Commission Briefing Paper 3C-01

2006 C&P Findings: Future Highway Investment Needs

Prepared by: Section 1909 Commission Staff
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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper summarizes key findings of the 2006 C&P report on future highway investment needs, showing projected impact of a range of alternative future funding levels on a variety of indicators of future highway system conditions and performance. This paper consolidates information previously provided to the Commission in other forms, plus additional supplementary information. This analysis addresses investment on the Federal-aid Highway System, and other public roads.

Background and Key Findings

The findings presented in this paper are extracted from the 2006 *Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance* Report to Congress. The investment analyses are based on data from 2004. Key findings include:

- If highway capital expenditures were maintained at 2004 levels through 2024, rising only with inflation, average highway user costs would be projected to increase; average pavement condition would decline slightly; and the operational performance of the system would decline significantly.

- At the Maximum Economic Investment level (the maximum average annual level of investment that could be utilized while still investing only in cost-beneficial highway improvements over 20 years) significant improvements would be made in both the physical condition of the infrastructure and in many measures of operational performance.

- Current expenditure levels for bridge rehabilitation and replacement are at a level sufficient to reduce the current backlog of cost-beneficial bridge investments, but below the level that would be needed to eliminate this backlog by 2024.

- Approximately 64 percent of the investment at the Maximum Economic Investment level would be on urban arterials and collectors, with the remainder on local roads and other rural roads. As suggested by the models, over two-thirds of the investment in rural areas

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would be for system rehabilitation, while the majority of investment in urban areas would be for system expansion.

Defining Investment "Needs"

There is no absolute definition of what constitutes an investment "need". In general, "needs" simply represent the level of investment that would be required to reach a particular goal. Such goals can be defined in either performance terms or economic terms based on benefit-cost analysis. In this context, the definition of a need becomes somewhat subjective, as it first requires the choice of a particular performance target.

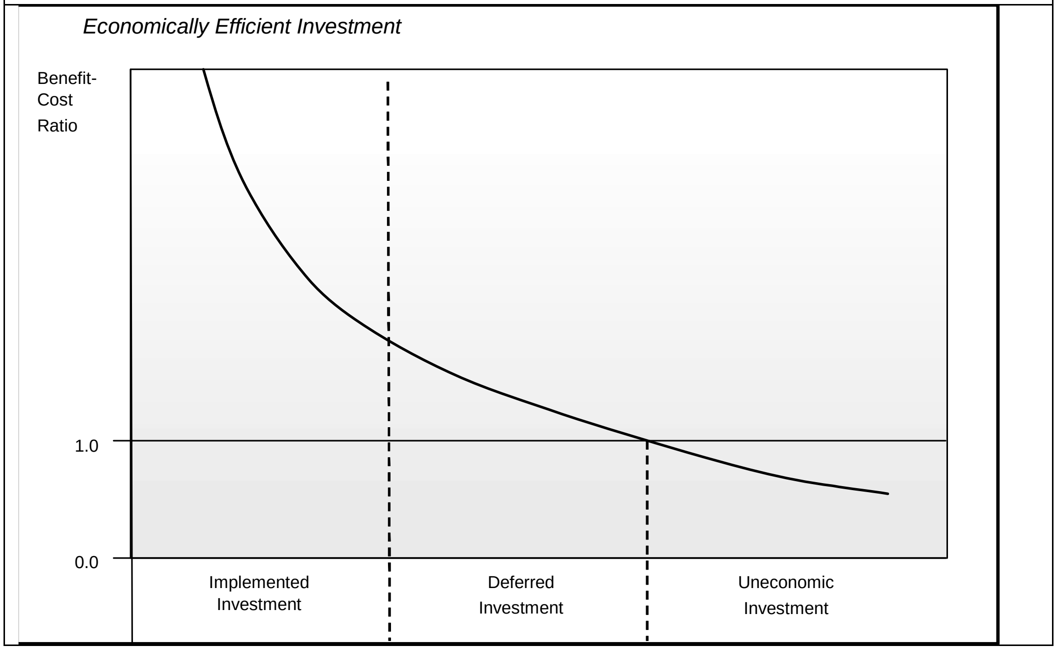
The current legislative requirements for an "Infrastructure Investment Needs Report" in Title 23 (and the comparable requirements for this type of report in the past) do not define exactly what a "need" is. Traditionally, this requirement has been met by presenting the results for two basic scenarios: one that would maintain conditions and performance at current levels, and one that would improve conditions and performance. The report does not endorse either of these scenarios as a target level of funding, nor does it make any recommendations concerning future levels of Federal funding.

Due to the nature of the different analytical tools to analyze highway, bridge, and transit investment for this report, and the limitations of the underlying data, the scenarios are defined and developed differently for different system components. The current generation of analytical tools combine engineering and economic procedures, determining deficiencies based on engineering standards but subjecting potential improvements to a benefit-cost analysis to determine which are economically justified, and to prioritize among them to some extent. The incorporation of economic analysis into the evaluation of investment requirements represented a significant advance over earlier models and methodologies, which strictly utilized an engineering-based approach.

This economic approach to transportation investment analysis is represented in Exhibit 1. Once potential investments have been identified and evaluated, they can be ranked by their benefit-cost ratios. In developing the investment scenarios, improvements with the highest benefit-cost ratios are implemented sequentially until a specified funding constraint is reached; the remainder of the potential improvements is deferred. Investments whose benefits exceed their costs (i.e., with benefit-cost ratios below 1) are not economically viable, and are not considered as part of the investment needs analysis. One of the advantages of this type of analysis is that it allows for tradeoffs between different types of investments, such as pavement improvements and capacity improvements.

The baseline investment analyses presented in the C&P report rely on several key assumptions, such as the continuation of current financing mechanisms and technology deployment trends. The analyses also assume that highway investment would follow the patterns suggested by the models, and that all of the improvements recommended by the models are technically feasible. The impact of alternative assumptions on the investment analyses are discussed in a separate briefing paper (3E-01).

Exhibit 1



Investment and Performance

The C&P analyses of highway and bridge investment describe the impacts that different levels of future investment could be expected to have on future measures of conditions and performance. These impacts are described as changes between base year (2004) values and the end of the 20-year analysis period (2024). The corresponding investment levels are all in constant 2004 dollars. Four different types of condition and performance measures are discussed here: highway user costs; pavement condition; operational performance; and the bridge investment backlog.

The minimum investment level shown in the analyses of this section is $70.3 billion. This level corresponds to total Federal, State, and local capital expenditures for highways and bridges in 2004, including outlays for system rehabilitation, expansion, and enhancement.

The maximum investment level addressed in these analyses is $131.7 billion. This total reflects the maximum average annual level of investment that could be utilized while still investing only in cost-beneficial highway improvements over 20 years, and to eliminate the backlog of economically justifiable bridge improvements by the end of 20 years. This is referred to in the C&P report as the Maximum Economic Investment level, and can be viewed as an “investment ceiling” above which it would not be cost beneficial to invest, even if unlimited funding were available.

While the investment levels cited in the text and exhibits below include capital outlays on all public roads, the corresponding highway performance indicators do not include rural minor collectors and local functional class roads in both rural and urban areas. The Highway Performance Monitoring System (HPMS) sample segment database used by HERS does not include data for these functional systems, which are not eligible for Federal-aid. Bridges on these functional classes, however, are included in the bridge investment spending and backlog estimates.

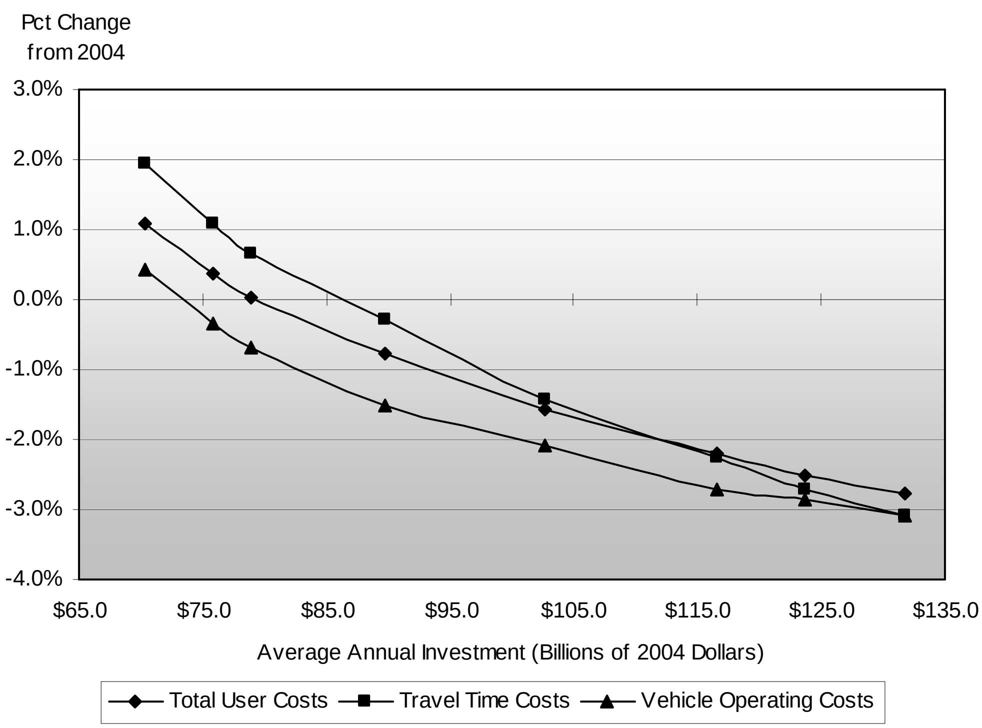
User Costs

The HERS model defines benefits as reductions in highway user costs, agency costs, and societal costs. Highway user costs are composed of travel time costs, vehicle operating costs, and crash costs. Since these costs are affected by both the physical condition of the highway infrastructure and by its operational performance, user costs can be viewed as a summary statistic for conditions and performance.

Exhibit 2 describes how average total user costs, travel time costs, and vehicle operating costs are influenced by the total amount invested in highways. The overall average crash costs calculated by HERS do not vary significantly at different investment levels.

Exhibit 2

Projected Changes in Average Total User Costs, Travel Time Costs, and Vehicle Operating Costs at Different Funding Levels



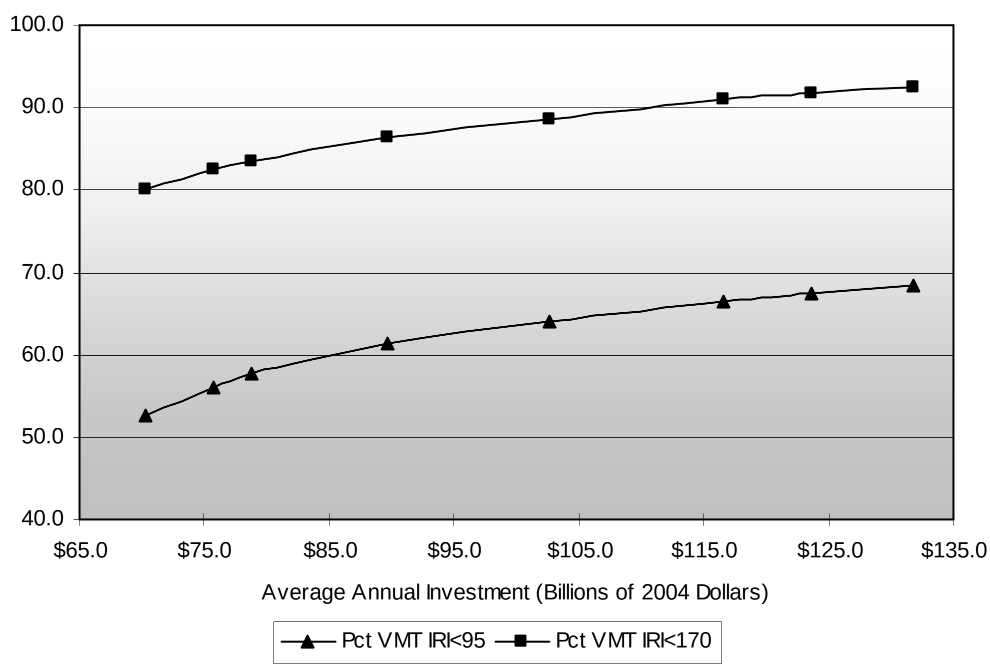
At an average annual highway investment of $78.8 billion (12.2 percent above actual highway capital spending in 2004), average highway user costs would be maintained at 2004 levels. This level of investment is thus referred to in the C&P report as the Maintain User Cost level, or the Cost to Maintain investment scenario. The effect on individual user cost components at this level of investment would vary. Travel time costs would rise by 0.7 percent, while average vehicle operating costs would fall by the same percentage. Average vehicle operating costs would increase at current funding levels, while travel time costs would decrease at annual average funding levels of $89.7 billion or higher.

The percent change in user costs shown here is tempered by the operation of the travel demand features in HERS. The model assumes that, if user costs are reduced on a section, additional travel will shift to that section. This additional traffic volume tends to offset some of the initial reduction in user costs. Conversely, if user costs increase on a highway segment, drivers will be diverted away to other routes, other modes, or will eliminate some trips entirely. When some vehicles abandon a given highway segment, the remaining drivers benefit in terms of reduced congestion delay, which offsets part of the initial increase in user costs.

Another important consideration is that the values reported are for the economic costs associated with highway conditions and performance, and do not include fuel taxes, tolls, or other user fees. A key recent addition to the HERS analysis for the 2006 C&P report is to connect increases in investment above base year 2004 levels with increases in user revenues to pay for them. As a result, actual user expenditures (including both user costs and user charges) would be higher in 2024 at the "maintain user Cost level than in 2004.

Exhibit 3

Projected Percentage of VMT on Roads with Good or Acceptable Ride Quality at Different Funding Levels



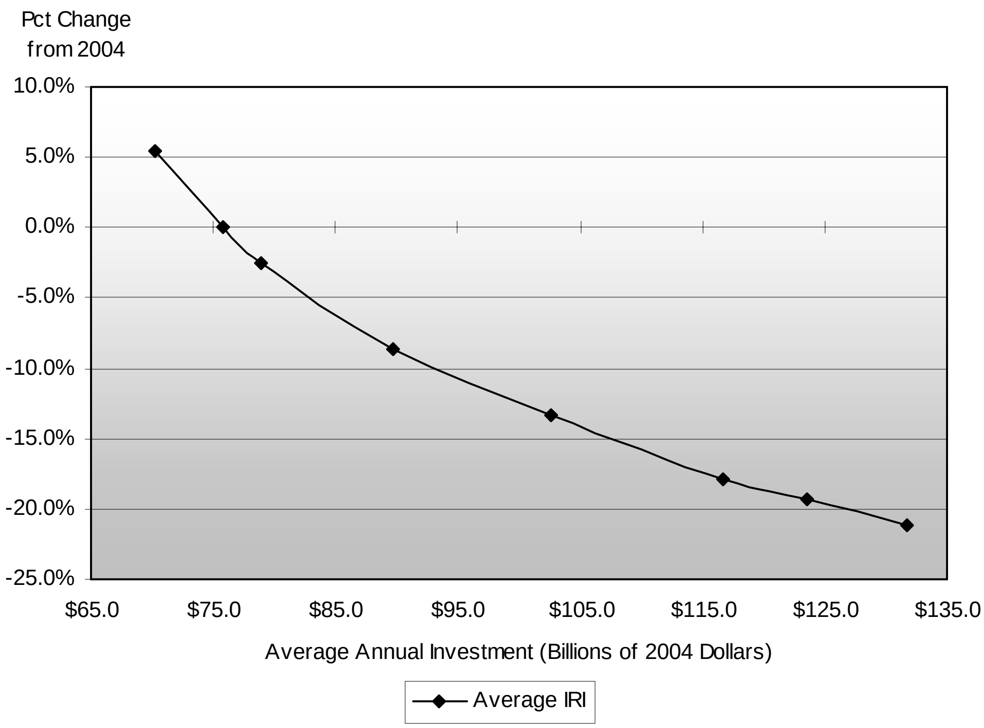
Pavement Condition

Exhibits 3 and 4 relate funding levels to changes in different indicators of pavement condition. At the Maximum Economic Investment for Highways and Bridges level ($131.7 billion annually), the percentage of VMT on pavement rated as adequate or better (with an IRI value below 170 inches per mile) would be projected to rise from 84.8 percent in 2004 to 92.5 percent in 2024, while the percentage of VMT on pavements rated as having good ride quality (IRI of 95 or lower) would increase from 45.2 percent to 68.3 percent over the same period. Average pavement roughness would decline by 21 percent at this funding level.

If highway spending were to be held at 2004 levels (in constant dollars) through the year 2024, increasing only with inflation, and if improvements were implemented in the manner recommended by HERS, the percentage of VMT on roads with good ride quality would increase to 52.6 percent, while the percentage on adequate ride quality pavement would decrease to 80.0 percent. Average pavement roughness would increase by 5.4 percent.

Exhibit 4

Projected Change in Average Pavement Roughness at Different Funding Levels



Operational Performance

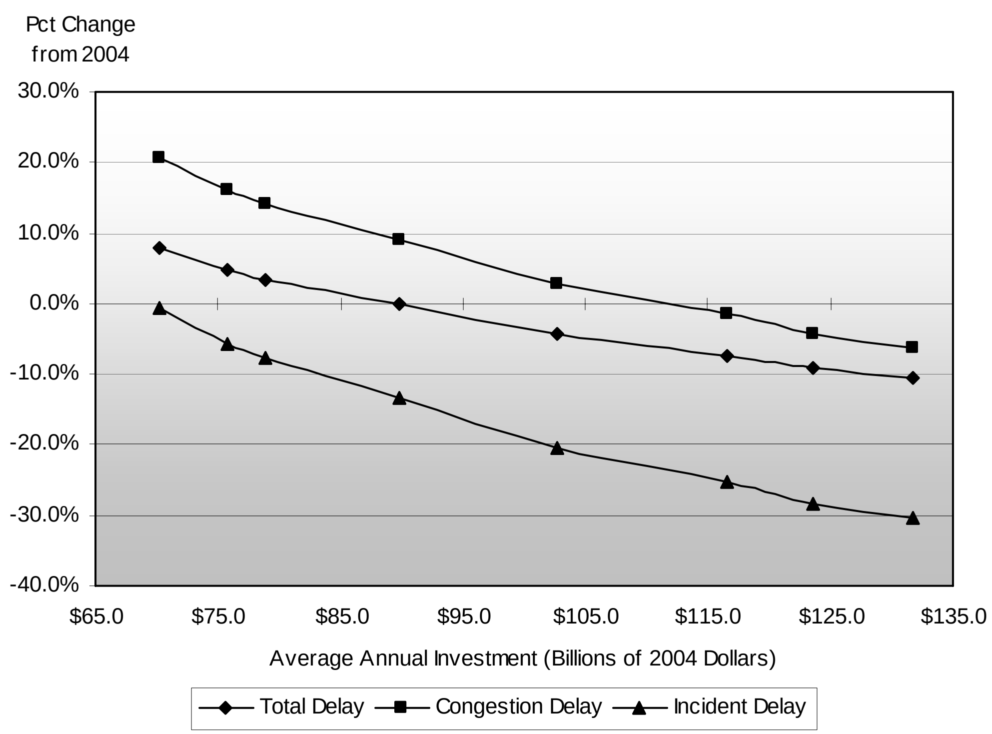
Exhibits 5, 6, and 7 link investment levels with different indicators of highway operational performance. Exhibit 5 shows how the HERS projections of average delay per VMT would change at different funding levels, including separate projections for recurring congestion delay and non-recurring incident delay. HERS calculates these values as part of its determination of average speed and travel time costs.

HERS estimates that an average annual expenditure level of $89.7 billion would be sufficient to maintain average total delay per VMT at 2004 levels. At current spending levels, average total delay would be projected to increase by 7.9 percent, while spending at the Maximum Economic Investment level would result in a decrease of 10.6 percent.

The impacts on congestion delay and incident delay at various funding levels differ somewhat. Congestion delay would be projected to decrease at higher funding levels, but would increase at lower investment levels, reaching 20.8 percent if spending remains at the 2004 level of $70.3 billion in constant dollar terms. Incident delay, however, would be projected to decrease at all funding levels, with significant reductions of over 30 percent at the Maximum Economic Investment level, and would increase slightly only at current spending levels. The level of future investments in operations and intelligent transportation systems assumed in these scenarios is expected to have a greater impact on reducing delay caused by incidents, making it possible to reduce average incident delay per VMT even at lower levels of funding.

Exhibit 5

Projected Change in Total Delay, Congestion Delay, and Incident Delay at Different Funding Levels



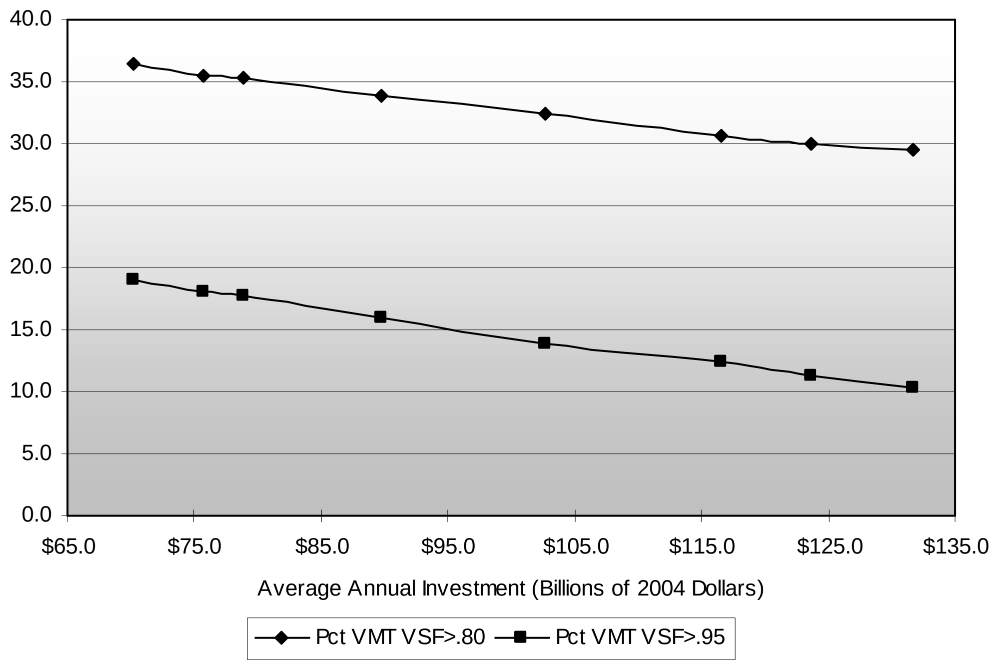
The next two indicators, in Exhibit 6, show the estimated percentage of VMT occurring on roads with peak volume-to-service-flow (capacity) ratios above 0.80 and above 0.95. These levels are often used to describe “congested” and “severely congested” operating conditions on highways, respectively.

If 2004 highway spending levels were maintained in constant dollar terms through 2024, the percentage of VMT on congested roads would be projected to increase from 23.7 percent to 36.4 percent, while the percentage on severely congested roads would increase from 13.3 percent to 19.1 percent. The percentage of VMT on congested roads would be projected to increase (to 29.5 percent) even at the Maximum Economic Investment level, while the percentage of VMT on severely congested roads would decline (to 10.4 percent).

For a potential capacity improvement to be included in a particular HERS scenario, the improvement must meet the minimum benefit-cost ratio (BCR) test associated with that scenario. As a result, there may be some road segments in a given time period that meet or exceed the threshold for being considered congested, but which do not merit capacity expansion in HERS. The results in this graph indicate that HERS is generally finding capacity improvements on severely congested roads to be more cost-beneficial than those on moderately congested routes, and is targeting investment accordingly.

Exhibit 6

Projected Percentage of VMT on Roads with V/SF Ratios above 0.80 and 0.95 at Different Funding Levels



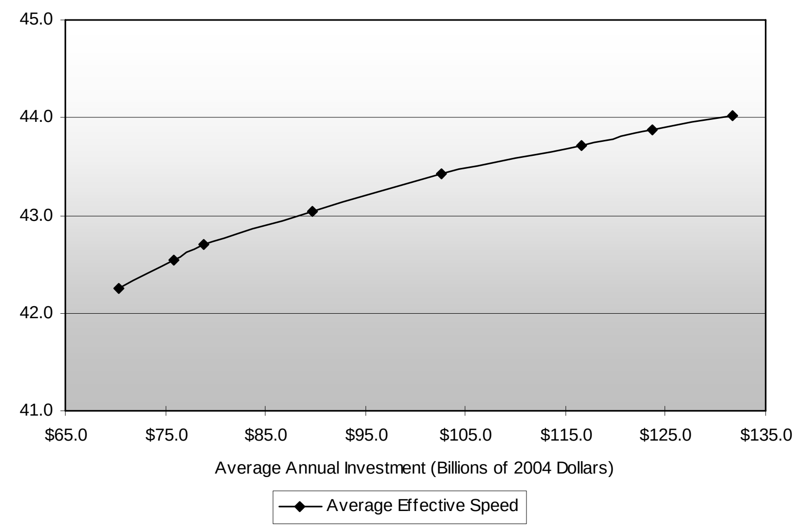
The average speed of highway vehicles is another simple measure of average traffic flow. Exhibit 7 indicates that an average annual investment of $89.7 billion would be sufficient to maintain average highway speeds at their 2004 level of 43.0 miles per hour. At the Maximum Economic Investment level of spending, average speeds would increase to 44.0 miles per hour.

Bridge Investment Backlog

The bridge investment backlog would be affected by different levels of investment in bridge rehabilitation and replacement. The estimated backlog of cost-beneficial bridge investments in 2004 was $65.3 billion. If bridge investment were maintained at the 2004 funding level in constant dollars ($10.5 billion), the bridge backlog would be projected to decrease by 47 percent, to approximately $34.5 billion. A funding level of $8.7 billion would be sufficient to maintain the constant dollar value of the bridge backlog, while bridge investment levels of $12.4 billion annually over a 20-year period would be sufficient to eliminate the existing backlog and correct other deficiencies that are expected to develop by 2024.

Exhibit 7

Projected Average Effective Highway Speeds at Different Funding Levels



Investment by Improvement Type

The benefit-cost ratios estimated by HERS are generally higher for system rehabilitation improvements (which are aimed at keeping the existing system operational) than for investments in system expansion (which tend to be much more expensive). As a result, when funding levels are lower, the model tends to recommend a mix of improvements that is weighted more toward system rehabilitation. If funding levels were to rise significantly, however, the analysis identifies a number of cost-beneficial potential investments to combat highway congestion, resulting in a greater share of investment being devoted to expansion of the highway system.

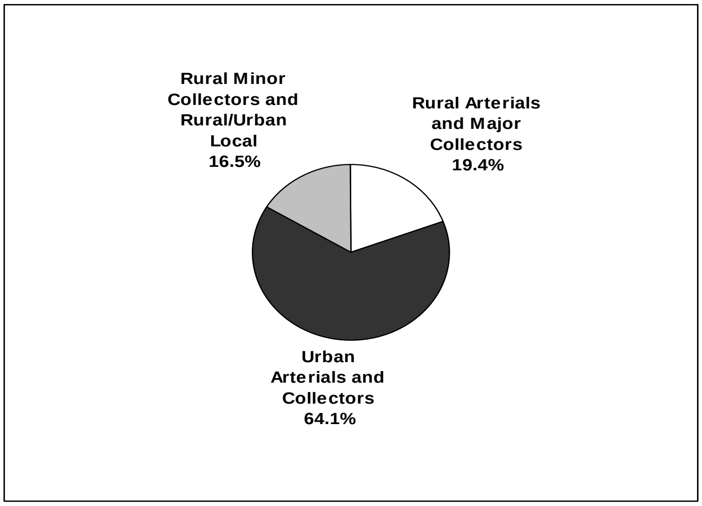
In 2004, 51.8 percent of highway capital outlay went for system rehabilitation (including pavement resurfacing/reconstruction and bridge rehabilitation/replacement), while 39.1 percent went for system expansion (including new roads and capacity additions to existing facilities). If funding levels were to rise slightly, to $78.8 billion, HERS would suggest a similar mix of improvements. However, if funding levels were to rise to the Maximum Economic Investment level ($131.7 billion annually), the suggested share of investment devoted to system rehabilitation would decrease to 46.3 percent, while the share for system expansion would increase to 44.6 percent.

Investment by Functional System

Exhibit 8 shows the percentages of future investment that would be made on different groups of functional systems at the Maximum Economic Investment level, as modeled in the C&P report. Over 64 percent of the investment is on urban arterials and collectors, while another 19 percent would be on rural arterials and major collectors. Investment on non-Federal aid highways (rural minor collectors and rural and urban local roads) makes up approximately one-sixth of total investment (note that most of this investment is not directly modeled). The distribution of investment among rural and urban areas is similar at lower funding levels.

Exhibit 8

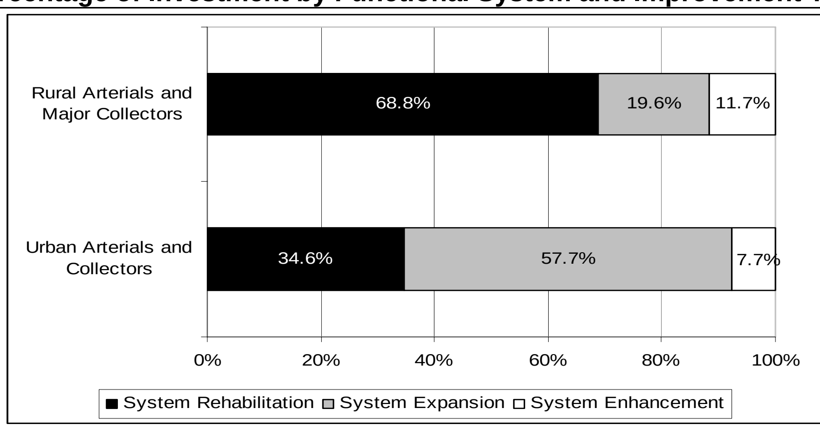
Percentage of Investment by Functional System



Investments in rural areas at this funding level are much more heavily weighted toward system rehabilitation than system expansion (see Exhibit 9), with more than two-thirds of total investment on rural arterials and major collectors aimed at the rehabilitation and replacement/reconstruction of existing roads. On urban arterials and collectors, however, investment is more heavily weighted toward capacity expansion relative to rehabilitation.

Exhibit 9

Percentage of Investment by Functional System and Improvement Type



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