

# **NCHRP 20-24(54)(E)**

## **Inflation Effects on National Investment Requirements**

*Requested by:*

American Association of State Highway  
and Transportation Officials (AASHTO)

*Prepared by:*

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## Disclaimer

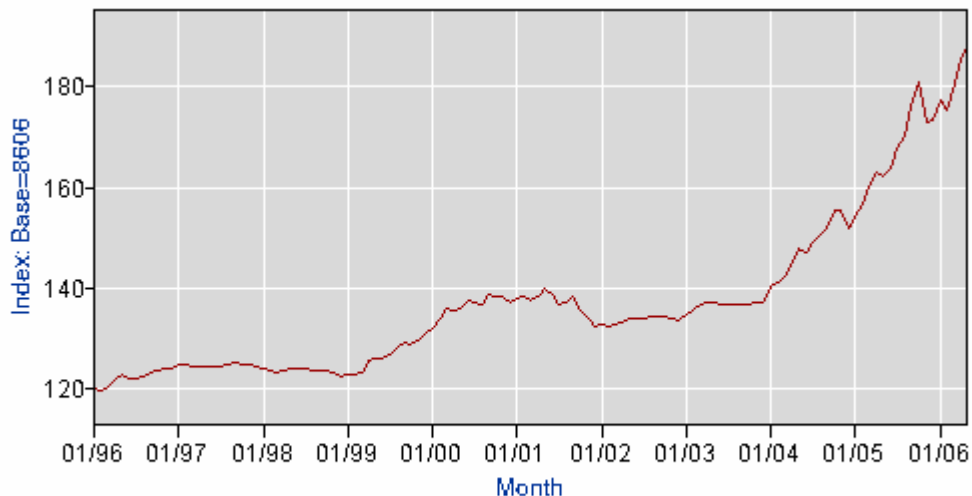
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## I. Background - The Role of Inflation in Projecting Highway and Transit Investment Requirements

All levels of government – federal, state, and local – face substantial needs for both capital investments and for ongoing maintenance and operations. A range of national, state, and local analyses have concluded that current revenues fall far short of what is needed to maintain or improve the existing transportation infrastructure. The most recent AASHTO Bottom Line report “*Transportation: Invest In America: The Bottom Line*”, 2002 and the most recent U.S. DOT report “*2004 Status of the Nation’s Highways, Bridges, and Transit: Conditions and Performance*”, and their predecessor reports all concluded that existing financial resources would not fund all of the nation’s needed capital investments in highways, bridges, and transit. Typical shortfalls identified were that investments in capital were 50 or 60 percent of what should be spent to support our nation’s justified capital investment needs.

Another problem has arisen since the publication of the most recent of these reports. Inflation of construction costs has become, since 2004, a problem of such significant magnitude that it now grossly compounds the investment shortfalls which those reports have historically demonstrated. Figure 1 illustrates this new problem of construction cost inflation.

**Figure 1. Producer Price Index for Highway and Street Construction: 1996-2006**



The data in this table is located at:

<http://data.bls.gov/PDQ/servlet/SurveyOutputServlet>

Prior to 2004, when the previous Bottom Line and Condition and Performance reports were published, inflation of construction costs was relatively modest. As can be seen in figure 1, the index has been rising with alarming speed since 2004, increasing from an indexed value of 140 to about 190. The increase is over thirty percent since the time of

those most recent reports, which used data from the year 2000 or the year 2002. This problem at “30 percent” is approaching the same order of magnitude as the previously identified problem at “40 or 50 percent” of the gap between resources and needed investment levels.

This means that the state of the practice of needs analysis must now recognize several problems that are compounding the issues faced by transportation agencies:

- The shortfall remains very large, even in constant dollars as reported by the previous AASHTO and U.S. DOT reports;
- Inflation is rapidly impacting on the magnitude of the shortfall; and
- The timing of the needed investments is even more important today.

This report takes some very partial steps towards dealing with these three important and interrelated issues. The findings of this report are that the very dramatic inflation in the recent past and the modest inflation that is forecast for the near term future will have a dramatic impact on the reporting of national investment needs. For just 2007, inflation adjustments will add over twenty percent to needs as estimated in 2000 dollars for the latest AASHTO Bottom Line report.

The timing of investments also has impacts on users that are dramatic. An analysis is reported here of the impacts of timing of the investing the same amount of money at different periods over the next twenty years. Even spending the same amount of money on highway investment over the traditional twenty year of analysis, but delaying that investment until the last 15 years instead of investing immediately, will cost users to incur additional operating costs of about half of the total investment. Both inflation and timing thus have very dramatic impacts on national investment needs and outcomes.

## **State of the Practice of Needs Analysis**

The analysis of capital needs for highways and public transportation has become highly developed at the national level. However, in these analyses, the forecasting of future investment needs has failed to highlight the potential financial impacts of time and inflation. FHWA and FTA have addressed this topic through sensitivity analyses of the effects of inflation in construction costs on needs. In the 2004 C&P, FHWA calculated that the maximum economic impact scenario needs would increase by 6.6 percent due to a 25 percent increase in construction costs, all other things being equal. More recent FHWA analyses have been conducted in which FHWA has estimated that a 25 percent increase in construction costs would increase needs in the maximum economic impact (“improve conditions and performance”) scenario by 11.2 percent. FTA’s analyses in the 2004 C&P indicated that a 25 percent increase in transit capital costs would increase the needs for the maintain conditions and performance scenario by 14 percent and the improve conditions and performance scenario by 9 percent. Future analyses by U.S. DOT and AASHTO should include a fuller discussion of the effects of general inflation, as well as the special effects of inflation in the construction industry. These analyses now need to be central elements of deliberations about transportation investment requirements. A constant dollar analysis should be a starting point only, and in order to marry it up with a future revenue stream, the costs need to be converted to nominal (year of expenditure) dollars.

The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) have developed model systems and analysis procedures to estimate highway, bridge, and public transportation capital needs. A series of reports titled “Status of the Nation’s Highway’s Bridges, and Transit: Conditions and Performance” have been issued by the U.S. DOT, documenting the current status of the nation’s capital infrastructure, and projecting twenty year needs. The latest “Conditions and Performance” or “C&P” report for the year 2004 was issued in early 2006. A draft 2006 C&P has been prepared by FHWA and FTA for issuance as the latest in this series.

The American Association of State Highway and Transportation Officials (AASHTO) has utilized the results of the C&P reports in its series of “Bottom Line” reports on investment needs, and in the preparation of the 2002 Bottom Line report “Transportation: Invest in America: The Bottom Line”, AASHTO also reported on the results of parallel analyses of highway needs undertaken by NCHRP and transit needs undertaken by TCRP. The parallel analyses reported by AASHTO in 2002 utilized slightly different input assumptions and slightly different years of analysis, and also discussed the shorter term (the next six year reauthorization cycle) rather than just a twenty year summary. The AASHTO analyses did not evaluate the impacts of inflation in construction costs.

Each of these federal and AASHTO reports provide economic evaluations of investments, and are conducted and reported in terms of “constant dollars”, i.e., they do not deal with the impacts of inflation. This is appropriate for economic analysis, but does not address real world issues of programming of sufficient funds under conditions where costs and benefits are changing due to inflation. The impacts of inflation are of course, of greater concern when inflation is high.

Beginning in 2004, the costs of construction materials began to rise more quickly than the overall rate of inflation. This trend appears to be continuing for the year 2006. The impacts of inflation and adjusting for future needs, specifically as they relate to the construction industry inflation numbers, are not well represented in the forecasts of the AASHTO Bottom Line Report and FHWA C&P.

The AASHTO Bottom Line Report estimated highway and bridge investment needs in two goal-based scenarios, based on past practice in the federal C&P reports. Four measures were employed to gain a sense of the effect of investment including pavement conditions, delays, speed of travel, and total user costs. The AASHTO Bottom Line Report focused on the six-year reauthorization period of 2004 – 2009 and all cost estimates were expressed in year 2000 dollars. The two goal-based scenarios are:

- “Maintain Conditions and Performance” scenario which holds user costs constant as travel demands grow; assures that travelers experience no new delay; and maintains system physical condition and prevents further degradation.
- “Improve Conditions and Performance” (also referred to as the “Maximum Economic Benefit”) scenario makes economically justifiable investments that improve pavement conditions; increase average speeds; reduce delays; and reduce user costs. Under this scenario, investments are made up to the level at which benefits no longer exceed costs.

These scenario assumptions used by AASHTO include a 20-year perspective, but also focus on a six-year time frame. They reflect total capital program estimates by all levels of

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government for all highways and bridges. Both scenarios used a factoring process to incorporate the costs for investments which are not modeled. These include elements such as roads on new rights of way, local roads, interchanges, and other improvements outside the right of way.

Two other studies can offer insight into future funding and financing in this era of increased inflation. A two-phase National Chamber Foundation study provides a blueprint for policymakers that contains long-, medium-, and short-term strategies for closing the funding gap and transitioning to a new financing mechanism for transportation. The first phase, Phase I: Current Outlook and Short-Term Solutions, found that the federal funding share falls short of what is needed to maintain and improve our nations' transportation infrastructure. The Phase II study lays out long-term options to fully fund our transportation system and quantifies specific strategies that can guide the transition to a new financing mechanism. A second study which is proceeding in parallel with NCHRP 20-24(54)(E) is NCHRP 20-24(49), which is examining revenue options to close the gap. For this study, procedures developed for estimating inflation impacts have been utilized in the interim report findings.

Two notable differences between the Bottom Line analysis and the Condition and Performance (C&P) process are that the C&P process employs a 20 year time frame starting with the year of the base year data, which is normally two years before the date of publication of the C&P reports. Therefore, the C&P issued in 2002 showed a 20-year perspective starting at year 2001, and the C&P for 2004 used 2002 as the data base and starting point. Some results for the C&P report for 2006 have been presented to the Commission established by SAFETEA-LU. The AASHTO Bottom Line focuses on the reauthorization timeline time frame beginning in 2004 and ending in 2009, and extending out twenty years to 2023. The AASHTO Bottom Line used the HERS to project highway conditions to a base year of 2004, by applying actual and projected spending for the years before the start of the period being analyzed (2004 to 2023). Other differences in input and computational assumptions resulted in slightly different results between the AASHTO and FHWA analyses. All results of course showed a significant gap between what level of investment is best for the economy and current investment levels.

## **Increasing Costs of Construction**

Many State DOTs have recently experienced significant increase in construction bid prices, reduced competition, and an increase in the number of single bids. While this trend may not be occurring in all states, it is significant enough to warrant further investigation. AASHTO conducted a survey on Construction Cost Increases and Competition (CCIC) in highway construction contracting where forty-four states, the District of Columbia, and two Canadian provinces responded.

During 2005 and early 2006, some construction material prices rose much faster than consumer or producer prices indices. In the survey over 85% of respondents had experienced significant cost increases in construction bids most notably for earthwork, asphalt, Portland cement concrete, and steel products. Twenty-seven percent of respondents experienced project delays due to material shortages. States have also

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experienced a noticeable reduction in competition with a steady decrease in the number of bidders on projects and the occurrence of single bidders on projects. With reduced competition, states will experience less buying power and may end up deferring projects. In order to foster competition, states were surveyed and asked to provide the most effective ways to foster competition. Rejection of non-competitive bids and re-advertising, balancing the work type in each letting, and bundling projects were all noted as effective initiatives used to increase competition and control costs.

Preliminary recommendations by FHWA resulting from the AASHTO CCIC Survey were for State DOTs to reject non-competitive bids to ensure competition. Further recommendations were for States to reconsider risk allocation through project scoping, contract size, price adjustment clauses, bundling contracts, and balancing lettings. It was also recommended that states perform market analysis for evidence of collusion and anti-trust issues as well as reconsider “bidder-lists” publications policies.

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## II. Considerations In Adjusting Highway and Transit Needs Estimates For Inflation

This section examines the impact of applying inflation factors to help transportation and transit agency have a clear picture of future capital costs and operations and maintenance (O&M) costs of the transportation system in future year of expenditure dollars. By taking current economic conditions into account and applying these indicators to program costs, agencies will be able to define the future investment requirements in year of expenditure dollars and thus manage their transportation programs.

Unanticipated inflation can cause costs for construction, maintenance, and operation of transportation facilities to increase more rapidly than projected revenues. To operate within available funding limits, many agencies are forced to cut future programs or adjust levels of service to make up for the needed funds.

At least two indicators of inflation are relevant to current and future programs, costs, and benefits. The consumer price index or CPI is the most widely utilized indicator of price changes. However, highway and transit agencies buy a very different mixture of items than consumers buy, and thus, consumer prices may not always reflect what agencies are experiencing with regard to cost inflation or deflation in their programs. There are a wide variety of producer price indices that are estimated also. One such index is for street and highway construction. There is no separate index for public transportation construction. It is likely that much of the cost of public transportation construction will track closely with the costs of street and highway construction. The exception will be that public transportation vehicles will represent a major cost item, which will require tracking separately from construction costs.

### The Consumer Price Index (CPI) and the Producer Price Index (PPI)

The Consumer Price Index (CPI) measures the average change in the prices paid for a market basket of goods and services. The CPI is the most widely used measure of inflation and is sometimes viewed as an indicator of the effectiveness of government economic policy. It provides information about price changes in the Nation's economy to government, business, labor, and private citizens and is often used as a guide to making economic decisions as well as guides government agencies in formulating fiscal and monetary policies. The *All Items CPI* measures the average change in prices over time of goods and services purchased for personal consumption by urban U.S. households, regardless of the item's country of origin. This index is comprised solely of prices for consumer goods, thus it excludes prices for capital equipment.

The *Producer Price Index for Finished Goods* tracks the average change in prices over time of domestically produced and consumed commodities. The index is comprised of prices for both consumer goods and capital equipment, but excludes prices for services. PPIs measure price change from the perspective of the producer or seller. This contrasts with other measures, such as the Consumer Price Index (CPI), that measure price change from the purchaser's perspective. Sellers' and purchasers' prices may differ due to government subsidies, sales and excise taxes, and distribution costs. Over 10,000 PPIs for individual products and groups of products are released each month. PPIs are available for the

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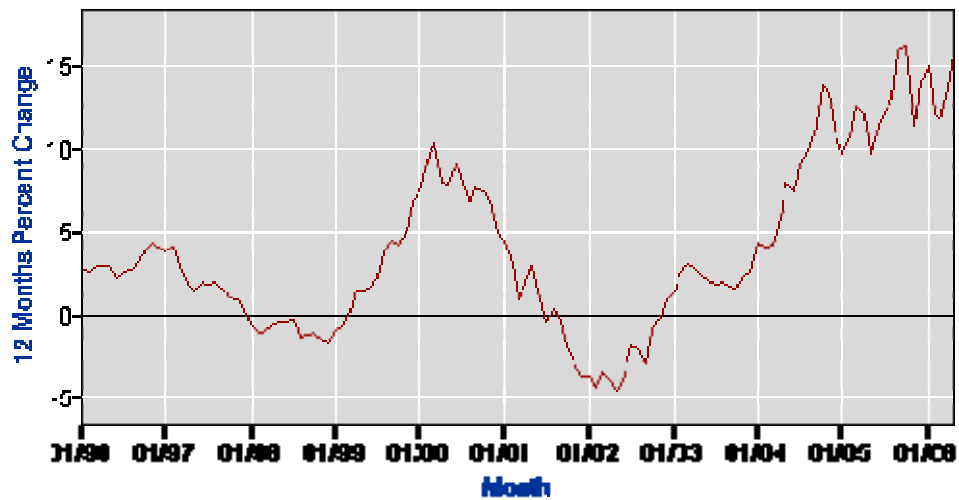
products of virtually every industry in the mining and manufacturing sectors of the U.S. economy.

The PPI is a materials based measure and does not include economic data with regard to labor data and figures. Analysis of the PPI for Highway and Street Construction does not contain data following or including labor rates and wages. While it is known that labor makes up a small portion of the costs of highway and street construction, there are no well accepted estimates of that portion of the costs. When assessing the economic indicators of Highway and Street Construction labor, a small portion of the larger picture should contain the labor analysis. Since these numbers are not considered as part of the street and highway PPI, additional research and consideration should address the statistics dealing with the labor within the street and highway construction industry.

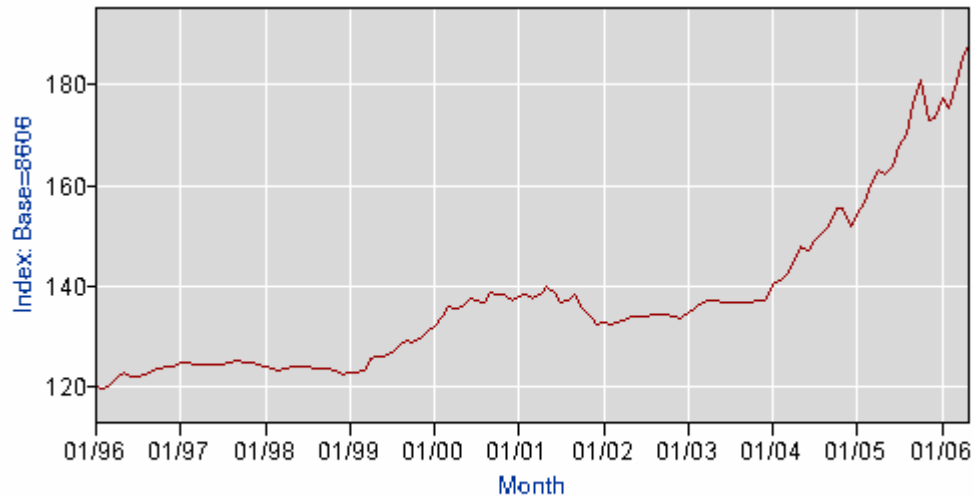
There has been substantial variation in the amount of inflation experienced by different construction segments in the past two years, although all segments have been hit by greater price increases than has the average business or consumer. The cost increases are approximated by Bureau of Labor Statistics (BLS) industry Producer Price Indexes (PPI), which weight the producer prices of construction material by the proportions used by that industry segment. As with commodity PPIs, industry PPIs do not take into account costs of labor, equipment or services. For the Highway & Street Construction index (Series ID: PCUBHWY#), the PPI has increased very substantially in the past two years, after several years of slow to no growth. The first five months of data in 2006 show this trend of increasing PPI is continuing.

Figures 2 and 3 show the highway and street construction PPI rates over the past twenty years as a percent change and as indexed, respectively. Figure 2 indicates that the twelve month percentage changes in the highway and street PPI have been over ten percent since 2004, in contrast to fairly low values – below five percent or negative – during the years of 2001 to 2004. There was a previous spike from 1999 to 2000 which moderated substantially in the three succeeding years. This coincided with the end of an economic expansion and lower economic growth in the years of the prices moderating or declining. The substantial price increases since 2004 have been much greater and more sustained than the price increases of 1999 to 2000. While reasons for price changes are complex, these recent price increases may be related to global market factors more than domestic factors. Figure 3 is a repeat of figure 1.

**Figure 2. PPI Highway and Street Construction – Twelve Month Percent Change 1996 - 2006**



**Figure 3. PPI Highway and Street Construction – Index 1996 - 2006**



The data in these tables is located at:

<http://data.bls.gov/PDQ/servlet/SurveyOutputServlet>

The analysis methodology is shown below, for adjusting for different rates of growth of the CPI and the PPI. These adjustments were made to update needs as computed by the AASHTO Bottom Line Report which utilized year 2000 cost and benefit data, and as computed by the 2004 C&P report, which used year 2002 cost and benefit data. As stated earlier, FHWA's more recent calculations are that an increase in construction costs of 25

percent results in an increase in needs of 11.2 percent in the maximum economic benefit scenario. This would weight the second stage adjustment factor to 3.9 percent instead of 2.3 percent as shown below.

**Inflation Adjustment for Needs 2000-2005 Using 2004 C&P Sensitivities**

Index	2000 annual index	2005 annual index	Percent Increase
CPI for All Urban Consumers (BLS)	172.2	195.3	13.4%
PPI for Highway and Street Construction (BLS)	136.5	166.8	22.2%
PPI adjustment to CPI			$(0.264 \times 8.8\%) = 2.3\%$
Total adjustment to 2000 AASHTO needs			15.7 %

Adjustment using later FHWA sensitivities is 13.4 percent plus  $(.448 \times 8.8)$  percent = 17.3 percent.

**Inflation Adjustment for Needs 2002-2005 Using 2004 C&P Sensitivities**

Index	2002 annual index	2005 annual index	Percent Increase
CPI for All Urban Consumers (BLS)	179.9	195.3	8.6%
PPI for Highway and Street Construction (BLS)	133.7	166.8	24.8%
PPI adjustment to CPI			$(0.264 \times 16.2\%) = 4.3\%$
Total adjustment to 2002 C&P needs			12.9 %

Adjustment using later FHWA sensitivities is 8.6 percent plus  $(.448 \times 16.2)$  percent = 15.9 percent.

From 2000 to 2005, analysis for this project indicated that consumer prices as measured by the CPI increased by 13.4 percent, but that highway and street construction prices increased by 8.8 percent more than the CPI. Clearly, both costs and benefits were at least 13.4 percent higher in 2005 than in 2000. This adjustment of 13.4 percent should therefore be directly applied to needs, since both benefits and costs are assumed to have gone up by this amount in terms of prices. All capital costs were updated from 2000 to 2005 dollars using an inflation factor of 13.4 percent. For the 2004 C&P, the comparable CPI adjustment factor is that all costs and benefits would increase by 8.6 percent to 2005.

An additional adjustment of 2.3 percent was included to account for the increase in highway construction costs over that period, as evidenced by the Highway Producer Price Index.<sup>1</sup> According to the *2004 Conditions and Performance*<sup>2</sup> report, the increase in needs when prices went up by 25 percent but benefits stayed the same was that needs went up by 6.6 percent, not by the full 25 percent. This is because, as construction costs increase while benefits do not, fewer projects will pass the benefit cost test. Thus, for increases in the PPI over and above increases in the CPI, needs will increase by  $6.6/25$  or  $.264$  for each

<sup>1</sup> U.S. Department of Labor, Bureau of Labor Statistics. Available at <http://www.bls.gov/ppi/home.htm>.

<sup>2</sup> U.S. Department of Transportation, Federal Highway Administration and Federal Transit Administration. *2004 Status of the Nation's Highways, Bridges and Transit: Conditions and Performance - Report to Congress*, Washington, D.C., February 2006.

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one percent increase in PPI costs over and above the CPI. With the later 11.2 percent increase as computed by FHWA, needs would increase by  $11.2/25$  or .448 for each one percent increase in PPI costs over and above CPI.

The PPI increased by 8.8 percent over CPI between 2000 and 2005, which leads to a CPI adjustment for the year 2000 to 2005 period of the AASHTO report of 2.3 percent (.264 times 8.8 percent) over that period. For the year 2002 to 2005 adjustment for the C&P report, the further adjustment is 4.3 percent (.264 times 16.2 percent). The total adjustment to year 2005 prices for AASHTO needs as estimated in 2000 dollars becomes 15.7 percent, and the total adjustment to year 2005 prices for C&P needs as estimated in 2002 dollars becomes 12.9 percent. Using the later FHWA sensitivity analysis, these increases would respectively be 17.3 percent and 15.9 percent.

This brings these figures up to only the last elapsed year of 2005. Future year inflation must also be forecast and utilized to provide needs estimates for those future years.

The two stage adjustment clearly applies to the improve scenario or maximum economic benefit scenario, and this sensitivity analysis to construction costs was reported on by FHWA for this scenario in the 2004 C&P report. Arguably, a direct one step adjustment of producer price changes (PPI) should be applied for the FHWA or AASHTO scenarios that “Maintain Conditions and Performance”, since construction costs have increased by that PPI percentage.

### **Example of Adjusting Investment Needs for Inflation**

For the NCHRP 20-24(49)report, which dealt primarily with revenues, an inflation adjustment developed jointly under that project and under this separate NCHRP 20-24(54)E was applied in late May 2006, to express all figures in year of expenditure dollars which are adjusted for inflation that has already accrued and also includes projected future inflation.

In its *Bottom Line Report*, the American Association of State Transportation and Highway Officials (AASHTO) estimated that an annual capital investment of \$110.9 billion (in 2000 dollars) was needed in 2000 to “maintain” the condition and performance of the nation’s highway and transit systems.<sup>3</sup> Adjusting the AASHTO Bottom Line estimate from 2000 to 2005 using the 22.2 percent adjustment for the Producer Price Index results in needs of \$135.5 billion per year. Of course, instead of this one example, these numbers should be adjusted separately for highways and transit using the latest analyses from FHWA and FTA.

The *2004 Conditions and Performance* report estimated that an annual capital investment of \$89.4 billion (in 2002 dollars) was needed to “maintain” the condition and performance of the nation’s highway and transit systems. The PPI inflation factor to update from 2002 to 2005 is 24.8 percent. After these adjustments were applied, the C&P needs to “maintain”

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<sup>3</sup> American Association of State Highway and Transportation Officials, *Transportation: Invest in America, The Bottom Line*, Washington, D.C., 2002.

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in year 2005 dollars that would be utilized in a hypothetical 2007 analysis are estimated at \$111.6 billion per year.

The costs to maintain differ between AASHTO and the C&P substantially, while the costs to improve (maximum economic investment) are much closer. This is primarily due to different procedures used in the AASHTO analysis for maintaining conditions and performance, and to differences in the years of the analysis. The AASHTO analysis although conducted two years earlier, models a period that is two years past the period of the 2004 C&P analysis. The approach taken by AASHTO to age the system in order to begin analysis as of the next reauthorization period results in a major portion of differences, particularly in the lower cost scenario “cost to maintain”. Future efforts by AASHTO should attempt to address the difficulties that are created in applying the models to periods beyond the actual base year of the available data.

The costs of operations, maintenance, administration, debt service, and other non-capital costs (collectively, “O&M”) must be added to annual capital needs to estimate the total expenditure needed to maintain the nation’s highway and transit systems. The Federal Highway Administration (FHWA) reported that \$69 billion was spent in 2004 on highway and bridge O&M.<sup>4</sup> The average annual O&M real growth rate over the last 25 years of 1.6 percent has been used to forecast O&M needs. This yields an annual O&M need in 2007 of \$78.6 billion. Finally, the Federal Transit Administration (FTA) reported that \$25.4 billion was spent in 2004 on transit O&M. Transit O&M real costs have grown at a rate of 1.7 percent annually, resulting in a projected annual O&M need in 2007 of \$29 billion.<sup>5</sup>

The estimated investment needed to “improve” the highway and transit systems is perhaps the best measure of needs, since this level is also the level which provides the maximum economic benefit to society. The 2004 C&P report and AASHTO estimated that an annual capital investment of \$142.9 (in 2002 dollars) and \$154.5 billion (in 2000 dollars), respectively, were needed to “improve” the nation’s highway and transit systems.<sup>6</sup> When these estimates are updated to 2005 dollars and further adjusted for assumed inflation of 3 percent per year for 2005 through the year 2007, and after highway and transit O&M costs are added, an annual expenditure between \$278 billion (2004 C&P) and \$296 billion (AASHTO) would be needed in 2007 to “improve” the nation’s highway and transit systems. Table 1 displays the breakout of these calculated adjusted needs for highway and transit. It should be noted that these are based on a chain of adjustments and that more direct calculations can be made when cost estimates are highly current.

As a simple comparison for highway capital needs, calculations for NCHRP Project 20-24(49) using the AASHTO Bottom Line estimates for the improve conditions or maximum

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<sup>4</sup> Federal Highway Administration, *2004 Highway Statistics*, Table HF-10.

<sup>5</sup> Federal Transit Administration, *National Transit Database*. Available at <http://www.ntdprogram.com>

<sup>6</sup> American Association of State Highway and Transportation Officials, *Transportation: Invest in America, The Bottom Line*, Washington, D.C., 2002.

economic benefit scenario, annual needs when adjusted for inflation are about \$30 billion per year higher in 2007 than the annual average as reported by AASHTO in the year 2000 constant dollars formulation, and about \$65 billion per year different, when adjusted or corrected for inflation, for the year 2017. The inflation adjustment for 2017 is thus for adding about 50 percent to the constant dollar AASHTO Bottom Line estimate of highway capital needs for the maximum economic investment scenario. Professionals may intuitively understand the differences between inflated and uninflated estimates. However, inflation adjustments are probably critical to a clear public understanding of the relationships between investment needs and likely resources.

**Table 1. Summary of Investment Needs to “Improve” in 2007**  
*Billions of YOE Dollars*

	<b>Capital</b>	<b>O&amp;M</b>	<b>Total</b>
<i>2004 C&amp;P Inflated Capital Plus O&amp;M</i>			
Highway	\$141.3	\$78.6	\$219.9
Transit	\$28.5	\$29.0	\$57.5
<b>Total</b>	<b>\$169.8</b>	<b>\$107.6</b>	<b>\$277.5</b>
<i>AASHTO Inflated Capital Plus O&amp;M</i>			
Highway	\$153.0	\$78.6	\$231.6
Transit	\$35.2	\$29.0	\$64.2
<b>Total</b>	<b>\$188.2</b>	<b>\$107.6</b>	<b>\$295.8</b>

Note: Totals may not add up due to rounding

## The FHWA Bid Price Index

FHWA also generates and maintains a database that can help transportation stakeholders understand how states’ costs to build, reconstruct, and maintain federally financed highways, roads, and bridges compare. This database allows for bid price data comparisons of an individual state’s costs over time but does not allow for comparisons between states. The database does not contain information in regards to how costs between states differ, for example when one state has a specification regarding smoothness of the surface compares to the same cost numbers for a state without such a specification.

FHWA has concerns with the quality of the bid price data reported in its *Price Trends for Federal-Aid Highway Construction* or *Highway Statistics* because of this comparison between states issue and issues associated with quality control procedures on data collection and

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processing. Most state departments of transportation and other users are aware of the bid price data flaws because this information has been provided informally to many stakeholders over the years and state departments of transportation use the published summaries primarily to cross-check other state highway construction cost data. FHWA is considering how to advise states and other users about the quality of the data in this report.

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### **III. Using the HERS for Hypothetical Estimates of the Impacts of Delaying Investment in Needs**

In addition to providing an estimate of the impacts of inflation on estimates of needs, this project has also examined the impacts of delaying investment on those needs. This analysis is not cross-modal, but relies instead on the capabilities of the HERS to analyze hypothetical differences in the timing of investments in needs. For the information presented in this report, the term hypothetical is used because the only information presented is the direct outputs of raw HERS runs. FHWA makes adjustments to these runs to account for other factors, so the information presented here is not similar to what appears in the Condition and Performance reports or the AASHTO Bottom Line reports.

This issue of the impacts of delaying investments is important because all of the needs analyses have concluded that there is a substantial current underinvestment in highway and transit capital needs, and the estimates of needs are then identified, spread over a twenty year analysis period. These analyses have not dealt with the issue of delaying or postponing investment, but have merely assumed that a certain level of investment will have been made by the end of a twenty year period.

#### **Previous AASHTO Analyses of Timing Effects**

Previous results that were developed to support the 2002 AASHTO Bottom Line report illustrate the impacts of a delay in investment. Two scenarios were examined and contrasted. The first was the maximum economic benefit scenario and the second was a scenario which maintained highway capital investments at year 2000 levels. These are discussed here, along with their performance and condition results. (The performance and condition results of the maintain condition and performance scenario are of course the same as the base values).

The growth support or improve scenario is analogous to the Maximum Economic Investment scenario in the FHWA Condition and Performance Reports of recent years, but is not a scenario in which there is a specific goal as a target to be achieved, e.g., hold user costs constant. Rather, this scenario determines what investments need to be done and what would be the accumulated measurable benefits of all of the investments exceeding a cost-benefit test.

In effect, this scenario identifies all of the beneficial investments that can be made within the strictures of the modeling process, and describes the resulting performance characteristics. It is a guide to what can be accomplished if we are willing to spend the money. By definition it is the highest priced system – with the highest benefits, within the scope of the models, as shown in Table 2 below. The scenario was estimated to cost \$129.7 billion per year over the 20-year period, compared to \$92 billion per year for the maintain conditions scenario.

**Table 2. AASHTO Bottom Line Growth Support Scenario Effects and Costs  
6 Year and 20 Year Perspectives**

	2004	2009	2023
<b>MEASURE</b>	Base Value	Growth Support Scenario	
Average International Roughness Index	125	109	98
Average Speed	40.6	42.02	44.74
Total hours of Delay Per 1000 VMT	4.3	3.89	3.58
Total User Costs \$ Per 1000 Vehicle Miles	\$937	\$913	\$882

The investments developed by the scenario were forecast to produce substantial improvements in the system by the end of the reauthorization period (2009). Pavement condition would improve by almost 15% from the base period. Much of this improvement occurs in urban areas, which are currently much poorer in quality than rural areas, reducing, but not eliminating, the disparity between urban pavement conditions and rural. The travel growth estimated in this scenario is over 13%, approximately one and a half percentage points higher than the Maintain Conditions scenario of 11.6%, as a result of the improved service conditions. The investments reduce delay by almost 13% despite the expected 13% growth rate in VMT in this scenario. The investments focus heavily on reducing delays in urban systems, where most of the delay exists, although they do reduce, but not eliminate, delay in rural areas. Urban delays remain five times that of rural areas per mile of travel. Average speeds also improve considerably with gains in both rural and urban areas.

There is a significant improvement in user costs, generating impressive benefits. The drop from \$937 per 1000 miles of travel to \$913 represents a 3.5% improvement. While this percentage seems small, recognizing that users travel in the range of 3 trillion miles per year indicates that a \$24 per 1000 miles saving equates to roughly a \$72 billion a year saving for users, more than compensating for the incremental costs of this scenario compared to maintaining conditions and performance.

The effects of the expanded levels of investment have even a greater impact over a full 20-year span as would be expected. The results are extraordinary:

- A more than 20% improvement in pavement conditions
- A greater than 10% improvement in average speeds
- A greater than 16% improvement in delay
- An almost 6% improvement in user costs, saving over \$165 billion per year in user costs by 2023

Some observers might consider that the positive effects of investment in the scenarios just cited seem relatively unimpressive in terms of percentage improvements in the operating

attributes of the system. These benefits must be measured on a scale against current spending and what the future effects of that level of spending would be. The following measures, shown in Table 3, express the state of the system if at the end of the next reauthorization period if spending has been maintained at the current levels of spending.

**Table 3. Scenario Effects Null Case- Current 2000 Investments**

MEASURE	BASE VALUE 2004	NEW VALUE 2009	CHANGE 2004-2009
Average International Roughness Index	125	147	18% degradation
Average Speed	40.6	35.9	12% degradation
Total hours of Delay Per 1000 VMT	4.3	4.64	8% degradation
Total User Costs \$ Per 1000 Veh. Miles	\$937	\$1,014	8% degradation
Total Program Cost Per Year (Billions \$)	\$60	\$60	

Comparison, for example, between the Growth Support scenario and the continuation of current investment levels creates a swing of almost 20% in physical condition; more than 10% in average speeds; and a difference in total user costs of about 10 cents a mile, just over a five year period.

### **New Hypothetical HERS Analysis of Timing Effects**

A new analysis of the timing effects of investments has been conducted specifically for this project, to examine the consequences of delaying investment in a more systematic manner. For this analysis, hypothetical HERS runs were conducted. No attempt has been made to conduct a complete needs analysis of all non-HERS investments such as bridges, roads on new alignments, local roads, etc. These runs of HERS have been made as follows:

- All runs are of the maximum economic benefit or improve scenario. B/C equals 1.0
- All runs use five year funding periods.
- All runs use elasticities selected for this analysis by the author that is -.2 for short run and -.4 for the long run, which are different and lower than the elasticities used in other analyses.
- A first unconstrained run is of total twenty year needs for the maximum economic benefit scenario.
- The total needs number for the unconstrained needs first run was multiplied by .5736 and divided by twenty, and this annual expenditure number was be input as a constraint in the following runs, which will be continuation runs. This factor is the

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2002 revenues spent on highway capital versus the amount needed to fund the maximum economic benefit needs from the 2004 C&P. This .5736 factor is a highly simplified assumption that is not based on any analysis of the spending on HERS related items versus other items that are included in capital budgets. A more detailed analysis would break these numbers out and would therefore give more refined estimates of the impacts of funding constraints.

- A first combined continuation run has .5736 times 20 year annual needs applied for the first five year funding period only; then the run continues with an unconstrained HERS run of fifteen years (three five year periods). This illustrates the impacts of delaying the needed investments for one funding period.
- A second combined continuation run has .5736 times 20 year annual needs applied for the first and second five year funding periods only; then the run continues with an unconstrained HERS run of ten years (two five year periods)
- A third combined continuation run has .5736 times 20 year annual needs applied for the first second and third five year funding periods only; then the run continues with an unconstrained HERS run of five years (one five year periods).

It has been noted that FHWA has found that continuation runs may have problems which make them different and non-comparable to the “normal” runs of the HERS which have the same rules for all analysis periods. These continuation runs represent dramatic changes in the rules between funding periods, and for these analyses there is a dramatic break between highly fiscally constrained periods and periods in which HERS can in effect spend whatever it deems desirable to correct deficiencies.

Because of the non-comparability of these analyses to the traditional uses of HERS, these analyses are merely intended to provide estimates of the impacts of delaying needed investments for various lengths of time, and do not represent more traditional scenarios. As with previous analyses for AASHTO and FHWA, the parameters that are monitored for each of the HERS runs are conditions and performance measures at the end of particular periods.

It is the intent of this analysis to illustrate the impacts of delaying needed investments. In fact, each of these analyses makes close to the same total investments over the course of the entire twenty year period. The totals differ by up to six percent. It has not been determined why there are differences in the totals. They represent gradations and extremes in terms of when the problem of the backlog is resolved by catching up with the needed investment level as estimated in the HERS model.

Table 4 shows the results of a first HERS scenario, which is an unconstrained run for the maximum economic benefit scenario. Under this scenario, HERS makes investments in the first funding period to clear up the backlog of projects which should already have been accomplished, but which have not been implemented due to prior funding constraints. The new value in 2009 for highway capital investments in those types of categories covered by HERS (rehabilitation, reconstruction, widening, etc., but not new roads, bridges, or interchanges) totals \$153 billion per year. Since the average investment

in these types of assets over twenty years is \$97 billion per year, and the average for the other funding periods is \$78 billion per year, the backlog is obviously very large.

Estimates of the three performance measures are shown in the tables. These are the international roughness index (a measure of pavement quality), average speed at the end of each funding period (a measure of performance), and average user costs per 1,000 miles of travel (a measure of user economic impacts). The user economic impact is emphasized here, because even though the variations in user costs per 1,000 miles seem small, these costs are spread over 2.51 trillion vmt at the beginning of the period and 3.75 trillion vmt at the end of the period. The average vmt over this twenty year period is 3.1 trillion per year. This vmt is only for those roads covered by the HERS, which do not include roads functionally classified as local or functionally classified as rural minor collectors. The roads covered by HERS are 969,000 miles out of about 4 million miles.

**Table 4. Scenario Effects Unconstrained Maximum Economic Benefit Scenario - Four Five Year Funding Periods**

MEASURE	BASE VALUE IN 2004	NEW VALUE BY 2009	NEW VALUE BY 2014	NEW VALUE BY 2019	NEW VALUE BY 2024	CHANGE 2004-2024
Average International Roughness Index	114	95	103	109	113	1% better
Average Speed	39.6	40.5	41.2	40.7	40.8	1.2 mph better
Total User Costs \$ Per 1000 Veh. Miles	\$1016	\$984	976	989	994	\$22 better
Total Program Cost Per Year (Billions \$2004) (HERS ONLY)	\$NA	\$153	\$53	\$73	\$108	

The table 4 unconstrained scenario for HERS expenditures only does not cover other needs that are not in HERS (bridges, local roads, etc.). No attempt has been made in this exercise to make the types of adjustments that FHWA makes to account for what is likely to be covered or not covered by HERS. The figures shown are developed just to illustrate the impacts of alternative timing of investments rather than any aspects of total needs. A total highway needs analysis has not been developed for this analysis of inflation impacts and of the impacts of timing.

Table 5 shows the impacts on the measures of a five year delay in applying unconstrained needs, and limits the expenditures to 57 percent of the approximately \$97 billion per year in unconstrained HERS expenditures. For only one constrained funding period, HERS chooses the most beneficial investments from a wide range of the large backlog of needs, and conditions and performance therefore do not deteriorate as rapidly as they do in later periods of constrained funding. Nevertheless, user costs by the end of the first five year

period (2009) average \$1009 per 1,000 vehicle miles versus \$984 per 1,000 vehicle miles under the first scenario, or \$25 per 1,000 miles higher. Once all needs are met, after the final funding period the user costs are reduced again to below current costs. Why this final number for this scenario is somewhat lower than under the first scenario is a result in HERS that we do not fully understand, and further sensitivity analysis should be done. The impacts of elasticities are one known reason, but the range of reasons has not been evaluated in this very brief project.

Table 6 shows the impacts of a ten year delay in making the needed investments to eliminate the backlog. User costs are obviously the same under this scenario at the end of five years as under the second scenario, and are \$25 dollars per 1,000 miles higher than under the first scenario, but at the end of ten years, user costs are still \$19 per 1,000 miles higher than with the first scenario.

**Table 5. Scenario Effects Constrained Maximum Economic Scenario - One Funding Period of Constraint**

MEASURE	BASE VALUE 2004	NEW VALUE 2009	NEW VALUE 2014	NEW VALUE 2019	NEW VALUE 2024	CHANGE 2004- 2024
Average International Roughness Index	114	114	101	108	113	1% better
Average Speed	39.6	39.6	41.1	42.0	41.0	1.4 mph better
Total User Costs \$ Per 1000 Veh. Miles	\$1016	\$1009	978	970	987	\$29 better
Total Program Cost Per Year (Billions \$2004) (HERS ONLY)	\$NA	\$55	\$148	\$67	\$95	

**Table 6. Scenario Effects Constrained Maximum Economic Scenario - Two Funding Periods of Constraint**

MEASURE	BASE VALUE 2004	NEW VALUE 2009	NEW VALUE 2014	NEW VALUE 2019	NEW VALUE 2024	CHANGE 2004- 2024
Average International Roughness Index	114	114	116	106	111	3% better
Average Speed	39.6	39.6	40.4	41.4	41.7	2.1 mph better
Total User Costs \$ Per 1000 Veh. Miles	\$1016	\$1009	995	976	977	\$39 better
Total Program Cost Per Year (Billions \$2004) (HERS ONLY)	\$NA	\$55	\$55	\$174	\$86	

Table 7 illustrates the consequences of delaying investment for three five year periods, and making the needed investment to reduce the backlog only in the last funding period. The user cost per 1,000 miles increases to \$1,006 by the end of the third period.

**Table 7. Scenario Effects Constrained Maximum Economic Scenario - Three Funding Periods of Constraint**

MEASURE	BASE VALUE 2004	NEW VALUE 2009	NEW VALUE 2014	NEW VALUE 2019	NEW VALUE 2024	CHANGE 2004- 2024
Average International Roughness Index	114	114	116	120	109	5% better
Average Speed	39.6	39.6	40.4	40.0	40.8	1.2 mph better
Total User Costs \$ Per 1000 Veh. Miles	\$1016	\$1009	\$995	\$1006	\$993	\$23 better
Total Program Cost Per Year (Billions \$2004) (HERS ONLY)	\$NA	\$55	\$55	\$56	\$214	

Comparisons of the user costs across scenarios cannot be done very readily within HERS. Therefore, approximations are necessary to interpret the impacts on users of delays in investments. All of these scenarios ultimately spend the same amount of money. The

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analysis here is thus of the impacts of delay in spending the needed money. Other analyses such as illustrated above from earlier work have already documented the dire consequences of never making the needed investments, which is the track the nation is currently on.

The differences between the first timing scenario and the last scenario – starting to meet all the needs now, or delaying for another fifteen years – average over \$60 billion per year in additional user costs over a fifteen year period. This is approximately \$900 billion of losses **just due to timing**. By comparison, the total investment made over all these years is about \$1,800 billion for each of these scenarios, to make the needed investments at some time or other. Thus, timing problems may cost about half as much as the total HERS-related investment needs. Obviously, this estimate is very approximate, but it does put the effects of timing in rough context with the total program costs.

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## IV. The Impacts of Earmarks

Transportation bills, such as SAFETEA-LU, are favorite places for lawmakers to secure federal funds for pet projects in their home districts, through a process called earmarks. These earmarks are increasingly taking a greater portion of the federal monies allocated for the nation's transportation program. By earmarking funds to specific pet-projects these lawmakers have taken funding away from pre-programmed transportation project. By having the lawmakers dictate what projects get funded, the state DOTs no longer have the decision making ability necessary to fund priorities within their core transportation programs. Projects deemed necessary by states can be subject to reduced funding because that funding is going to lower-priority "earmarked" projects.

This section addresses the impact of earmarking on the core programs of state DOTs – funded projects that disregard the process – and the disproportionate share going to certain activity that is not commensurate with the benefits.

Transportation earmarks have a detrimental impact on the overall transportation program as core funding needed for maintaining the basic transportation program levels are designated for pet projects. The recently passed \$286 billion SAFETEA-LU bill contained a record 6,371 pet projects inserted by members of Congress. These projects totaled more than \$24 billion, nearly nine percent of the total spending, funding that is no longer available for core programs.

As this latest legislation worked its way through the systems the level of earmarks were cited as examples of government waste in news stories and chastised by taxpayer advocacy groups. These earmarks are seen as a negative image that state highway departments are tagged with whether they supported the earmark or not.

While it is not possible to determine the characteristics of 6,371 earmarks in order to evaluate the impacts of those earmarks on performance, it is feasible to estimate the potential impact on core programs in terms of the budgetary reductions that result from the earmarks. If the earmarks total \$24 billion out of \$286 billion of federal funding, and those earmarks require a state match of 20 percent, or another \$6 billion, the total costs are approximately \$30 billion over the reauthorization period. Assuming that the earmarks of \$30 billion cover five years, they would average \$6 billion per year. FHWA estimated \$68.2 billion of highway capital investment in 2002 and FTA estimated \$12.3 billion of transit capital investment in 2002, a total of about \$80.5 billion in total capital investment. The \$6 billion is thus equivalent to a potential maximum reduction in resources devoted to real needs of  $6/80.5$  or about 7.5 percent of needs. It is possible that this impact is less, of course, because some earmarks may have merit as investments, even if not as much merit as alternative projects that were displaced.

Because the earmarks are in many instances for initial phases of multi-phase projects as "seed" money, it is also possible that the impacts of the earmarks are greater than this. There is an economic cost of having projects that are losers move forward rather than projects that are winners. These impacts cannot be quantified in any meaningful way, but are important to note.

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## V. Summary

The inflation effects on national investment requirements can be summarized as consisting of substantial increases in needs and funding gaps, with a significant impact on compounding the past results of needs analyses that have all identified very significant shortfalls in planned expenditures versus justified needs.

Inflation adjustments are now absolutely critical to understanding the magnitude of needs. In addition, the timing of capital investments has major impacts on the outcomes for users of the system.

Prior to 2004, when the previous Bottom Line and Condition and Performance reports were published, inflation of construction costs was relatively modest. As was shown in figure 1, the index has been rising with alarming speed since 2004, increasing from an indexed value of 140 to about 190. The increase is over thirty percent since the time of those most recent reports, which used data from the year 2000 or the year 2002. This problem at “30 percent” is approaching the same order of magnitude as the previously identified problem at “40 or 50 percent” of the gap between many estimates of likely resources and needed capital investment levels.

Likewise, the timing impacts of investments can also have very large impacts on user costs, also perhaps on the order of 50 percent or so of total twenty year investment needs. Earmarks can also have a large but difficult to calculate impact on the ability of agencies to deliver needed improvements.

This project is not intended to produce actual needs estimates, but rather to set the stage for future needs analyses. The kinds of inflation-related analyses and impacts of delay analyses that are suggested by the calculations in this should be incorporated into future AASHTO analyses of needs.

## Appendix: Additional Data Tables

### PPI Highway and Street Construction – Twelve Month Percent Change 1996 - 2006

<http://data.bls.gov/PDQ/servlet/SurveyOutputServlet>

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1996	2.9	2.6	3.0	3.0	3.0	2.3	2.6	2.8	3.2	4.0	4.3	4.1	3.1
1997	3.9	4.1	3.0	1.9	1.5	2.0	1.8	2.1	1.6	1.1	0.9	0.2	2.0
1998	-0.6	-1.0	-1.0	-0.6	-0.4	-0.4	-0.2	-1.2	-1.1	-1.0	-1.3	-1.6	-0.9
1999	-0.8	-0.6	0.2	1.5	1.5	1.7	2.3	3.8	4.4	4.2	5.1	6.9	2.5
2000	7.5	9.3	10.3	8.1	7.9	9.2	8.0	6.6	7.7	7.5	6.8	5.0	7.8
2001	4.4	3.1	1.0	2.1	3.0	0.9	-0.4	0.3	-0.4	-2.2	-3.1	-3.6	0.4
2002	-3.6	-4.2	-3.4	-3.8	-4.4	-3.5	-1.8	-2.0	-2.9	-0.7	-0.1	1.0	-2.4
2003	1.4	2.5	3.1	2.9	2.4	2.2	1.9	2.0	1.8	1.7	2.4	2.6	2.2
2004	4.3	4.1	4.2	5.9	8.0	7.4	9.1	9.9	11.0	13.8	13.3	10.8	8.5
2005	9.8	10.8	12.6	12.2	9.8	11.4	12.3	13.0	16.0	16.3	11.4	14.1	12.6
2006	15.0	12.1(P)	11.8(P)	13.7(P)	15.9(P)								

P : Preliminary. All indexes are subject to revision four months after original publication.

**PPI Highway and Street Construction – Index 1996 - 2006**

<http://data.bls.gov/PDQ/servlet/SurveyOutputServlet>

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1996	119.9	119.8	120.6	122.0	122.6	122.0	122.0	122.3	123.0	123.5	123.8	124.0	122.1
1997	124.6	124.7	124.2	124.3	124.5	124.4	124.2	124.9	125.0	124.9	124.9	124.3	124.6
1998	123.8	123.4	123.0	123.6	124.0	123.9	124.0	123.4	123.6	123.6	123.3	122.3	123.5
1999	122.8	122.6	123.3	125.4	125.9	126.0	126.9	128.1	129.0	128.8	129.6	130.7	126.6
2000	132.0	134.0	136.0	135.6	135.8	137.6	137.1	136.6	138.9	138.5	138.4	137.3	136.5
2001	137.8	138.2	137.4	138.5	139.9	138.8	136.6	137.0	138.4	135.4	134.1	132.4	137.0
2002	132.9	132.4	132.7	133.3	133.8	133.9	134.1	134.2	134.4	134.4	133.9	133.7	133.7
2003	134.7	135.7	136.8	137.1	137.0	136.9	136.7	136.9	136.8	136.7	137.1	137.2	136.6
2004	140.5	141.2	142.5	145.2	147.9	147.0	149.2	150.5	151.8	155.5	155.4	152.0	148.2
2005	154.3	156.5	160.4	162.9	162.4	163.7	167.6	170.0	176.1	180.8	173.1	173.4	166.8
2006	177.5	175.4(P)	179.4(P)	185.2(P)	188.3(P)								

P : Preliminary. All indexes are subject to revision four months after original publication.