Maintain scenario are $32.9 billion and 43.3 percent. Exhibits 7-2 through 7-4 indicate that system expansion requirements are much larger in urban areas than in rural areas, both in the total amount and as a share of overall investment requirements, under both investment scenarios.

System Enhancements

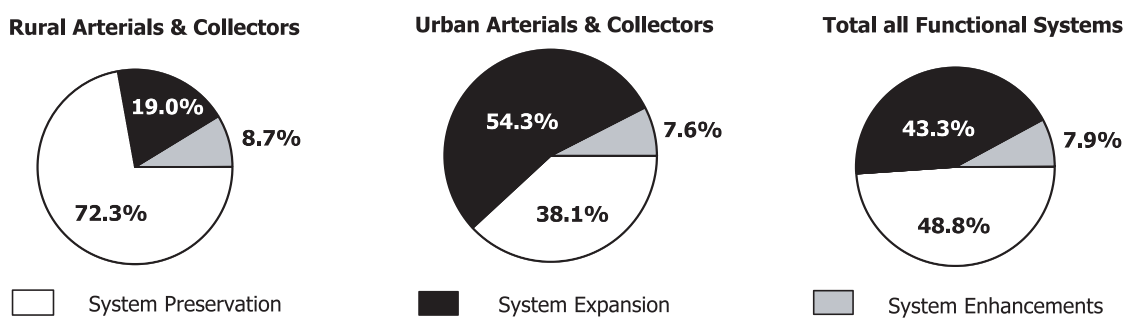
Investment requirements for system enhancements represent 7.9 percent of both the Cost to Improve Highways and Bridges ($8.4 billion) and the Cost to Maintain Highways and Bridges ($6.0 billion). Investment requirements for safety enhancements, traffic operation facilities, and environmental enhancements are not directly modeled, so this amount was derived solely from the external adjustment procedures described on the next page.

Exhibit 7-4

Cost to Improve Highways and Bridges, 2001-2020
Distribution by Improvement Type



Cost to Improve Highways and Bridges, 2001-2020
Distribution by Improvement Type



Source: Highway Economic Requirements System and National Bridge Investment Analysis System.

Q. Can highway capacity be expanded without adding new lanes or new roads and bridges?

A. Yes. In some cases, highway capacity can be increased more cost effectively by improving the utilization of the existing infrastructure. Consequently, a portion of the investment requirements identified for “System Expansion” could also be met through increased investment in types of “System Enhancements” that also increase capacity. Some of the potential strategies for increasing effective highway capacity, including intelligent transportation systems, are discussed in Chapter 21. A limited number of these strategies have been incorporated into the calculations made by HERS (See Appendix A). Procedures for evaluating additional strategies have been developed, but could not be incorporated in HERS in time for this edition of the C&P report.

The methodology used to estimate system expansion requirements also allows high cost capacity improvements to be considered as an option for segments with high volumes of projected future travel that have been coded by States as infeasible for conventional widening. Conceptually, such improvements might consist of new highways or bridges in the same corridor (or tunneling or double-decking on an existing alignment), but the capacity upgrades could also come through other transportation improvements, such as a parallel rail line, busway, or mixed-use high occupancy vehicle/transitway. See Appendix A for more on this feature.

Sources of the Highway and Bridge Investment Requirements Estimates

The estimates of investment requirements for highways and bridges under the Improve and Maintain scenarios were derived from three sources:

- Highway and bridge capacity expansion and highway preservation investments were modeled using HERS.
- Bridge preservation investments were modeled using the NBIAS.
- The HERS and NBIAS results were supplemented by external adjustments made to account for functional classes not included in the data sources used by the models, types of capital investment that are not currently modeled, and missing State data.

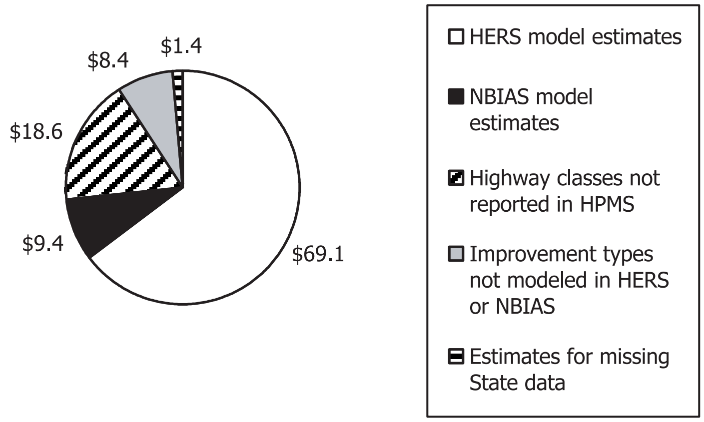
The model scenarios used in HERS and NBIAS to construct the Improve and Maintain scenarios are discussed in greater detail below. Exhibit 7-5 shows the sources of the highway and bridge investment requirements estimates.

The percentage of total investment requirements that are modeled in HERS is somewhat larger than was the case in the 1999 C&P report. The reason for this change is that investment requirements for new highway and bridge construction are now being directly modeled along with expansion of existing roadways, through the use of the high cost capacity improvements feature in HERS. This change is discussed in greater detail in Appendix A.

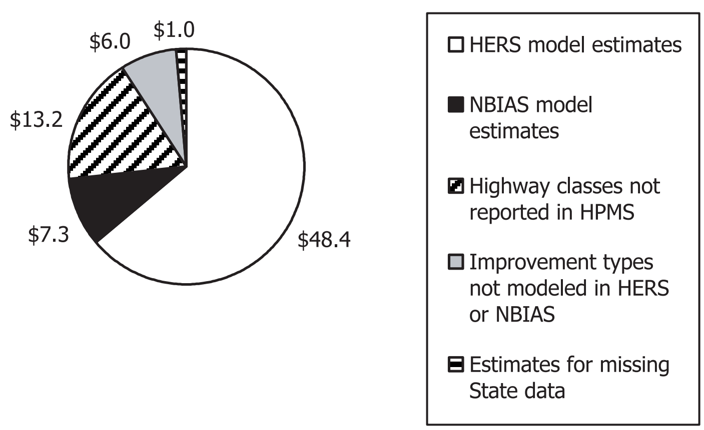
Exhibit 7-5

Sources of the Highway and Bridge Investment Requirements Estimates (Billions of 2000 Dollars)

Cost to Improve Highways and Bridges



Cost to Maintain Highways and Bridges



External Adjustments

External adjustments were made to the directly modeled improvements generated by HERS and NBIAS in two areas:

- Highway functional classes. Bridges on all functional classes are represented in the National Bridge Inventory (NBI) database used by NBIAS, so all of the investment requirements for bridge preservation shown in this report are derived directly from NBIAS. However, the

Highway Performance Monitoring System (HPMS) sample segment database used by HERS does not include rural minor collectors, rural local roads or urban local roads. Consequently, HERS does not provide estimates for these systems and separate estimates for highway preservation and system expansion were applied.

- Improvement types. The improvement options that HERS and NBIAS consider primarily address pavement and capacity deficiencies on existing highway and bridge sections. Currently, HERS and NBIAS do not directly consider system enhancements. Estimates for this improvement type were applied across all functional classes.

The adjustment procedures assume that the share of total highway investment requirements represented by these functional classes and improvement types would be equivalent to their share of current highway capital spending. The amounts derived from these external adjustments are identified separately in this report, since they would be expected to be less reliable than those derived from HERS and NBIAS.

Q. **Why does the analysis assume that the share of future highway investments for non-modeled items would remain the same?**

A. No data are currently available that would justify an assumption that this percentage would change. If this percentage of highway capital expenditures used for rural minor collectors, rural and urban local roads, and/or system enhancements were to rises in the future, then the investment requirements presented in this chapter would be understated. If this percentage falls over time, then the investment requirements shown would be overstated.

Adjustments for Missing State Data

A third adjustment was made to compensate for missing State data. The reliability of the investment requirement projections derived from the HERS model depends heavily on the accuracy of the HPMS sample data collected by States and reported annually to the FHWA. In some previous editions of this report, the HPMS data for certain States was not complete enough to be analyzed by HERS or its predecessor models, so some States were excluded from the analysis, and the national results were factored upward to compensate. Such procedures were not utilized in the production of the 1999 C&P report, as the data for all States was deemed sufficiently complete to be included in the analysis. This was possible in part because of major improvements to the HPMS software provided by the FHWA to the States. The software now includes a variety of new features to assist the States in improving the quality of their data submissions.

For this edition of the report, however, the data reported by one State in the 2000 HPMS did not include pavement condition data for those roads not under State jurisdiction. As a result, the HPMS data for that State did not represent a statistically valid sample of all roads within the State. Consequently, all 2000 HPMS sample data for that State were removed from the data used to run HERS for this report, and a separate analysis was conducted processing older HPMS data through HERS to derive an adjustment factor to supplement the results of the national analysis.

Highway Economic Requirements System (HERS)

The investment requirements shown in this report for highway preservation and highway and bridge capacity expansion are developed primarily from HERS, a simulation model that employs incremental benefit/cost analysis to evaluate highway improvements. The HERS analysis is based on data from the HPMS, which provides information on current roadway characteristics, conditions, and performance and anticipated future travel growth for a nationwide sample of more than 113,000 highway sections. While HERS analyzes these sample sections individually, the model is designed to provide results valid at the national level, and does not provide definitive improvement recommendations for individual highway segments.

HERS initiates the investment requirement analysis by evaluating the current state of the highway system using information on pavements, geometry, traffic volumes, vehicle mix, and other characteristics from the HPMS sample dataset. It then considers potential improvements on sections with one or more deficiencies, including resurfacing, reconstruction, alignment improvements, and widening or adding travel lanes. HERS then selects the improvement with the greatest net benefits, where benefits are defined as reductions in direct highway user costs, agency costs, and societal costs. In cases where none of the potential improvements produces benefits exceeding construction costs, the segment is not improved. Appendix A contains a fuller description of the project selection and implementation process used by HERS.

One of the key features of HERS as an economics-based model (introduced in the 1997 C&P report) involves its treatment of travel demand. Recognizing that drivers will respond to changes in the relative price of driving and adjust their behavior accordingly, HERS explicitly models the relationship between the amount of highway travel and the price of that travel. This concept, sometimes referred to as travel demand elasticity, is applied to the forecasts of future travel found in the HPMS sample data. HERS assumes that the forecasts for each sample highway segment represent a future in which average conditions and performance are maintained, thus holding highway-user costs at current levels. Any change in user costs relative to the initial conditions calculated by

Q. Does HERS identify a single "correct" level of highway investment?

A. No. HERS is a tool for estimating what the consequences may be of various levels of spending on highway conditions and performance. If funding were unlimited, it might make sense to implement all projects identified by HERS as cost-beneficial. In reality however, funding is constrained, and highways must compete for funding with other public sector priorities. The investment requirement scenarios in this chapter estimate the resources that would be required to attain certain levels of performance, but are not intended to endorse any specific level of funding as "correct."

Q. How closely does the HERS model simulate the actual project selection processes of State and local highway agencies?

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

HERS will thus have the effect of either inducing or suppressing future travel growth on each segment. Consequently, for any highway investment requirement scenario that results in a decline in average user costs, the effective VMT growth rate for the overall system will tend to be higher than the baseline rate derived from HPMS. For scenarios in which highway user costs increase, the effective VMT growth rate will tend to be lower than the baseline rate. A discussion of the impact that future investment levels could be expected to have on future travel growth is included in Chapter 9. Appendix A includes a further discussion of how travel demand elasticity is implemented in HERS, as well as recent changes in the elasticity procedures to account for traffic diversion and segment length.

While HERS was primarily designed to analyze highway segments, and the HERS outputs are described as "highway" investment requirements in this report, the model also factors in the costs of expanding bridges and other structures, when deciding whether to add lanes to a highway segment. All highway and bridge investment requirements related to capacity are modeled in HERS; the NBIAS model considers only investment requirements related to bridge preservation.

Highway Investment Backlog

The highway investment backlog represents all highway improvements that could be economically justified for immediate implementation, based on the current conditions and operational performance of the highway system. HERS estimates that a total of $271.7 billion of investment could be justified based solely on the current conditions and operational performance of the highway system. Approximately 82 percent of the backlog is in urban areas, with the remainder in rural areas. About 58 percent of the backlog relates to capacity deficiencies on existing highways; the remainder results from pavement deficiencies.

Note that this figure does not include rural minor collectors, or rural and urban local roads and streets, because HPMS does not contain sample section data for these functional systems. The backlog figure also does not contain any estimate for system enhancements. Appendix A explains how the backlog was calculated.

HERS Investment Scenarios

Two HERS investment scenarios were developed in order to generate the HERS-modeled portion of the two highway and bridge investment requirements scenarios. The HERS portion of the Cost to Improve Highways and Bridges was drawn from the HERS Maximum Economic Investment Scenario, and the HERS Maintain User Costs scenario fed into the Cost to Maintain Highways and Bridges. Exhibit 7-6 shows the estimated investment requirements under the two HERS scenarios. The impact of the various levels of investment on user costs and other indicators of highway condition and performance is presented in Chapter 9.

Q. How is the HERS model used to produce investment requirements estimates for the various funding scenarios?

A. The HERS model selects projects on the basis of their benefits and costs as calculated within the model. HERS can thus assign a benefit-cost ratio (BCR) to each selected improvement. The total investment over the 20-year forecast horizon is then estimated by establishing a minimum BCR for all improvements implemented in a given model run. By varying the minimum BCR in different HERS runs and examining the output for different indicators, the user can then determine the level of investment that will achieve certain levels of condition and performance. It is important to note that these estimates represent the economically efficient levels of investment that would meet the targets, rather than the minimum amount of investment necessary to meet the same criteria.

Exhibit 7-6

HERS Investment Requirements Scenarios 2001-2020 (Billions of 2000 Dollars)

SCENARIO/BENCHMARK	AVERAGE ANNUAL INVESTMENT REQUIRED TOTAL	HERS-MODELED
Maximum Economic Investment	$106.9	$69.1
Maintain User Costs	$75.9	$48.4

The **Maximum Economic Investment** scenario is of interest mainly because it defines the upper limit of highway investment that could be economically justified. It was used to generate the highway preservation and system capacity expansion components of the **Cost to Improve Highways and Bridges**. In this scenario, all improvements with a benefit-cost ratio greater than or equal to 1.0 are implemented in HERS. While this scenario does not target any particular level of desired system performance, it would eliminate the existing highway investment backlog and address other deficiencies that will develop over the next 20 years due to pavement deterioration and travel growth. As shown in Exhibit 7-6, the average annual investment modeled by the HERS Maximum Economic scenario is $69.1 billion.

Q. Why was the Highway Maintain User Costs scenario used to estimate the Cost to Maintain Highways and Bridges, rather than the Highway Maintain Conditions scenario, which was used in the 1999 C&P report?

A. The change was made for several reasons. The first relates to the use of the NBIAS model for bridge investment requirements estimates in this report. The investment estimates produced by this model, which is more economics-based than previous bridge investment models, are more comparable to the highway scenarios and benchmarks based on economic indicators. Second, the Maintain User Costs scenario is more in line with the concept of maintaining both conditions and performance, as in the baseline Maintain scenario for transit investment outlined in this chapter. The Maintain User Costs scenario is also more consistent with the Cost to Maintain scenarios used in C&P reports up to 1997. Third, the definition of user costs has been improved to include delay due to incidents and the premium that travelers place on travel time reliability. Finally, the user cost concept has found increasing acceptance within the transportation community in recent years as a measure of conditions and performance from the vantage of system users, as was reflected in the feedback received at outreach sessions conducted after the release of the 1999 C&P report.

The second major highway investment requirement scenario in this report is the **Maintain User Costs** scenario. It was used to generate the highway preservation and system capacity expansion components of the **Cost to Maintain Highways and Bridges**. This scenario gives the level of investment sufficient to allow total highway user costs per vehicle miles traveled (VMT) at the end of the 20-year analysis period to match the baseline levels. Highway user costs include travel time costs, vehicle operating costs, and crash costs. The average annual investment modeled by HERS under this scenario is estimated to be $48.4 billion.

The **Maintain User Costs** concept was introduced in the 1997 C&P report to provide a new highway system performance benchmark based on economic criteria. It focuses on highway users, rather than the traditional engineering-based criteria, which are oriented more toward highway agencies. This scenario is also an important technical point in the operation of HERS, since the VMT growth rates in the model are partly dependent on changes in user costs, due to the operation of the travel demand elasticity feature.

The impact on individual highway user cost components at this and other levels of investment are discussed in Chapter 9.

National Bridge Investment Analysis System (NBIAS)

The bridge investment requirements shown in this report are derived primarily from the NBIAS, which is summarized in this section. Appendix B provides a more comprehensive look at this approach. Although NBIAS was introduced in the 1999 C&P report, this edition is the first to use it as the primary model for estimating future investment requirements for bridge preservation.

NBIAS is the latest in a series of bridge models used by the FHWA and its partners. It replaces the Bridge Needs and Investment Process (BNIP) model, which estimated bridge investment requirements for the 1999 C&P report. Like BNIP, NBIAS is based on data from the NBI, which provides information on the characteristics and conditions of more than 525,000 bridges in the United States.

The internal logic of NBIAS is derived from the PONTIS Bridge Management System. PONTIS is licensed by the American Association of State Highway and Transportation Officials to 45 State departments of transportation. Because this approach relies on having element-level condition data, which is not currently contained in the NBI, NBIAS begins its analysis by synthesizing element condition data from the general bridge condition ratings that are available. NBIAS considers individual bridges for improvement and replacement needs, but the current version of the model analyzes maintenance, repair, and rehabilitation (MR&R) needs on an aggregate level, rather than looking at individual bridges.

NBIAS improves upon BNIP in several ways. NBIAS includes a benefit/cost screen, which filters out improvements that are not cost-beneficial within the 20-year funding horizon. NBIAS is also more accurate in evaluating bridge subcomponents and determining the value of routine repair and rehabilitation of bridge elements. Finally, NBIAS provides estimates that are more reflective of the way State and local transportation agencies undertake bridge management strategies.

Q. How does NBIAS aggregate bridge data?

A. Aggregation of bridge data is a prerequisite for NBIAS analysis. Instead of managing individual bridges, NBIAS groups them into a number of cells. Each cell represents a group of bridges with common modeling characteristics. The common characteristics are called strata, and the process of grouping the bridges is known as stratification. NBIAS considers four main stratification dimensions for a bridge: its functional system; whether it is part of the National Highway System; average daily traffic (ADT); and climate zone. There are 13 functional systems, two NHS categories, five ADT classes, and four climate zones, producing 520 cells of bridges with common modeling characteristics.

Bridge Investment Backlog

As defined in this report, the bridge investment backlog represents the cost of improving all existing bridge deficiencies, if the benefits of doing so exceed the costs. NBIAS, like BNIP, defines deficiencies broadly, and covers more than the structurally deficient and functionally obsolete categories defined in Chapter 3. NBIAS estimates that $54.7 billion of investment could be invested immediately in a cost-beneficial fashion to replace or otherwise address currently existing bridge deficiencies.

The $54.7 billion bridge investment backlog is substantially lower than the $87.3 billion backlog reported in the 1999 C&P. This is due to the use of benefit/cost analysis in the NBIAS model. NBIAS determines that the optimal time to address some bridge deficiencies may not be in the first year of a 20-year planning horizon; instead, improvements or replacements may be made at other points of the planning period. This is more consistent with the real world experiences of State and local transportation agencies, which deal with bridge deficiencies over a multi-year planning period.

Bridge Investment Requirements Scenarios

While modeling techniques have changed from the BNIP to NBIAS models, the investment requirements scenarios are defined similarly. Two scenarios are examined: the **Eliminate Deficiencies** and **Maintain Backlog** scenarios. The results are described in Exhibit 7-7.

The Eliminate Deficiencies scenario is the bridge component of the Cost to Improve Highways and Bridges described earlier in this chapter. Where it is cost-beneficial to do so, the Eliminate Deficiencies scenario would eliminate the existing bridge investment backlog and correct other deficiencies that are expected to develop over the next 20 years. **The average annual investment required under this scenario is estimated to be $9.4 billion**, which is 8.8 percent of the $106.9 billion average annual investment required to improve highways and bridges over a 20-year period.

The Maintain Backlog scenario is the bridge component of the Cost to Maintain Highways and Bridges. The Maintain Backlog scenario identifies the level of annual investment that would be required so that the bridge investment backlog would not increase above its current level. Existing deficiencies and newly accruing deficiencies would be selectively corrected to minimize the investment required to maintain the same backlog of deficient bridges in 2020 that exists in 2000. **The average annual investment required under this scenario is estimated at $7.3 billion**, or 9.7 percent of the $75.3 billion average annual investment required to maintain highways and bridges over a 20-year period.

Exhibit 7-7

NBIAS Investment Requirements Scenarios 2001-2020 (Billions of 2000 Dollars)

	AVERAGE ANNUAL INVESTMENT REQUIRED	
SCENARIO/BENCHMARK	TOTAL	NBIAS-MODELED
Eliminate Deficiencies	$106.9	$9.4
Maintain Backlog	$75.9	$7.3

Q. How do the 1999 NBIAS estimates compare with the BNIP estimates in the 1999 Conditions and Performance Report?

A. NBIAS estimates higher investment requirements to maintain the backlog than does BNIP, but projects lower investment requirements to eliminate all deficiencies. To avoid costly replacements in the future, NBIAS recommends more investment in repair and rehabilitation. This is consistent with a sound bridge management and asset management strategy.

BNIP estimated that the average annual investment required under the Eliminate Deficiencies scenario between 1998 and 2017 would be $10.6 billion. For the same scenario, NBIAS estimates a $9.4 billion average annual investment between 2001 and 2020. Approximately $0.5 billion is the result of a reduction in the number of deficient bridges that has occurred since 1997. The rest is due to the application of a cost/benefit analysis. Some bridge improvements are not cost-beneficial within the 20-year funding horizon. This is an improved, more realistic way to model the way governments make bridge investments.

For the Maintain Backlog scenario, BNIP estimated an average annual investment of $5.8 billion between 1998 and 2017. For the same scenario, NBIAS estimates a $7.3 billion average annual investment between 2001 and 2020. NBIAS does a better job of identifying repair and rehabilitation actions that will become increasingly necessary as the average age of the Nation's bridges increases.

Transit Investment Requirements

The Federal Transit Administration (FTA) uses the Transit Economic Requirements Model (TERM), based on engineering and economic concepts, to estimate future transit capital investment. TERM was developed to improve the quality of estimates of future transit capital funding needs. The 1997 Conditions and Performance Report was the first in this series to report investment requirements based on TERM. For this report, TERM was used to project the dollar amount of capital investment that will be required by the transit sector in order to meet various asset condition and operational performance goals by 2020. These capital investment requirements estimates are based on the condition estimation process and results provided in Chapter 3, ridership growth projections, and data from the National Transit Database (NTD) on the existing transit asset base, (e.g., number of vehicles and stations) and operating statistics, (e.g. operating speed). Estimated requirements are presented on an average annual basis, though as calculated by TERM, they fluctuate from year to year. All investments identified by TERM are subject to a benefit-cost test, requiring that all investments incorporated in the model have a benefit-cost ratio that is greater than 1. (A technical description of TERM is provided in Appendix C.)

TERM projects transit capital investment requirements for the four following investment scenarios:

- **Maintain Asset Conditions**
  Transit assets are replaced and rehabilitated over the 20-year period such that the average condition of the assets existing at the beginning of the period remains the same at the end of the period.

- **Maintain Performance**
  New transit vehicles and infrastructure investments are undertaken to accommodate increases in transit ridership so that the vehicle utilization rate existing at the beginning of the period remains the same at the end of the period. Ridership growth estimates are obtained from Metropolitan Planning Organizations (MPOs).

- **Improve Conditions**
  Transit asset rehabilitation and replacement is accelerated to improve the average condition of each asset type to a least a "good" level at the end of the 20-year period (2020).

- **Improve Performance**
  The performance of the Nation's transit system is improved as additional investments are undertaken in urbanized areas with the most crowded vehicles and slowest systems to reduce vehicle utilization rates (and crowding) and increase average transit operating speeds.

Investment Requirements

Exhibit 7-8 provides estimates of the total annual capital investment that will be necessary to meet the four investment scenarios. These estimates combine those calculated by TERM with FTA staff estimates of rural and special service investment requirements. Annual transit investment requirements, at a minimum, are estimated to be $14.8 billion to Maintain the Conditions and Performance of the Nation's transit systems at their 2000 level, assuming an average annual increase in transit ridership of 1.6 percent. To improve the average condition level of transit assets to "good" by 2020, as well to Improve Performance by increasing transit speeds and reducing occupancy rates to threshold levels, would require an additional $5.8 billion per year for a total average annual capital investment of $20.6 billion.

As shown in Exhibit 7-9, replacement and rehabilitation costs are estimated to be $9.2 billion to Maintain Conditions and Performance, and $10.3 billion to Improve Conditions and Performance. Asset expansion costs needed to meet the projected 1.6 percent average annual increase in ridership growth are estimated to be $5.6 billion if conditions are maintained and $5.7 billion if conditions are improved to a "good" level. The incremental $1.1 billion needed for asset rehabilitation and replacement under the Improve Conditions scenario results from the extra investment that will be required to rehabilitate and replace additional asset purchases. The expenditures needed to Improve Performance are estimated to be $4.6 billion annually.

Exhibit 7-8

Summary of Average Annual Transit Investment Requirements, 2001-2020 (Billions of 2000 Dollars)

CONDITIONS	PERFORMANCE	AVERAGE ANNUAL COST
Maintain	Maintain	$14.8
Improve	Maintain	$16.0
Maintain	Improve	$19.5
Improve	Improve	$20.6

Source: Transit Economic Requirements Model and FTA staff estimates.

Exhibit 7-9

Average Annual Transit Investment Requirements by Type of Improvement (Billions of 2000 Dollars)

TYPE OF IMPROVEMENT	MAINTAIN CONDITIONS & PERFORMANCE	IMPROVE CONDITIONS & MAINTAIN PERFORMANCE	MAINTAIN CONDITIONS & IMPROVE PERFORMANCE	IMPROVE CONDITIONS & PERFORMANCE
Replacement and Rehabilitation	$9.2	$10.3	$9.2	$10.3
Asset Expansion	$5.6	$5.7	$5.7	$5.7
Performance Improvements			$4.6	$4.6
Total	**$14.8**	**$16.0**	**$19.5**	**$20.6**

Source: Transit Economic Requirements Model and FTA staff estimates.

Average Annual Costs to Maintain and Improve Conditions and Performance

Exhibit 7-10 provides a detailed breakdown of transit investment requirements by TERM scenario and area population size. More than 90 percent of transit investment will be required in urban areas with populations of over 1 million, reflecting the fact that 90 percent of the Nation's passenger miles are currently in these areas. It is estimated that an average of $13.4 billion would be needed annually to Maintain Conditions and Performance of transit assets in these large urban areas and $18.1 billion annually to Improve Conditions and Performance. The needs of less populated areas, i.e., those with populations under 1 million, are estimated to be considerably lower because they currently have fewer transit assets. It is estimated that $1.4 billion would be needed annually to Maintain Conditions and Performance of the transit infrastructure in these areas and $2.5 billion to improve them.

Exhibit 7-10

Transit Infrastructure
Annual Average Cost To Maintain and Conditions and Performance, 2001-2020
(Millions of 2000 Dollars)

MODE, PURPOSE & ASSET TYPE		COST TO MAINTAIN CONDITIONS & PERFORMANCE	INCREMENTAL COSTS TO IMPROVE CONDITIONS	INCREMENTAL COST TO IMPROVE PERFORMANCE	COSTS TO IMPROVE CONDITIONS & PERFORMANCE
Areas Over 1 Million in Population					
Non-rail (*)					
Replacement & Rehabilitation	(Vehicles)	$1,421	$471		$1,892
	(Non-Vehicles) (**)	781	0		781
Asset Expansion	(Vehicles)	585	12		598
	(Non-Vehicles)	990	0		990
Improve Performance	(Vehicles)			286	286
	(Non-Vehicles) (**)			345	345
Special Service(***)	(Vehicles)	27	14		41
Subtotal Non-rail		**3,804**	**497**	**631**	**4,933**
Rail					
Replacement & Rehabilitation	(Vehicles)	2,044	-122		1,923
	(Non-Vehicles) (**)	3,810	293		4,103
Asset Expansion	(Vehicles)	1,007	0		1,007
	(Non-Vehicles) (**)	2,785	0		2,785
Improve Performance	(Vehicles)			317	317
	(Non-Vehicles) (**)			3,038	3,038
Subtotal Rail		**9,646**	**171**	**3,355**	**13,171**
Total Areas Over 1 Million		**13,450**	**668**	**3,986**	**18,104**
Areas Under 1 Million in Population					
Non-rail (*)					
Replacement & Rehabilitation	(Vehicles)	517	188		705
	(Non-Vehicles) (**)	194	0		194
Fleet Expansion	(Vehicles)	174	3		177
	(Non-Vehicles) (**)	82	0		82
Improve Performance	(Vehicles)			120	120
	(Non-Vehicles) (**)			71	71
Special Service (***)	(Vehicles)	151	82		233
Rural	(Vehicles)	237	207	315	758
	(Non-Vehicles) (**)	4	9	11	24
Subtotal Non-rail		**1,359**	**489**	**517**	**2,364**
Rail					
Replacement & Rehabilitation	(Vehicles)	5	3		8
	(Non-Vehicles) (**)	6	0		6
Fleet Expansion	(Vehicles)	4		0	4
	(Non-Vehicles) (**)	17		0	17
Improve Performance	(Vehicles)			10	10
	(Non-Vehicles) (**)			102	102
Subtotal Rail		**32**	**3**	**112**	148
Total Areas Under 1 Million		**1,391**	**492**	**629**	**2,512**
Total		**14,841**	**1,160**	**4,615**	**20,616**

(*) Buses, vans and other (including ferry boats.)
(**) Non-vehicles comprise guideway elements, facilities, systems and stations.
(***) Vehicles to serve the elderly and disabled.

Source: Transit Economic Requirements Model and FTA staff estimates.

Non-rail Needs in Urban Areas with Populations over 1 Million—The cost of maintaining the conditions of the non-rail infrastructure (buses, vans, and ferryboats) in urban areas with populations over 1 million is much lower than the cost of maintaining the rail infrastructure. About 30 percent of the total transit investment requirement in these areas, or about $3.8 billion annually, would be needed to maintain this infrastructure's conditions and performance. Fifty-eight percent, or $2.2 billion annually, would be needed to rehabilitate and replace assets to Maintain Conditions and 42 percent, or $1.6 billion, to purchase new assets in order to Maintain Performance. It is estimated that sixty-five percent of rehabilitation and replacement expenditures would be for vehicles, while asset expansion would be geared more heavily toward non-vehicles. The incremental costs to improve non-rail conditions are estimated to be $497 million annually, of which $471 million, would be needed for vehicle rehabilitation and replacement. The incremental costs to Improve Performance are estimated to be $631 million annually, of which 45 percent, or $286 million, would be spent on new vehicles (principally buses) and 55 percent, or $345 million, on new non-vehicle assets. Expenditures on non-vehicle assets include investments for the purchase or construction of dedicated highway lanes for Bus Rapid Transit. A total of $4.9 billion would be needed on an average annual basis to Improve both Conditions and Performance.

Rail Needs in Urban Areas with Populations over 1 Million—About 70 percent of the total transit investment requirements of large urban areas, or about $9.6 billion annually, would be needed to Maintain Conditions and Performance of the rail infrastructure. Sixty-one percent, or $5.9 billion annually, would be required to rehabilitate and replace assets to Maintain Conditions, and 39 percent, or $3.8 billion, for asset expansion, i.e., to purchase new assets to Maintain Performance as ridership increases. Sixty-six percent of the investments to rehabilitate and replace existing assets and 75 percent of the investment to acquire new assets would be for non-vehicles. The incremental cost to improve rail asset conditions so that they achieve an average condition rating of "good" by 2020 is estimated to be $171 million annually. This $171 million results from an incremental increase of $293 million for non-vehicle asset rehabilitation and replacement coupled with an incremental decrease of $122 million in vehicle rehabilitation and replacement. Vehicle rehabilitation and replacement expenditures are reduced under this scenario since vehicles are replaced earlier in their useful life leading to a reduction in rehabilitation expenses. The incremental costs to Improve Performance of these rail systems are estimated to be $3.4 million annually, including the cost of purchasing rights-of-way. Ninety percent, or $3.0 billion, of this would be needed to expand the non-vehicle rail infrastructure. This split between vehicle and non-vehicle investment for performance improvement is typical for new heavy and light rail infrastructure development projects. A total of $13.2 billion would be needed on an average annual basis to Improve both Conditions and Performance of rail in these areas.

Non-rail Needs in Areas with Populations of Under 1 Million—Over 95 percent of the transit investment requirements in areas with populations under 1 million is projected to be for non-rail transit. The annual cost to Maintain Conditions and Performance of the non-rail transit infrastructure in these areas is estimated to be $1.4 billion. The incremental investment required to Improve non-rail conditions, is estimated to be $489 million annually, with the bulk to be spent for vehicle acquisitions. Of the $517 million incremental annual investment to Improve Performance 84 percent, or $435 million, would need to be invested in acquiring new vehicles and 16 percent or $82 million would need to be invested in the new non-vehicle infrastructure. Sixty-three percent of investment required to Improve Performance stems from the lack of coverage by rural transit systems and unmet rural transit needs. The total amount needed to Improve both Conditions and Performance of non-rail transit in these areas is estimated to be $2.4 billion annually.

Rail Needs in Areas with Populations of Under 1 Million—Rail needs in these less populated areas are minimal because only three light-rail systems currently operate in them. An estimated $32 million annually would be needed to Maintain Conditions and Performance. An additional $3 million would be required to Improve Conditions by increasing the rate at which old vehicles are replaced with new vehicles. The additional $112 million to Improve Performance will be principally for expansions of light rail. Of this amount, $10 million is estimated to be needed to purchase vehicles and $102 million to purchase non-vehicle assets—reasonably in line with the industry rule-of-thumb that light rail projects typically have a ratio of vehicle-to-total-system costs of about 11 percent. A total of $148 million would be required to Improve both Conditions and Performance of rail in rural areas.

Q. Why have estimated requirements for rural areas increased so significantly since the last C&P Report?

A. Investment requirements in rural areas have been reevaluated to take into account their lack of transit coverage. This lack of coverage was most recently documented in a 1994 survey of rural systems undertaken by the Community Transportation Association of America (CTAA), but estimates of the unmet requirements were not included in the 1999 C&P Report. (The most recent CTAA survey in 2000 did not resurvey rural system coverage.) Although the number of rural transit vehicles increased at an average annual rate of 7.8 percent between 1994-2000 and the population in areas of less than 50,000 inhabitants decreased by 3.4 percent between 1990-2000, there are still believed to be significant unmet rural transit needs. Recent surveys of rural transit needs in five states—Minnesota, Montana, North Carolina, Vermont and West Virginia—identified considerable unmet requirements within these states. The investment requirements estimates presented here assume an annual rural vehicle growth rate of 3.5 percent.

Average Annual Investment Requirements by Detailed Asset Type

Exhibit 7-11 provides disaggregated annual investment requirements for rail and non-rail transportation modes by asset type for:

- asset replacement and rehabilitation,
- asset expansion, and
- performance improvement.

Assets are disaggregated into 5 categories—facilities, guideway elements, stations, systems, and vehicles. The annual funding requirements for supporting services are provided under "other project costs." These include expenditures for administrative services and vehicles used for administrative or security purposes. The annual investment needed to design rail new systems and acquire rights-of-way to support new rail investments are reported under the Improve Performance scenario.

Rail—More than 40 percent of rail rehabilitation and replacement investment, both in the Maintain Conditions and Improve Conditions scenarios, is estimated to be required for investment in guideway elements, including elevated structures, systems structures, and track. Investment required to Maintain guideway conditions is estimated to be $2.3 billion annually, and to Improve guideway conditions, $2.6 billion annually. Guideway elements are estimated to account for slightly more than 40 percent of the total value of the existing U.S. transit asset base. Twenty-four percent of elevated structures, 23 percent of underground tunnels, and 17 percent of rail track are in less than-adequate condition (below condition level 3).

Exhibit 7-11

Transit Infrastructure
Average Annual Investment Requirements by Asset Type, 2001-2020
(Millions of 2000 Dollars)

MAINTAIN CONDITIONS AND PERFORMANCE

ASSET TYPE	REHABILITATION AND REPLACEMENT	ASSET EXPANSION	IMPROVE PERFORMANCE	TOTAL
Rail				
Guideway Elements	$2,318	$1,427		$3,746
Facilities	111	123		235
Systems	1,007	231		1,239
Stations	379	313		692
Vehicles	2,049	1,011		3,060
Other Project Costs		707		707
Subtotal Rail	**5,865**	**3,813**		**9,678**
Non-Rail				
Guideway Elements	11	342		353
Facilities	802	325		1,127
Systems	145	62		207
Stations	21	141		162
Vehicles	2,352	759		3,111
Other Project Costs	0	203		203
Subtotal Non-Rail	**3,331**	**1,832**		**5,163**
Total Maintain Conditions	**9,196**	**5,645**		**14,841**

IMPROVE CONDITIONS AND PERFORMANCE

ASSET TYPE	REHABILITATION AND REPLACEMENT	ASSET EXPANSION	IMPROVE PERFORMANCE	TOTAL
Rail				
Guideway Elements	2,607	1,427	768	4,802
Facilities	111	123	59	294
Systems	1,012	231	120	1,363
Stations	379	313	289	981
Vehicles	1,930	1,011	327	3,269
Other Project Costs		707	614	1,321
System Design and Right-of-Way Acquisition			1,290	1,290
Subtotal Rail	**6,039**	**3,813**	**3,467**	**13,319**
Non-Rail				
Guideway Elements	11	342	107	460
Facilities	802	333	258	1,393
Systems	145	62	2	209
Stations	21	141	37	199
Vehicles	3,314	774	721	4,809
Other Project Costs	0	203	24	227
Subtotal Non-Rail	**4,293**	**1,855**	**1,149**	**7,297**
Total Improve Conditions	**10,332**	**5,668**	**4,616**	**20,616**

Source: Transit Economic Requirements Model and FTA staff estimates.

More than 32 percent of total rail rehabilitation and replacement investment will be needed for vehicles—$2.0 billion annually to Maintain vehicle conditions and $2.9 billion annually to Improve vehicle conditions.

Rail systems (substations, overhead wire, and third rail), estimated to comprise about 10 percent of the value of the transit asset base, would also require investments—$1.0 billion annually, or 17 percent of total rail infrastructure investment needs. Although many of these systems are in adequate or better condition (level 3 or above), they have an average useful life of around half that for other non-vehicle assets and have a more accelerated replacement schedule.

Facilities and stations would require the smallest levels of investment. Although 36 percent of facilities and 16 percent of stations are in less than adequate conditions, they have longer average replacement ages and comprise a relatively smaller proportion of the total rail infrastructure base (about 10 percent each).

The largest incremental investments needed to Maintain Performance through the expansion of the asset base would be for guideway elements ($1.4 billion annually) and vehicles ($1.0 billion annually). To Improve Performance $1.3 billion annually is estimated to be required for system design and rights-of-way acquisition.

Non-rail—Vehicles account for the largest component of non-rail investment requirements. The bulk (70 to 75 percent) of non-rail rehabilitation and replacement expenditures would be for vehicles—$2.4 billion annually to Maintain Conditions and $3.3 billion annually to Improve Conditions. Vehicles are also estimated to account for the largest proportion (about 40 percent) of non-rail asset expansion investments, at about $800 million under both the Maintain and Improve scenarios. Guideway elements and facilities would also account for considerable proportions (20 percent each) of future non-rail asset expansion—$342 million annually for guideways and $333 million annually for facilities. About 62 percent of the expenditures required for performance improvement would be for vehicles ($721 million annually), 22 percent for facilities ($258 million annually), and 9 percent for guideway elements ($107 million annually).

Existing Deficiencies in the Transit Infrastructure

TERM estimates the amount of investment that would be required in order to correct existing deficiencies in the Nation's transit infrastructure. This deficiency may also be referred to as the transit investment "backlog" similar to the backlog requirement calculated by HERS. TERM corrects infrastructure deficiencies by replacing all assets with conditions below the specified replacement level. These expenditures are averaged

Q. **Could U.S. Federal Lands benefit from additional investment in transit?**

A. A recent study of transportation alternatives on Federal Lands managed by the Interior Department identified transit investment requirements of $1.71 billion in 1999 constant dollars over the period 2001-2020, which converts to about $1.75 billion in 2000 dollars. The largest investments will be required by the National Park Service ($1,554 million) with considerably smaller amounts required by the U.S. Fish and Wildlife Service ($126 million) and the Bureau of Land Management ($30). (In 2000 dollars these estimated investment requirements are $1,586 million, $129 million and $31 million, respectively.) These investment requirements, which have been estimated outside the TERM framework and which have not explicitly been included in the estimates of transit investment requirements presented in this chapter, are discussed in more detail in Chapter 27.

over the 20-year investment period. *[See Appendix C]*. TERM estimates that the $16.4 billion would be needed to correct all existing deficiencies under the Maintain Conditions scenario and $30.7 billion under the Improve Conditions scenario**.** These numbers do not include the costs of correcting for deficiencies in rural or special service transit services.