

# Managing Risks and Using Metrics in Transportation Asset Management Financial Plans



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# 1. Introduction

Transportation agencies have the responsibility and the challenging task to maintain, preserve and improve infrastructure assets (assets) for current and future generations. While maintaining existing assets is an overriding concern for transportation agency officials, most agencies are grappling with funding issues. Considering the fact that assets such as pavements and bridges have long useful lives, a sound asset management practice will necessitate the development of long-term asset management plans. Practices and experiences from other countries with mature asset management processes and also from transportation agencies within the U.S. show that implementing and sustaining the performance and condition of assets requires long-term financial plans that support and are linked to long-term asset management strategies. Comprehensive transportation asset management plans (TAMPs) could show the expected and desired projections of asset performance and condition for ten or more years into the future. A pragmatic TAMP would address the amount of investment required each year for the rehabilitation, preservation and maintenance of assets during their useful life. The associated financial plan can be linked to the targeted performance and conditions of the assets identified in the TAMP.

The financial plan can show the expected and desired funding projected for the future, often for ten or more years. To be useful to decision-makers, the financial plan can establish how the agency will address the resources needed to achieve and sustain the long-term asset management objectives. It could clearly illustrate the financial state of the agency and express the financial needs for the plan period, shedding light on the gaps, and the funds needed to bridge the gaps between the current conditions and those established in the asset management plan. The elements of the financial plan can succinctly highlight the actions that need to be taken

over the long-term to maintain the health, performance and condition of the assets. The financial plan also can address financial risks. It could enable the agency to monitor and compare the funding available to the expected funding projections throughout the life of the plan, make tradeoffs, and take corrective actions to accomplish the agency's asset management objectives. The financial plan is thus critical to the successful implementation of the agency's TAMP. Finally, well developed financial plans would allow agencies to communicate with the public and the stakeholders the value of transportation assets, the current, projected and desired performance and condition of assets, the funding required to support the projected and desired performance and condition targets, the financial risks and the level of performance and condition that stakeholders can expect. It also can summarize any changes in strategy that may be required to address changing financial realities.

This third installment of the five-part financial report series addresses two related components of financial plans. The first is how to identify, communicate, manage and perhaps capitalize upon the risks inherent in long-term strategies for financing complex and aging infrastructure assets. The second is how to use financial performance measures to illustrate the adequacy of investment levels and the magnitude of accumulating backlogs.

This two topics are closely related. How well risks are managed can influence how well the assets perform. Later in this report, two tools will be explained that can help explain the potential risks and rewards inherent in an agency's asset management and financial plan. A risk register is a simple matrix-like document that summarizes the risks, their consequences, likelihood and impact surrounding the financial plan. The risk register provides an at-a-glance summation of the risks that will determine the success of the financial plan.

Also, this report will present a series of financial metrics to accompany the plans. These metrics provide “shorthand” ratios that illustrate the degree of adequacy of the financial plan to sustain asset conditions. The metrics are like heuristics or rules of thumb that allow the “body politic” to understand benchmarks of whether the financial plan is adequate to sustain assets, and if not, by how much.

## 2. Risks and Rewards of Financial Plans

A financial plan is defined here as a component of a transportation asset management plan. It includes forecasts of expected revenues, allocations of those revenues, gaps between the allocations and the amounts needed to meet asset-condition targets and scenarios to address the gaps. Although not defined in statute, it is likely that most state transportation agencies will adopt a timeframe of approximately 10 years.

Tables 1-4 represents a possible format for the financial summary in a financial plan. This format and these spending categories are not required by FHWA but are presented to illustrate the concepts important to long-term financial plans that support asset management. The first two sections in Tables 1 and 2 (see pages 5 and 6) are common in most “sources and uses” tables. They illustrate what revenue is expected and how it is predicted to be used. The third section in Table 3 (see page 7) captures whether the allocations are adequate to meet the asset-investment needs. “Needs” would be the amount of investment required to meet the asset-condition targets. The need estimate generally would be produced by the agency’s bridge, pavement or maintenance management system, or other estimating processes.

### **RISK**

*is the positive or negative effects of uncertainty or variability upon agency objectives.*

As can be seen, a financial plan with its long-term perspective and its capturing of need as well as revenues can include more than a typical budget document. Most state budgets are one, or two-year documents that

focus only upon known revenues and how they will be allocated. If needs exceed revenues the needs are “off the books” and their consequences are not included in the



Sources	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Totals
State Revenue	\$800	\$808	\$816	\$824	\$832	\$841	\$849	\$858	\$866	\$875	\$884	\$9,253
Federal Revenue	\$750	\$750	\$750	\$750	\$750	\$750	\$750	\$750	\$750	\$750	\$750	\$8,250
Other Revenue	\$50	\$51	\$51	\$52	\$52	\$53	\$53	\$54	\$54	\$55	\$55	\$578
Total Sources	\$1,600	\$1,609	\$1,617	\$1,626	\$1,635	\$1,643	\$1,652	\$1,661	\$1,670	\$1,680	\$1,689	\$18,082
Inflation Adjusted Sources	\$1,600	\$1,544	\$1,490	\$1,438	\$1,388	\$1,340	\$1,293	\$1,248	\$1,205	\$1,163	\$1,123	\$14,834

**Table 1. A financial plan summary of sources of funds.** (All figures in \$ Millions)

Uses	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Bond Payments	\$160	\$161	\$162	\$163	\$163	\$164	\$165	\$122	\$119	\$120	\$100	\$1,599
Operating Needs	\$320	\$330	\$339	\$350	\$360	\$371	\$382	\$394	\$405	\$418	\$430	\$4,098
Roadway Maintenance	\$128	\$131	\$133	\$136	\$139	\$141	\$144	\$147	\$150	\$153	\$156	\$1,558
Pavement Budget	\$304	\$304	\$304	\$304	\$304	\$304	\$304	\$304	\$304	\$304	\$304	\$3,344
Bridge Budget	\$160	\$160	\$160	\$160	\$160	\$160	\$160	\$160	\$160	\$160	\$160	\$1,760
Safety	\$64	\$65	\$65	\$66	\$67	\$67	\$68	\$69	\$69	\$70	\$71	\$740
Traffic/ITS	\$64	\$65	\$67	\$68	\$69	\$71	\$72	\$74	\$75	\$76	\$78	\$779
Trans. Alternatives	\$80	\$80	\$80	\$80	\$80	\$80	\$80	\$80	\$80	\$80	\$80	\$880
Local Projects	\$128	\$128	\$128	\$128	\$128	\$128	\$128	\$128	\$128	\$128	\$128	\$1,408
Mobility/Capacity	\$192	\$186	\$179	\$172	\$165	\$156	\$149	\$184	\$179	\$171	\$182	\$1,915
Total	\$1,600	\$1,609	\$1,617	\$1,626	\$1,635	\$1,643	\$1,652	\$1,661	\$1,670	\$1,680	\$1,689	\$18,082

**Table 2. A financial plan summary of uses of funds. (All figures in \$ Millions)**

Financial Need and Gaps	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Pavement Need	\$304	\$316	\$329	\$342	\$356	\$370	\$385	\$400	\$416	\$433	\$450	\$4,100
Pavement Gap	\$0	\$12	\$25	\$38	\$52	\$66	\$81	\$96	\$112	\$129	\$146	\$756
Bridge Need	\$160	\$163	\$166	\$170	\$173	\$177	\$180	\$184	\$187	\$191	\$195	\$1,947
Bridge Gap	\$0	\$3	\$6	\$10	\$13	\$17	\$20	\$24	\$27	\$31	\$35	\$187
Roadway Maintenance Gap	-	0	0	0	0	0	0	0	0	0	0	0

**Table 3. A financial plan summary of financial gaps, condition targets and sustainability index.**  
(All figures in \$ Millions)

Investment Results	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Sustainability Gap	\$0	\$15	\$31	\$48	\$65	\$83	\$101	\$120	\$140	\$160	\$181
Asset Sustainability Index	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.77	0.74	0.72
Percent of Pavements Meeting Target	90	90	88	87	85	85	84	82	80	79	78
Percent of Bridges Meeting Target	95	95	95	94.5	94	93	93	92.5	92	91	90

**Table 4. Metrics summarizing the results of the investment levels.** (All figures in \$ Millions)

financial reports. Asset management financial plans allow agencies to put their revenues and expenditures in greater context. Because assets are long-lived, the financial plan parallels more closely the timeframes in which agencies plan ahead for treating highway assets.

Although long-term revenue and needs forecasts have been included in transportation agency long range plans, the asset management financial plan can fill a void by focusing specifically on the revenues, expenditures and needs to sustain assets at acceptable conditions for the long-term. A long range plan captures the estimated costs to meet mobility, safety, transportation alternatives and other needs but not always the costs to sustain assets to a specific condition. What is different about the needs for sustaining assets compared to other program categories such as mobility is that asset-investment needs are not discretionary over the long term. Although assets may be underfunded for years, the unmet needs accumulate as a long-term liability that eventually must be paid. The costs of underfunded pavements, bridges and other assets manifest themselves as poor pavements and bridges that increase vehicular operating costs, contribute to crashes and cost more to repair. These higher future costs generally don't appear in current financial documents such as long-range plans, State Transportation Improvement Programs (STIPs), and importantly, State budgets. An agency's State budget could be published without any acknowledgement of the looming backlog in unmet asset investment need. The asset management financial plan can present the agency's assumptions of how it will spend resources to manage these assets but it also can illustrate the "off the books" liabilities that accrue through deferred maintenance and report them as a growing liability that eventually must be paid.

Tables 3 and 4 summarize the amount of unmet need for bridges and pavements by year and for the 11-year period. They also illustrate the forecasted decline in conditions for

bridges and pavements and summarize the Sustainability Gap, or total unmet need, over the period which is \$943 million.

Also shown in this financial plan is the Asset Sustainability Index (ASI.) The Asset Sustainability Index is the ratio of what is budgeted to preserve the bridge and pavement assets divided by the amount needed to achieve the targets. As seen in 2015, pavements and bridges are adequately funded to meet target but by 2025 only 72 percent of what is needed to sustain them is expected to be allocated. By including the funding gaps, the declining conditions and Asset Sustainability Index, the financial plan presents a more complete picture of the agency's asset funding than would a short-term, two-year budget document that focuses only on cash balances. The inclusion of these future financial conditions illustrates what trends, conditions and liabilities will accumulate and have to be addressed eventually.

Financial plans focusing on the costs to sustain assets originated in Australia. The statutory concept underlying Australian financial plans is that agencies' budgets are not really in balance if they are accumulating a large backlog of unmet maintenance needs that are being pushed off upon future users. The concept is akin to the current U.S. focus of requiring States and municipalities to face their unmet pension liabilities. The pension payments may not be large enough today to imbalance a one or two-year budget. But over the long term, those growing pension liabilities represent a bill coming due that the agencies are not prepared to pay. This approach to budgeting is called an "accrual" approach. It means the agency is trying to capture its future assets and liabilities that are accruing and it is not focused only on its short-term cash flow balances.

The scenario presented in Tables 1-4 is not conducive to sustaining assets, which is why it is shown here. An examination of this financial plan shows that the agency is not

increasing its pavement and bridge expenditures at a time when its need to increase pavement expenditures rises by 4 percent annually. In a typical sources and uses-type document or a typical budget document, the need is not reported, only the revenues and expenditures. The financial plan offers an opportunity to explain the long-term needs and illustrate how they may be accumulating. In this example, the annual pavement gap grows from \$12 million in 2016 to \$146 million by 2024. Commensurately, the percent of miles meeting the pavement target fall from 90 to 78. Unmet bridge needs are less but grow from \$3 million in 2016 to \$35 million by 2024. With the report of the gaps and declining conditions, unmet asset liabilities are no longer “off the books” but a prominent part of the financial plan. With this information, decision makers know the consequences of current budget forecasts and know how much revenue they need to generate, or shift from other uses, if they are to sustain their assets at targeted levels. This information can inform development of future budgets and programming decisions.

### ***Communicating with a Financial Plan***

By itself, a dense table of numbers such as Tables 1-4 is unlikely to be an effective tool to communicate with stakeholders. Most agencies are likely to augment this summary table with narratives, trend line charts and even pictures of pavements that meets condition targets and ones that don't. However, nearly each line of this summary table can serve as the basis for greater discussion of the factors influencing the investment tradeoffs.

The agency can explain how the State Revenue grows only by an estimated 1 percent annually because of the slow increase in annual fuel consumption and because no increase in state fuel tax rates is expected in this forecast. Similarly, the forecast assumes no growth in Federal revenue, assuming that at best Congress will maintain current expenditures.

The agency also forecasts a 4 percent inflation rate that drops the effective purchasing power of the agency's budget by about 34 percent by the last year of the plan. All of these factors influence how much the agency can spend to maintain assets, and how much is left over for discretionary programs such as capacity expansion projects.

A transportation agency needs to communicate with multiple stakeholders each with different interests and levels of understanding. The public may be best reached with pictures of different asset conditions and summary narrative of how different funding levels and different investment tradeoffs will affect basic highway conditions. Members of MPO boards are likely to have a higher level of understanding and may be best communicated with by using scenarios that illustrate contrasting outcomes from different investment scenarios they could make. A small but critical audience is the senior legislators, their staff and state budget staff who review agency budgets. These staff are disproportionately influential in the legislative process and usually knowledgeable of how agency budgets have evolved over time. These stakeholders often are interested in the level of detail seen in this financial plan. Legislators usually rely on a few key members and staff to analyze agency budgets. The conclusions of these key staff and legislators often will sway an entire House or Senate to act. For those stakeholders, detailed and insightful analysis of how spending levels affect long-term asset conditions and how various scenarios and tradeoffs affect the outcomes generally are of significant interest.

### ***Risks and Rewards of Forecasting***

A ten year horizon creates risks because it brings both threats and opportunities. The threats include inaccurate revenue forecasts, inaccurate investment need estimates from management systems, incorrect inflation forecasts and uncertain asset performance a decade into the future.

Agencies are taking a chance when they stake the credibility of their financial plan on management system forecasts of how thousands of bridges or pavements will perform in 10 years without having reliable data or forecasting models. They also must estimate how much Federal-aid Congress will provide, or how weather and traffic loadings years from now will impact assets. These risks will be discussed further in Forecasting and Model Risks.

However, the rewards of a long-term financial plan can be numerous. The first benefit is demonstrating how adequate preservation investment today pays future financial dividends. Relatively small percentages of underfunding of preservation in the early years of a plan stimulates compounding growth in backlogs of deferred maintenance that create serious future financial liabilities. The effects of sound preservation don't show up in the short-term, but only over the longer horizon. With a short-term horizon, an agency could "save" money by cutting preservation. Only over the long-term do the costs of deferred maintenance become apparent.

A second benefit is related to the first. The financial plan can capture the value of the deferred maintenance and show it in "monetized" dollar terms as a growing and unaddressed financial liability. The 10-year forecast of needs, expenditures and gaps illustrates the backlog of deferred maintenance as an unmet cost that the agency carries into the future. This "accrual" approach brings into the agency's financial planning process the liability of unmet asset investment that otherwise would not be represented on short-term financial statements. With an "accrual" approach, obvious future assets and liabilities are recognized and reported.

A third benefit is a long-term financial plan encourages long-term strategic thinking that is needed for the lifecycle management of long-lived assets. The lifecycle of a bridge



or pavement spans decades. Treating that asset at the appropriate point with the proper “mix of fixes” requires strategic understanding of the asset’s lifecycle. The complexity required for such strategic thinking is multiplied by the thousands of assets an agency manages. A financial plan provides “advance warning” to decision makers and allows them to plan years in advance for investments needed to sustain assets. Legislative efforts to raise new transportation revenue often take years, and sometimes only after repeated failures. The long-term perspective of the financial plan allows legislators and other decision makers long lead times to anticipate how to close financial gaps. Or, the agency can decide whether to lower condition targets or defer discretionary projects such as ones for congestion relief. It also can lead to strategic decisions on how to manage revenue sources such as bonds to be timed strategically over a decade to provide revenues when most critically needed to sustain asset targets.

Therefore, the longer timeframe for the asset management and financial plan is essential for incentivizing and documenting good asset management practices and for keeping decision makers focused on sustaining assets. A longer period of 20 or 30 years is likely to lose credibility because agencies lack the data and analytical programs to accurately predict asset conditions much beyond 10 years. Therefore, the 10 year period is long enough to illustrate the benefits of a lifecycle approach but short enough to be credible.

### ***Forecasting Risk***

Without a thorough statement of the risks, uncertainties and assumptions inherent in them, the asset management and financial plans could provide a false sense of confidence, or be criticized for “crying wolf” if investment gaps are emphasized. As was described in Report 2, Financial Planning for

Transportation Asset Management: Components of a Financial Plan, the financial plan includes a table of revenues, expenditures, projected investment needs and investment gaps. Taken at face value, these will be assumed to be credible forecasts that the agency expects to occur. However, nearly every element of a forecast beyond the first or second year of a financial plan will be influenced by factors and parties beyond the agency's control. Federal-aid will be determined by Congress. State funding sources will be influenced by legislators, commissions and governors. Tax receipts are subject to the economy, fuel consumption, tax diversions and tax rates. Construction costs will be influenced by larger market forces of global materials demand, the amount of construction industry competition and the availability of key inputs such as aggregates. In metropolitan areas, programming decisions are influenced by metropolitan planning organization (MPO) boards. In short, the agency will be responsible for achieving long-term asset conditions when much of its operating environment is beyond its control.

Failing to acknowledge these uncertainties aggravates several risks and undermines several potential opportunities. The negative risks are that stakeholders will question the agency's credibility if its targets are not achieved because of factors the agency had not predicted. Conversely, the agency could use these same risks as opportunities to emphasize to the outside stakeholders their role in assisting the agency with achieving the public's long-term asset targets. For instance, if local agencies that own parts of the NHS do not adopt preservation and preventive maintenance strategies on those sections, the risk of higher future costs increases. Also, the forecasted investment needs can convince MPO boards to include adequate preservation investment in the Transportation Improvement Program. (TIP) The asset management plan and financial plan can be an opportunity to engage

legislators, the Congressional delegation and key stakeholders such as MPO boards. If all are focused on the same goal of striving for sound asset conditions the agency is more likely to achieve them.

Some of the key risks in the financial plan can be categorized as forecasting or “model” risk. Model risk is commonly recognized in the financial industry. As investment firms try to pick the best portfolio of investments to meet their desired rate of return, they model important financial inputs such as the rate of future inflation, growth in the economy, currency exchange rates and other factors that will influence the performance of their portfolio. As is analogous with transportation agencies, the amount of nominal or non-adjusted future dollars is less important than knowing how much inflation-adjusted revenue an agency will have. Therefore, the agency’s models for forecasting need, asset performance, inflation and revenue are important. One author compared those who measure risk with models to pilots who fly by instruments in bad weather. If they aren’t confident in their navigational instruments they will fly off course.<sup>[1]</sup>

Transportation agencies that need to extrapolate long-term forecasts of revenues, expenditure needs and asset conditions are also “flying by instrument.” In their case, however, the instruments are the revenue, bridge, pavement and other asset models they use to convert today’s known data points into forecasts of where the agency’s revenues and asset conditions are heading ten years in the future.

### ***Inflation Risks***

Model or forecast risk is particularly important in asset management and financial plans for two reasons. First, the power of compounding that can be an issue with any forecast is particularly acute with the long timeframes and large sums included in a financial plan. As in the example in Table 1, if an

agency spends \$304 million on pavements in year one of its 10-year plan, the compounding effect of an inflation forecast can be significant over a decade.

As Table 5 shows, the inflation rate that the agency represented in Tables 1-4 assumes for its 10-year forecast can have a major bearing on the plan's outcome. If the agency is currently meeting its pavement targets and it assumes that an inflation-adjusted expenditure of \$304 million for each of the next ten years will be adequate to continue meeting its asset targets then the inflation-rate forecast will be a critical input to the plan. As can be seen in Table 5, the effect of a 5 percent annual inflation growth rate is significantly different than the effect of a 2 percent annual inflation rate. The difference between the 2 percent and 5 percent inflation assumptions total nearly \$124 million annually by the tenth year. For this example state, \$124 million would equal all the funds passed through to local governments, or the majority of the Mobility/Capacity budget. Therefore, the agency faces risks with its pavement-inflation forecast. Under estimating could mean that in later years of the plan the agency will not meet condition targets because it cannot afford all the treatments needed. It would then have to defer programmed projects in other categories, such as capacity-expansion, and transfer money to pavements or accept lower condition

Base Year Pavement Budget	Annual Inflation Rate Scenarios	Pavement Budget Needs at End of 10 Years	Additional Amount Needed from Base Year
\$304	2%	\$371	\$67
\$304	3%	\$409	\$105
\$304	4%	\$450	\$146
\$304	5%	\$495	\$191

**Table 5. The effects of differing inflation assumptions on an agency's pavement budget.** (All figures in \$ Millions)

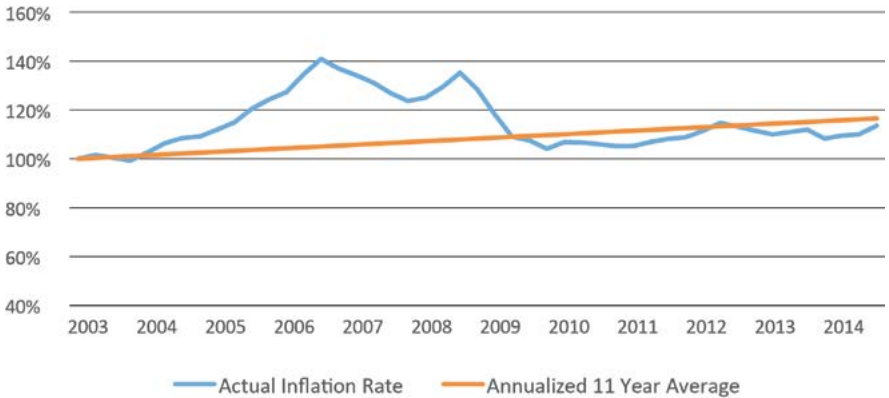
levels. Conversely, if it overstates inflation it may not realize that it has more pavement budget than it needs. It could postpone for several years planning for other projects that are important to the safety, mobility and well-being of communities which could have been paid for with the extra pavement dollars.

The inflation example tries to illustrate the zero-sum nature of long-term transportation budgeting. Agencies face demands for a virtually unlimited amount of project requests from communities, MPOs, businesses and interest groups. If the agency overestimates its asset-preservation needs it is denying these groups projects they see as important. Underestimating the effects of inflation could lead to reduced asset conditions, or the need to re-direct resources later by deferring other projects that are under development.

The last two rows of Sources of Funds in Table 1 illustrate the effects of inflation. The Total Sources line illustrates the unadjusted, nominal income forecast. The Inflation Adjusted Sources line shows the effect of assuming a 4 percent annual inflation rate. By the tenth year, the effective purchasing power in 2025 is 34 percent less than the nominal budget. The \$1.689 billion of 2025 is worth only \$1.123 billion in 2015 dollars. The effects are more acute in this era when revenues grow slowly, if at all.

Figure 1 (see next page) illustrates the potential difficulty and risk of predicting construction price trends. These data from the FHWA National Highway Construction Cost Index only have a compound annual growth rate of 1.16 percent between 2003 and 2014. However, at the peak of inflation in 2006, prices had risen 36 percent from the base year of 2003 before dropping in 2007, rising again in 2008 and then falling until late 2009. A construction inflation estimate in 2006 probably would look much different than one made in 2003 or 2014. This variability illustrates why an agency

### FHWA Construction Inflation Trends



**Figure 1. Actual and compound average annual construction inflation 2003-2014.** SOURCE: FHWA

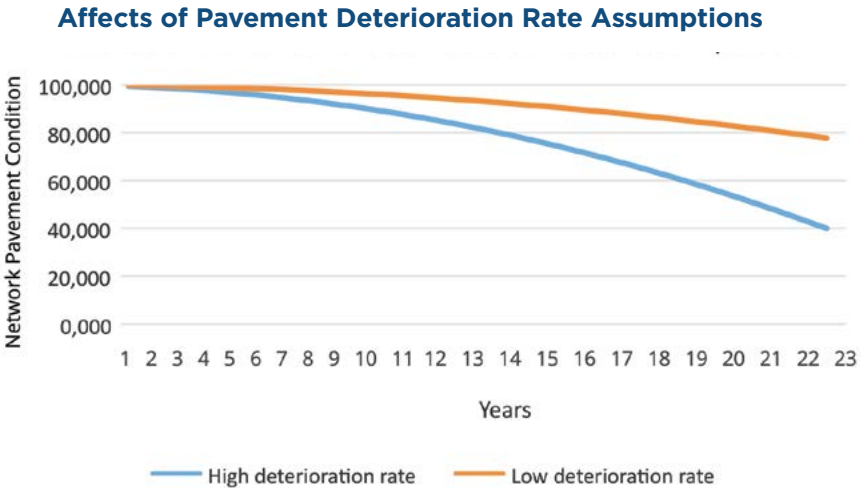
may want to state its inflation assumptions, express the consequences of variability in those assumptions and regularly monitor price changes to update its forecast through the life of the plan. The agency also could express its confidence levels in its forecasts and note they could vary substantially above or below the annualized average forecast.

### **Model Risk**

In addition to the risk of predicting an accurate inflation rate, another significant risk is inherent in the forecasts produced by bridge or pavement management systems. The bridge and pavement forecasts are central to financial plan assumptions. They provide the estimates of investment needed to meet and preferably sustain the asset condition targets over the forecast period.

As with the inflation forecasts, the pavement and bridge investment analysis assumptions are influential because of the large amount of money involved and the long horizon that compounds future cost assumptions. Pavement and bridge programs are among the agency's largest and create the largest financial demand when they increase. Differing from the inflation assumption, however, is the exponential growth in costs created by the non-linear and escalating rate of deterioration of assets as they age, particularly for pavements. According to FHWA statistics<sup>[2]</sup> the average state has 6,010 center line miles of rural highways which can be assumed to equal 12,020 lane miles. A relatively small difference in assumptions of pavement deterioration rates produce substantially different forecasts of condition levels and needed investments when extended over 10 or 15 years as seen in Figure 2. These differences in the amount of forecasted deterioration multiplied by a large number of lane miles and increased over time by inflation costs can create significant differences in pavement-need forecasts in the later years of an asset management plan.

In Figure 2 (see next page), the rate of pavement deterioration in the High Deterioration Rate Scenario is only about 1 percent greater in the early years of the forecast than the assumed deterioration rate for the Low Deterioration Rate Scenario. Because of the exponential rate of deterioration assumed as pavements age, the effects upon network pavement conditions are significant over time. Over 20 years, the high deterioration rate assumption requires nearly twice as many lane miles to need treatment compared to the low deterioration rate assumption. This scenario was conducted assuming the lane miles were all rural, two-lane routes many of which are subject to relatively light treatments which can deteriorate quickly when not applied at the proper times. For a statewide analysis, all pavements would need to be included.



**Figure 2.** Slight differences in pavement forecasts can have major financial implications.

Inherent within the model risks for pavements are several contributing risks. One is the quality of data collection. If quality assurance/quality control processes are not in place the agency may lack confidence in its pavement condition data that are foundational to model forecasts. The models often are calibrated based upon year-to-year changes in pavements. If those changes are not captured correctly then the model will be less accurate.

The extent of historic data also contributes to the confidence in the forecast. If an agency has many years of data of how pavement sections changed over time based upon treatment types and costs it is likely to have more confidence in its forecasts. This is particularly true for forecasts in the early years of the plan. The “input-output” confidence can be high if an agency has 20 years of complete data and it is forecasting for the first five years of its asset management plan. Its confidence may be lower for the second five years of the plan. Alternatively, an agency that is only now developing a



pavement model and lacks extensive pavement treatment, expenditure and performance history probably would have less confidence in its forecasts of how pavements will perform over the next decade. This lack of confidence may be compounded when agencies have not tracked program expenditures, or when they now are relying on relatively new treatment strategies. As more agencies adopt pavement preservation strategies, they need to assume how those strategies will affect network-level pavement conditions for the next decade.

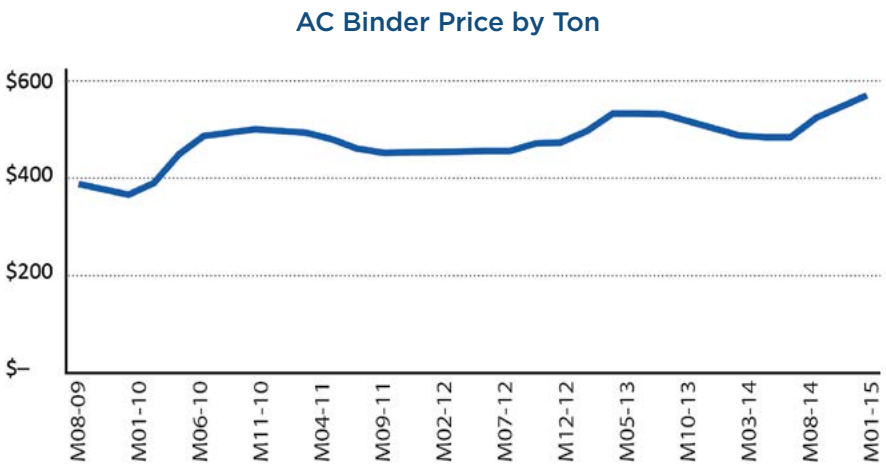
Two examples based on theoretical but typical state transportation agencies illustrate the differing levels of forecast confidence. Agency A has 20 years of data on each pavement section, how it was treated and its performance over time with given treatments and traffic loadings. Agency A also has a history of using lower-cost preservation treatments and has both historical data of how they performed and confidence in how they will perform in the future. With a large sample size and a known amount of variance in how the pavements performed it could calculate statistically a confidence level in its forecast.

Alternatively, Agency B does not have consistent pavement performance data. At most its data is eight years old and for some years data were not collected. The agency lacks historic information on the treatments for each section. The agency also has not relied heavily upon preservation treatments. Now, as the agency develops its pavement management forecast it has less confidence than Agency A. Agency B is developing a 10-year treatment plan and assumes based upon rules of thumb how each treatment will perform. However, its forecast is weighted heavily on assumptions of future treatment costs and performance and is not as heavily weighted by the historical data such as Agency A possesses. Agency B intends to emphasize pavement preservation in its plan but it lacks empirical data on

how those treatments will perform given its traffic, climate and pavement conditions. Agency B will have less confidence in its pavement forecast which could be significantly inaccurate in the later years of its plan. Agency B may want to disclose its assumptions of future pavement conditions and performance, monitor the performance year-to-year and update its forecast annually as it recalibrates its model based on actual pavement performance.

### Material Cost and Market Risk

While the overall impacts of inflation already have been discussed, the impacts of some key materials also can be a significant variable in forecasting investment needs. Although prices have moderated since the over-heated construction cost years of pre-2008, the prices for key inputs such as steel, aggregates, cement and asphalt binder are still important variables to consider. The agency may benefit from noting in its financial plan the assumptions it makes regarding these key inputs. As Figure 3 shows, the prices of



**Figure 3.** The variability in a key price input, asphalt binder.  
SOURCE: OHIO DOT

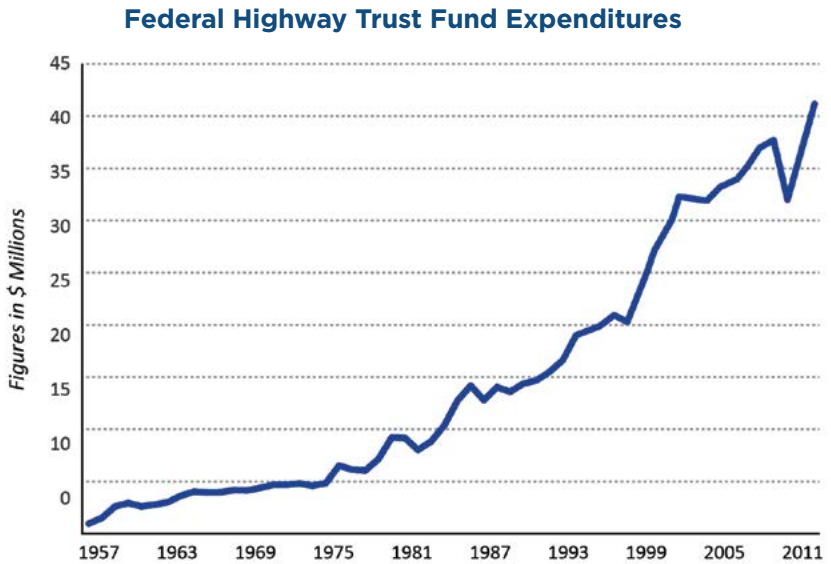
key inputs, in this case asphalt binder, can vary considerably and are subject to national and international market forces beyond an agency's control.

### ***Social, Political and External Financial Risks***

Model risk is not limited to technical, engineering, performance or empirical cost data. Unit costs assumed for pavements and bridges can vary widely depending on the scope elements that an agency anticipates it will need to accommodate, such as curb ramps. The agency also may want to consider other external risks such as appropriation risk, or the risk that State, Congressional or local officials will not approve budget amounts, or budget categories, as assumed in the plan. Finally, a broad range of external factors such as floods, storms, seismic events or even economic changes can influence the assumptions in a plan. This section examines some of the most likely external variables that an agency may want to consider in its financial plan.

### ***Appropriation Risks***

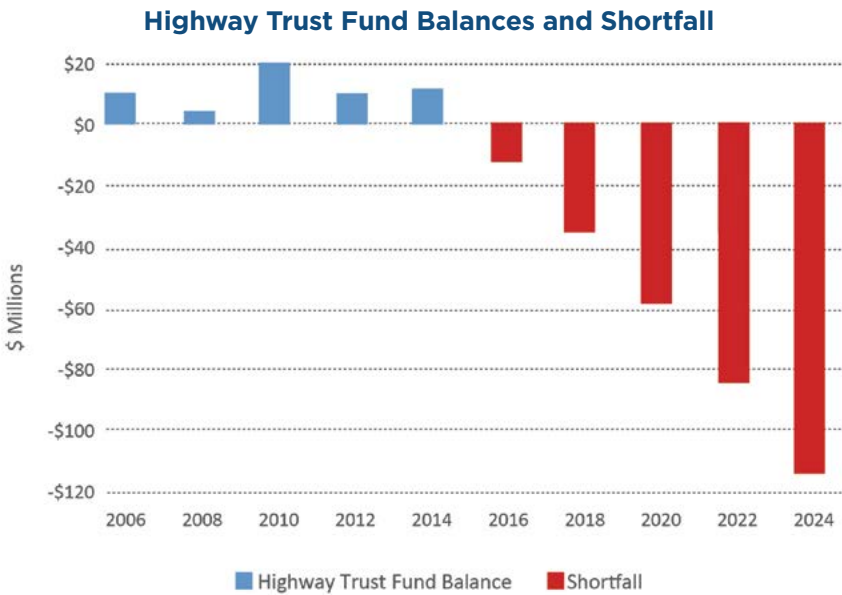
The juxtaposition of Figure 4 and 5 (see pages 24 and 25) illustrates the uncertainty State agencies will face in forecasting Federal-aid amounts. Figure 4 shows the steadily increasing levels of Federal Highway Trust Fund expenditures from 1957 through 2012. The trend equates to a 7.1 percent compound annual growth rate. From the 1950s through the early 2000s, agencies could forecast future State and Federal income levels based upon the slow but steady rates of growth in their fuel-driven highway tax appropriations. However, the declining rates of fuel consumption caused by increased vehicle fuel efficiency, increased urbanized and greater use of transit has decreased fuel consumption growth. At the Federal level and in many states the fuel tax rates have remained unchanged. Higher expenditures out of the Highway Trust Fund in past years have outpaced receipts



**Figure 4. Historic Federal highway expenditures grew steadily from 1957 to 2012.** SOURCE: FHWA HIGHWAY STATISTICS TABLE FE-21

leading to the results of Figure 5. It shows that the Highway Trust Fund would be in a serious deficit if expenditures and receipts remained at current levels. Since the trust fund can't operate at a deficit, Figure 5 is a hypothetical illustration of the degree current expenditures are not supported by projected receipts.

An important variable for agencies to address will be their assumptions for Federal-aid and State revenues. The fictional agency in Tables 1-4 in 2015 received \$750 million in Federal-aid and its forecast assumed no growth in that amount for 10 years. On the other hand, if the agency forecasts that Federal-aid growth returns to its historic levels of 7.1 percent annually, the fiscal forecast would be substantially different. In the tenth year it would be forecasting to receive \$1.489 billion in Federal-aid, instead of \$750 million. Therefore, the



**Figure 5. Current apportionments cannot be supported with current Trust Fund balances.**

rate of growth in Federal-aid and State revenue will be an important variable for the agency to address. Whether an agency forecasts that it will have the revenues to achieve its condition targets may hinge upon how much State and Federal revenue it forecasts.

### ***Forecasting Bond Capacity***

One benefit of the longer timeframe of an asset management plan is the opportunity to plan for bond issues years in advance to help offset forecasted shortfalls. Agencies tend to issue bonds for 10 and 20 year periods, with many agencies opting for the 10-year horizon because of the lower interest costs. When an agency plans 10 years into the future, it can anticipate when payments for past bonds end, or are “off-loaded” from the balance sheet. As bond

payments end, the bond payment amounts become available. They can be used as cash for on-going investments or the agency could plan to borrow again and use the available cash to pay for a new issuance. As a general rule of thumb, borrowing is not advised for short-lived assets. The result is the owner is paying interest for an asset that is beyond its useful life. However, agencies could consider bonding for particularly high-cost and long-lived assets such as major bridges, or the reconstruction of pavements on major corridors. Strategic issuance of bonds during the planning horizon can create several benefits. If the bond proceeds bring major bridges or many lane miles of pavements to their condition target it helps the agency achieve its asset condition targets. A sound asset also can reduce maintenance costs. Bonding to replace poor-performing major assets also can reduce risk. If the asset were to deteriorate rapidly during the planning horizon it could cause resources to be diverted from achieving targets for other assets. Strategic issuance of bonds can be an effective strategy particularly when interest rates are low, future construction costs high and asset conditions are poor.

### ***Scope Risks, Uncertainties and Opportunities***

Social and political issues also can create financial uncertainty. The need to comply with social imperatives can influence what scope items are included in pavement and bridge projects, particularly in urban areas. An agency may face growing needs to address curb ramps and sidewalks. The degree to which these costs must be included in pavement forecasts creates a significant variable. In some cases, repairing sidewalks, curb ramps and features such as lighting can cost more than the pavement. Societal insistence that these elements be included with paving projects creates uncertainty over project costs but also over treatment timing. In urban areas, the repair of sidewalks and

curbs can trigger changes in drainage structures that lead to environmental permitting. Although these additional project elements have high social value, they significantly complicate the forecasting of unit costs and treatment timing. As agencies, particularly in urban areas, forecast their bridge and pavement unit costs and treatment timings these factors may be significant sources of risk or uncertainty.

The interface between technical and social issues is likely to become more of a variable as both State transportation agencies and MPOs increase their cooperation to achieve the MAP-21 performance requirements. In the urbanized areas because of the cooperative planning process and the expansion of the National Highway System to include more locally owned routes, state agencies, local governments and MPOs will be sharing many decision-making and planning functions related to assets. The need to clarify limits or assumptions about project scopes will complicate asset-cost forecasting. When bridges and pavements are repaired in urban areas the questions of how to include “complete street” and similar attributes will be an important variable in estimating the costs to repair and rehabilitate aging streets and bridges.

### ***Climatic or Seismic Risks***

Another set of risks that agencies may want to note in their financial forecasts are those caused by storms, seismic events and other natural disasters. The agency’s ability to achieve its performance targets is contingent upon not having to divert resources or experience higher costs because of these unexpected events. There are few established means for accurately forecasting the likelihood of such events in the decade of a financial plan. The most an agency may be able to do is note that these events could occur, would affect the achievement of the targets and that the plan will need to be updated should a major event occur.

## ***Hedging Financial Risks***

Many of these risks are beyond the agency's control and the agency can only monitor, tolerate and react to them. The significant number and potential impact of the risks may well lead the agency to monitor them frequently and to assess how frequently the plan assumptions should be updated. In a mature performance management environment, the agency leadership is likely to be frequently monitoring performance and reviewing the inputs to that performance, such as revenue streams. Although the frequency of update of financial plans is not determined, it may behoove agencies to update them regularly, such as annually. Some may want to consider annually refreshing key assumptions, such as income streams and inflation rates based upon economic and legislative developments. A rolling 10-year plan that is updated annually with a new tenth year added could create a dynamic and responsive financial planning process.

## **Updating Forecasts by Monitoring Leading Indicators**

A way to monitor key financial assumptions is to track leading cost indicators, such as national construction price trends, bid prices for key materials and bidding trends. Each agency bid letting provides an opportunity to track key price inputs such as the price of cement, aggregate, steel and labor. A feedback loop from the estimating department to the asset management planning office can give the asset management unit advance warning when estimators see that unit prices are rising. If the prices are rising faster than expected in the financial plan, it can serve as an indicator that plan assumptions may have to be updated.

National price-monitoring services also can give insight into whether prices are expected to rise. These services track key indicators such as the price of "futures" which are financial instruments tied to the expected price of key commodities



such as oil and steel. By tracking futures costs, agencies can have some advance warning of trends that industry experts believe will eventually affect prices.

### **Strategic Borrowing to “Smooth” Revenues**

All agencies face financial, legal and practical limits to the amount they can borrow. Borrowing amounts are often set by legislative limits and subject to approval by state treasurers or budget officials. Within fiscally prudent limits, agencies can strategically use borrowing to “smooth” out shortfalls in a 10-year forecast of revenue. An example would be for the agency in Tables 1-3. If the agency has the capacity to borrow an additional \$200 during the next 10 years it could hold that in reserve and use it in the later years of the fiscal period if the State and Federal revenue streams remain as constrained as they are forecast. If additional State or Federal revenue materializes above the forecast, the bonding may not be needed. As noted earlier, bonding can be prudent for high-cost, long-lived assets if their higher conditions will remain sound beyond the period of the borrowing. For instance, replacing several large, high cost bridges that are 60 or 70 years old could reduce future maintenance costs for decades. The cost saving from eliminating the maintenance costs could offset the cost of the bond financing. Each case has to be examined individually to ensure that borrowing is prudent and allowed under the agency’s appropriations. However, the strategic thinking encouraged by the long timelines of the financial plan could include the well-timed issuance of bonds to lower long-term maintenance costs and to improve asset conditions.

### **Sound Preservation as a Risk-Mitigation Strategy**

As noted earlier, the precedent for financial and asset management plans originated in Australia. There, the state governments require local governments to develop financial and asset management plans to ensure that the agencies remain fiscally solvent and do not accumulate deficits that

will diminish services or require state “bail outs.” Several audits of the local government financial plans concluded that over time they led to increased spending on preservation and maintenance, greater understanding of long-term asset liabilities and less tendency to build new assets that create future maintenance costs.<sup>[3]</sup>

Most pavement and bridge management scenarios that include significant amounts of preservation tend to demonstrate that higher conditions can be sustained over time for lower cost when preservation is emphasized over “worst first.” Allocating sufficient funds for preservation and ensuring that they are applied appropriately is both an asset management strategy and a financial management one. Over the longer timeframe of the 10 year asset management plan the higher conditions for lower cost become more apparent than when analyzed only over the four year period of a state transportation improvement program (STIP.)

## 3. The Financial Risk Register

MAP-21's requirement for risk-based asset management plans leads many agency officials to seek a better understanding of risk, risk management and its applicability to asset management. Risk management is defined here as the cultures, processes and structures that are directed towards the effective management of potential opportunities and threats. While risks are events or issues, risk management is the organizational architecture to address them.

Risk management evolved from what used to be a narrow specialty focusing on reducing insurance claims to a broader, more strategic discipline. In much of the corporate world risk management supports the agency's performance management and strategic planning functions. The logic is that organizations can't achieve their objectives if they don't identify and manage the risks to them. Also, organizations need to take well-reasoned risks to achieve their objectives. The degree of return an organization receives from an investment is generally correlated to the degree of risk it will accept.

When Congress adopted a performance-based transportation program in MAP-21, it also emphasized risk management. Although not articulated in MAP-21, the linkage between risk and performance management is logical. The more ambitious and far-reaching are the objectives of an organization, the more events or factors could arise to impede them. Risk management is a practice that parallels performance management. While performance and asset management set goals and focus an organization upon their accomplishment, risk management serves as a navigational aide that helps to identify and avoid risks to the goals. It also can help differentiate a threat from an opportunity and allow an organization to capitalize upon them.

In a performance-based environment it is likely that agencies will develop dashboards, track metrics and regularly update legislators, commissioners and other stakeholders about performance progress. A tool that can complement performance reporting is a risk register. It is a relatively simple table that includes a list of the risks facing an agency. The summarized format provides at-a-glance information about the risks, their likelihood, impact, mitigation strategies and to whom their management is assigned. The risk register is similar to a dashboard but it focuses upon the issues that could impede performance objectives. It helps with the tracking of performance by addressing the risks, variability, uncertainties, threats and opportunities that face an organization's objectives.

Tables 6, 7 and 8 (see pages 33 and 34) include three examples of a risk register populated with three risks to the agency's financial plan. The three risks being monitored in this excerpt from a larger risk register are inflation, Federal-aid funding levels and risks inherent in the pavement model forecasts. Risk registers vary widely and there is not a set format. Generally, they are simple table-like documents as seen here. The intent is to provide a quick summary of a risk, its importance, management strategies for addressing it and an update of its status. The risk register accompanies other performance-tracking tools. In a mature risk-and-performance environment, an organization is likely to have a performance dashboard or repository of metrics that is reviewed regularly. The risk register can accompany the performance dashboard and be regularly reviewed. Risk registers are required for many local and state governments in Australia and Canada.

In those agencies, the risk register is included with annual budgets, asset management and performance reports. In many agencies, they are reviewed at regular meetings of the board or commission managing the agency. The concept is

Inflation Risk	Likelihood	Impact	Value	Comments	Action Required	Status
Construction inflation could exceed 4 percent annually which could impact our ability to deliver the projects and maintenance activities anticipated in our asset management plan.	Moderate	Significant	High	To date, construction inflation has not exceeded 4 percent. It has stayed at less than 3 percent on an annualized basis. Predicted continued low oil prices are viewed as a positive inflationary factor.	Continued diligence on monitoring construction prices and being prepared to adjust the program if needed.	Good

**Table 6. Example of an inflation risk register.**

Federal Funding Risk	Likelihood	Consequence	Value	Comments	Action Required	Status
Federal-aid funding could fall below projected levels which would necessitate reductions in the asset management funding levels and require reducing treatment targets or diverting resources from other programs.	Moderate	Significant	High	No certainty exists for if and when transportation appropriations will be re-authorized or at what level.	Continued monitoring and outreach to keep stakeholders apprised of status and potential consequences.	Requires continuous monitoring

**Table 7. Example of a Federal-aid risk register.**

Pavement Model Risk	Likelihood	Consequence	Value	Comments	Action Required	Status
The new pavement model may not produce accurate forecasts of investment need which cause us to over or under estimate adequate funding levels.	Low	Low	Low	So far the model has been calibrated and its forecasts comport with expected values.	Continued refinement of deterioration curves. QA/QC of data collection. Integration of pavement model in the GIS system.	Good

**Table 8.** Example of a pavement model forecasting risk register.

that the performance reports track progress on the agency's objectives. The risk reports serve as a monitoring system of the issues that could affect that performance.

In these three examples, the agency could be tracking the expected rate of inflation to determine if this key assumption in its asset management plan is evolving as expected. The risk owner is the asset management lead and the chief estimator. They could be monitoring bid prices and following the industry's estimates of how key input prices are changing nationally and internationally. Prices such as for steel, oil, binder and cement are influenced by international demand. As the economies in China, India, Europe and elsewhere expand and contract the price pressures on these commodities change. The price spikes seen from 2005-2008 were caused by the U.S. housing bubble and double-digit economic growth in China and to a lesser extent India. That put pressure on commodities such as cement, steel and binder that are traded internationally. Tracking bid prices and futures prices can provide an agency insights into whether its long-term inflation forecast remains realistic.

The Federal-aid funding risk is more affected by political decisions than economic ones. The tracking of this risk is assigned to the asset manager and to the agency's Federal liaison. They would be expected to follow Washington developments and apprise the agency of any likely Federal appropriation or re-authorization issues that could affect the agency's estimate of its Federal-aid.

The third example addresses the agency's new pavement management system. It provides the estimates of overall and by-district funding needs for the pavement program that is the largest component of the agency's asset management and financial plan. As such, the pavement management system forecast is one of the most critical assumptions in the asset management plan. If it over-estimates or under-estimates the

amount needed to achieve the pavement targets, the entire 10-year program will be imbalanced. The risk surrounding the pavement forecast is assigned to the pavement program owner who is expected to inform the leadership if the pavement forecast needs to be adjusted.

The value highlight the agency's estimates of the likelihood and impact, or consequence, of the different risks. The likelihood is multiplied by consequence to generate a score, or "expected value." Generally, once an agency embraces risk management it produces standardized scales that staff use to estimate the likelihood and consequence. They use standardized values to estimate those two factors, generate a score and rank order the risks. A risk with a low rating may be tolerated and only monitored. A risk with a high rating may be actively managed with mitigation taken to reduce its effect.

The risk register is designed assuming the agency has an active, ongoing and dynamic performance environment. Both performance and risk are tracked and decision makers focus their attention on achieving the performance and managing the risks.

### ***Keep it Simple***

The risk management process does not have to be complex. "Keep it simple" is the advice from the participants in an FHWA International Technology Scanning Program study tour of transportation agencies with active risk management programs.<sup>[4]</sup> The identification of risks, the assessment of their likelihood and impact were done by agency staff based upon their experience and professional judgment. Complex predictive models are not required. Although Wall Street uses complicated models of risk compared to expected returns such models are not common for most risk management programs. The agencies in Australia, England and



the Netherlands that were studied on the scan tour relied upon the insights of their staff to compile the risks, their likelihood and impact. The benefits of a comprehensive risk program are that staff are solicited to anticipate what issues could affect their objectives and how those issues should be addressed. One Australian official described risk as “what keeps us up at night.” They are the factors that knowledgeable staff realize must be managed to achieve the agency’s objectives.

## 4. Financial Metrics

Another set of tools for monitoring risks and the adequacy of investments are financial metrics. These metrics are not commonly used by U.S. transportation agencies but are common in Australia, and are essential for private sector businesses. As international and corporate practices such as risk management and asset management become more common with U.S. transportation agencies they may want to also adopt financial performance metrics. They provide transparency and predictive insights into trends of past, current and future performance.

If transportation agencies were to use forecasted financial performance measures they would be adopting best practices that U.S. and international regulators have required for banks, insurers, publicly held corporations and other organizations that affect the public's and nation's financial well-being. After a series of corporate collapses such as the failure of Enron and WorldCom, Congress enacted the Sarbanes-Oxley Act (SOX) that increased the degree of financial reporting required of publicly traded companies to give investors more insights into companies' financial strengths.<sup>[5],[6]</sup> Similar reforms were adopted in Europe for banks, insurers and corporations there.<sup>[7]</sup> A series of assessments of Australian local governments documented in the early 2000s that they were accruing backlogs of unfunded maintenance that threatened their future service levels and financial strength. Those led to new statutes such as the Queensland Local Government Act of 2009 that require communities to adopt asset management plans, financial plans and risk management. The Act says a government is financially sustainable if it is able to maintain its financial capital and infrastructure capital over the long term. Short-term budgets that focus on short-term cash balances are insufficient to provide insights into the long-term sustainability of asset conditions and service levels.

Included in the financial plans are financial metrics that illustrate how solvent the agency will be and how well it can finance its asset conditions.

An advantage of financial metrics generated by a 10 year plan is they are leading measures, with predictive ability. Many performance measures such as current pavement or bridge conditions are lagging measures. They indicate what has happened to date but not what is likely to occur in the future. Leading measures allow decision makers to change course, or to at least understand what is likely to occur if current trends continue. Additionally, the leading financial measures provide insights into whether the actions of today's decision makers will create financial burdens and deteriorated asset conditions for future users. The need to consider the sustainability of assets for future users has been referred to as "inter-generational equity" by some Australian and British planners. The concept is that current users should not consume assets essential for future users. A "pay as you go" approach is to replace the assets "consumed" by current users, such as replacing the bridges and pavements that deteriorated based on the use by the current generation. Financial metrics based upon projected income and investment need can assess the degree to which financial plans will sustain assets for future users.

### ***Selected Financial Metrics***

The following is a partial list of possible financial sustainability metrics that could be included in a financial plan. A review of a basic business finance textbook would provide dozens of business financial metrics that could be relevant to transportation agencies if they were slightly altered for public agency circumstances. Nearly all the metrics are ratios. Ratios provide insight into the relative financial strength of organizations. The amount of outstanding debt or need for Rhode Island may be significant to it but

insignificant if held by California. Like volume to capacity ratios (V/C) or benefit-cost (B/C) ratios that transportation officials are familiar with, these financial ratios generally divide some type of demand or need volume by some type of income or asset-condition measure. The result is a financial strength or adequacy measure that provides insights into future direction.

### ***Percent of System Conditions Meeting Target***

A set of measures that assess both condition and risk are ones that forecast the percentage of assets that meet condition targets into the future based on projected funding levels. Table 9 is excerpted from the Table 4 financial plan. It shows the percentage of the theoretical state's bridge and pavement conditions expected to meet condition targets for the each of the next 10 years. This forecast indicates steady decline in conditions. This forecast indicates that either future users can expect lower conditions and higher vehicular operating costs or the future users will need to raise new revenues to replace the assets consumed by earlier users.

### ***Asset Sustainability Ratio or Index***

The asset sustainability ratio calculated here is a conceptually simple metric in which the amount budgeted for an asset category is divided by the amount needed to sustain its condition at the targeted level over the forecast period. It was first described by FHWA in July of 2012.<sup>[8]</sup> While conceptually simple, the credible calculation of needed investment can be complex when the variables of forecasting error and inflation error are considered, as was described earlier. This ratio was proposed to be a simple measure that gives decision makers a relative idea of the degree to which assets, or classes of assets, are adequately funded to achieve desired condition targets. As seen in Table 9, the ratio in 2015 was

Investment Results	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Sustainability Gap	\$0	\$15	\$31	\$48	\$65	\$83	\$101	\$120	\$140	\$160	\$181
Asset Sustainability Index	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.77	0.74	0.72
Percent of Pavements Meeting Target	90	90	88	87	85	85	84	82	80	79	78
Percent of Bridges Meeting Target	95	95	95	94.5	94	93	93	92.5	92	91	90

**Table 9. Summary of forecasted declines in pavement and bridge conditions.** (All figures in \$ Millions)

1.0 which indicates the agency believes there is no funding gap for those assets and the level of investment is adequate to meet condition targets. The ratio steadily declines and falls to .72, or 72 percent of needed investment levels, by 2025. In this example, the total need to meet bridge and pavement conditions is divided into the budget for bridges and pavements to produce the ratio. The metric can be either a ratio or an index. If only one asset class is measured, the FHWA report proposed producing a Sustainability Ratio for that class of assets. When the ratios for several asset classes are combined, they can be totaled into an Asset Sustainability Index. In this case, the assets that are combined into the Asset Sustainability Index are the bridge and pavement assets. If an agency had confidence in its forecasts of need for other assets, such as signs and lighting, they could be included in the index.

The sustainability index is assumed to serve several functions. If decision makers assume that sustaining existing assets at acceptable levels is a fundamental objective of transportation planning, then the asset sustainability index can be a baseline, or core, metric. It can be developed early

in the financial planning process and used to guide later decisions regarding how much to allocate to important, but optional, categories such as mobility/capacity. Conversely, if an agency decides for political or economic reasons that it has to fund other categories at higher levels, the ASI can “keep track of” the amount of future revenue that will be needed to restore the assets to their targeted condition level. The name, asset sustainability index, also intends to emphasize the policy objective of maintaining assets at acceptable levels for future users, or ensuring financial sustainability.

The U.S. asset sustainability index is derived from a similar index successfully used in Australia. That index, however, is based on the amount needed to restore or maintain assets at their current valuation. Valuation means assigning monetary value to an asset based on its age and condition. For instance, a new bridge built for \$2 million has a valuation of \$2 million. As it ages and deteriorates, its valuation declines. Australian investment levels are determined in part by the amount needed to maintain a desired valuation for a network of assets. In Australia, agencies devote considerable effort to valuing their assets and capturing the estimates of depreciation and impairment that are needed to estimate the current monetary value of an older asset. In the U.S., asset valuation is conducted differently and is not used for investment decision making. While the term “asset sustainability index” was borrowed from Australian practice the U.S. version is calculated differently.

### ***Debt Ratios***

Another ratio that could provide insight for financial decision making is a debt ratio. It could be calculated in various ways such as total debt divided by total income, or state debt divided by state income or federal debt divided by Federal income. Or, an agency could set a percentage

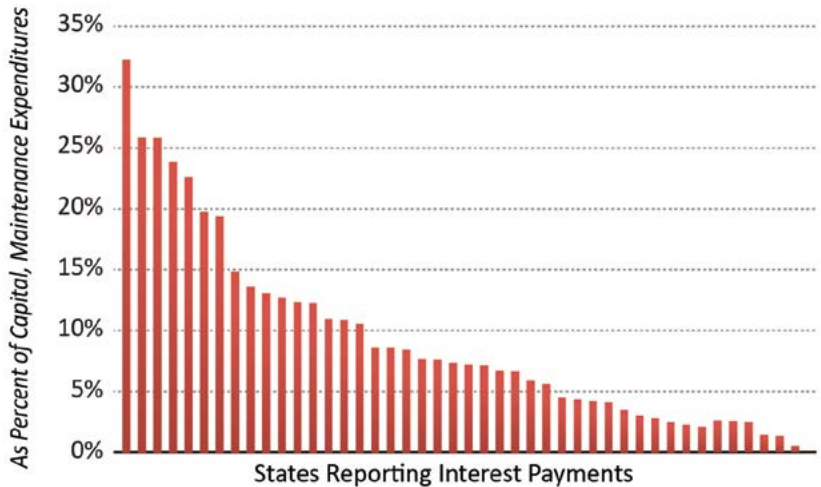
limit it deems prudent, such as debt should not exceed 10 percent or some other percentage of State or Federal income. Whether an agency selects a dollar limit of debt, or a percentage, having a limit can serve the purpose of advising decision makers of the prudence of adopting additional debt to allow increased investment to sustain asset conditions. Five states report no debt. This provides their decision makers with many fiscally responsible options should the State face an economic or funding crisis. The agency could assume some prudent level of debt to carry its highway investments through a temporary downturn. Agencies with low debt levels can be considered to be economically resilient. Other States have high debt levels as seen in Figure 6. Because the size of States vary so much, the total amount of debt per State may be less important than the amount of debt compared to the agency's resources. Figure 6 (see next page) is derived from FHWA statistics of the amount of interest paid by each state as a percentage of its expenditures on capital and maintenance. It shows that for some states interest payments are high relative to the amount they have to spend on capital and maintenance. For others, debt is a relatively small percentage of outlays. Tracking debt levels and their impact on future ability to sustain assets can be an important financial metric.

### ***General Financial Adequacy Measures***

A typical business would produce measures such as the operating ratio, which is a measure of how much of its total income is required to meet its basic business expenses. The higher the ratio, generally the less profitable is the business because a high percentage of its income is consumed just to meet basic business costs and the less remains for profits.

Similarly, some agencies in the public transportation sector are reporting some of these general types of metrics that

### Interest Payments on Debt As Percent of State Capital, Maintenance Expenditures



**Figure 6. Interest payments as a percentage of states' capital and maintenance outlays.** SOURCE: FHWA TABLE SF2

indicate how well the agency will be able to cover its desired investment levels into the future. First is an example from Australia of an operating surplus.

The operating surplus is an indicator of how resilient an agency is expected to be. It measures how much revenue is left over after basic needs are met. This can be reported as an absolute amount, which would be the operating surplus. Or it can be a ratio of the amount of surplus as a percentage of total income. Either way, it captures the degree of flexibility or resiliency an agency's finances may have. If it is forecasting that all dollars will be allocated without any surplus, then any change in financial circumstances will require the agency to cut spending in some other category. Table 10 comes from a typical Australian local government financial plan, this for the Council of Barossa in South Australia. It is



a collection of small communities united through a common Council government. As seen in Table 10 (see page 46), this summary table captures major income and expenditures highly consolidated down to a few categories. The depreciation and impairment category consolidates several more detailed expenditure estimates of the amounts needed to sustain assets in good condition after accounting for age, depreciation, impairment or the “wear and tear” that assets incur over time. As seen, this small community is forecasting it will need to allocate \$6.364 million annually to offset asset depreciation and impairment in 2013 growing to \$9.308 million by 2022. After it plans for other expenses such as employee costs, finance costs or debt, materials and contracts it will have an operating surplus of \$210,000 in 2013 rising to \$2.682 million by 2022. This estimate informs community decision makers of the latitude, or lack of latitude, they have in adding services or new assets without having to cut some already planned service or investment in an existing asset.

A similar analysis but on a much larger scale is evident in the Short-Range Transit Plan and Capital Improvement Plan for the Bay Area Rapid Transit (BART) for FY 2015-2024. Its 138-page plan includes extensive documentation of the financial state and evolution of its agency from the past decade and forecasts of its revenues, needs and shortfalls for the upcoming one. It includes extensive tabular summaries of need and expenditures but also substantial interpretive narrative explaining the trends, policies, priorities and plans upon which it bases its future forecasts. Table 11 (see page 47) includes a summary of BART’s Operating Financial Forecast. In the financial plan, a few summary paragraphs explain each line of the estimated revenues and expenses. The bottom line, as shown in Table 12 (see page 48), is that the total estimated expenditures over 10 years exceed estimated income by about 5 percent in total. The Net Result line shows a growing forecasted “deficit”

Sources and Uses Categories	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Income	\$31,737	\$33,141	\$33,811	\$35,577	\$37,271	\$39,128	\$40,820	\$42,689	\$44,633	\$46,776
Employee costs	\$10,836	\$11,277	\$11,668	\$12,143	\$12,637	\$13,152	\$13,688	\$14,247	\$14,828	\$15,432
Materials, Contracts	\$12,985	\$13,411	\$13,864	\$14,584	\$15,288	\$16,135	\$16,650	\$17,500	\$18,186	\$19,021
Depreciation, Impairment	\$6,364	\$6,734	\$7,016	\$7,335	\$7,613	\$7,953	\$8,282	\$8,620	\$8,958	\$9,308
Finance Costs	\$1,342	\$1,224	\$1,112	\$1,007	\$898	\$735	\$613	\$502	\$399	\$333
Total Expenses	\$31,527	\$32,646	\$33,660	\$35,069	\$36,436	\$37,975	\$39,233	\$40,869	\$42,371	\$44,094
Operating Surplus	\$210	\$495	\$151	\$508	\$835	\$1,153	\$1,587	\$1,820	\$2,262	\$2,682

**Table 10. An estimate of income and major expenditures with the Operating Surplus calculated.**  
(All figures in \$ Thousands)

Income Sources	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Fare Revenue	421.2	435	448.8	459.7	475.4	488.1	497.9	507.9	515.7	523.7
Fare Increase for Priority Capital	18.8	27.1	36	45.1	55.1	64.9	74.8	85.7	96.7	108
ADA Passenger Revenue	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Parking Revenue	26.2	26.8	27.4	28	28.6	29.2	29.8	30.5	31.2	31.9
Advertising Revenue	8.7	9.2	10	10.8	11.5	11.5	11.6	11.6	11.6	11.6
Other Operating Revenue	11.4	11.5	11.6	11.7	11.8	11.9	12.1	12.2	12.3	12.4
Sales Tax	228.7	235.6	242.6	249.9	257.4	265.1	273	281.3	289.7	298.4
Property Tax	33.7	34.7	35.7	36.8	37.9	39.1	40.2	41.4	42.7	44
State Transit Assistance	21.9	22.5	23.1	23.7	24.3	25	25.7	26.3	27	27.8
Local and Other Assistance	3.7	8.7	2.8	2.8	2.9	2.9	3	3	3.1	4.6
Rail Swap Assistance	77	0	0	0	0	0	0	0	0	0
<b>Total Sources</b>	<b>852.1</b>	<b>811.9</b>	<b>838.9</b>	<b>869.4</b>	<b>905.8</b>	<b>938.6</b>	<b>969</b>	<b>1000.8</b>	<b>1030.9</b>	<b>1063.3</b>

**Table 11. BART's Operating Financial Forecast.** (All figures in \$ Millions)

Debt Service & Allocations	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Bond Debt	56	56.3	56.5	56.8	56.9	57.1	57.2	57.4	57.6	57.7
Priority Capital Projects	63.8	72.1	81	90.1	55.1	64.9	74.8	85.7	96.7	108
Capital Renovation	37	33.8	26.6	25.2	25.7	24.7	25.3	25.8	26.4	27
Additional Renovation	6	11	6	1	26	25	25	25	25	25
Operating Reserve	0	0.3	2.1	3.2	2.2	1.4	1.2	1.2	1.3	1.3
SFO Operations	8.7	10	11.1	11.2	12.7	14.2	15.1	16	16.8	9.5
Parking Fees	4.3	4	4	4.2	4.4	4.6	4.9	5.1	5.4	5.7
Other Leases	2.7	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	3.1
Total Debt Service and Uses	178.5	189	188.8	193.2	184.5	193.5	205.1	217.8	230.8	237.3
<b>Total Uses</b>	<b>854.6</b>	<b>820.2</b>	<b>861.5</b>	<b>929.4</b>	<b>965.8</b>	<b>1003.1</b>	<b>1038</b>	<b>1074.8</b>	<b>1112.8</b>	<b>1145.3</b>
Unfunded Pension Liability	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3	3.1	3.2
<b>Net Result</b>	<b>-0.1</b>	<b>-5.8</b>	<b>-20</b>	<b>-57.4</b>	<b>-57.3</b>	<b>-61.7</b>	<b>-66.1</b>	<b>-71</b>	<b>-78.8</b>	<b>-78.8</b>

**Table 12. BART's Uses of Funds and Net Results.** (All figures in \$ Millions)

starting at \$5.8 million in 2016 increasing to \$78.8 million by 2024. The document notes that the negative Net Results line indicates the amount by which revenues will have to be increased or costs decreased to balance the plan over its life.

The BART capital improvement plan then goes into detail on an additional \$9.6 billion in capital investment needs to expand service, replace rolling stock and rehabilitate aging stations and other facilities. It described the growing population and ridership demand in its region and how it will be hard pressed to serve that demand with existing facilities. It provides types of facilities that need to be rehabilitated and replaced and additional service extensions needed to meet demand. It reports, however, that while \$9.6 billion in capital expansion needs exist it can identify only \$4.5 billion in “committed” funds, or the funds likely to be available.

The BART Short-Range Transit Plan and Capital Improvement Plan provides a reader with:

- A summary of the expected revenues for 10 years
- Forecasts of on-going operating and capital expenses needed to maintain existing services
- A realistic estimate of its operating shortfall and its growth over 10 years
- A list of needed capital improvement and expansion projects
- The gap between the available sources and the desired capital improvements the region needs to keep pace with ridership and service demands.

## 5. Summary and Conclusion

The addition of financial sustainability and performance metrics along with risk analysis can provide even greater insights to those already existing in a financial plan. The metrics and risk register provide succinct descriptions of the adequacy of investment and the major risks that must be addressed if the expected revenues are to materialize. The metrics and risk analysis also clarify the costs that must be controlled if resources are to be available to meet the agency's capital needs.

Transportation agencies are often one of the largest in State government and as a result some stakeholders assume they have excess resources for new projects to support mobility, economic development or community enhancement. The financial plan, risk register and metrics can illustrate that while revenues may be large, the massive size of the existing transportation network generally requires more revenue than the agency reasonably can expect over the next decade. The risk analysis and the description of uncertainties can emphasize the tenuous nature of agency revenues. The close linkage of agency revenues to State and Federal fuel taxes creates vulnerability because of slow growth, or actual decline, in fuel consumption. The financial plan and metrics can illustrate the slow growth in State taxes and the significant uncertainties in Federal resources that are likely to confront agencies for many years.

The financial plan, its metrics and risk analysis can be used to communicate to multiple audiences. The trend lines of declines in purchasing power and asset conditions can make convincing graphics that can communicate to the public and key local decision makers. The more detailed spreadsheets and sources and uses tables will be of interest to state budget agencies and legislative staff who play a critical role in State budgeting. The state budget officials and legislative

staff need to be convinced of the imperative of sustaining adequate asset investments if they are to convey that message to governors and legislators.

One of the most important roles of metrics and risk analysis is to emphasize the tenuous nature of revenue forecasts. Although asset deterioration brought on by traffic, age and climate are inevitable, agency revenues are not. Agencies control very few of the inputs that determine their revenues. Factors such as political decisions, economic growth, and market forces will determine how much their income will change and how much their costs may increase. The financial plan can emphasize the truly uncertain nature of agencies' future costs and how much revenue they may have to meet them.

Audits of local governments concluded that after several years of developing financial plans and examining investment risks, appropriators better understood the need to invest in asset management and preservation of assets.

Finally, the financial plan and risk analysis can help create an ethos of financial sustainability. In Australia the development of financial plans gradually led to an increasing number of government officials thinking strategically about how to manage long-lived transportation assets. Audits of local governments concluded that after several years of developing financial plans and examining investment risks, appropriators better understood the need to invest in asset management and preservation of assets. The audits concluded that while financial plans did not eliminate all backlogs of investment needs they led to increased investments in assets and a better understanding of whole life costs.

The evolution of financial plans, risk registers and financial performance metrics can represent a further evolution of State transportation practices. These practices that are expected of private sector asset managers can also lend transparency and credibility to the public sector.



## 6. Endnotes

<sup>[1]</sup> Crouhy, Michel, Dan Galai, Robert Mark, *The Essentials of Risk Management*, McGraw-Hill, 2006, pp. 397.

<sup>[2]</sup> FHWA Highway Statistics 2014 Table HM 16 rural “Other” highways owed by States, divided by 52.

<sup>[3]</sup> New South Wales Division of Local Government, Local Government Infrastructure Audit, June 2013.

<sup>[4]</sup> Braceras, Carlos, Robert Tally et al US DOT FHWA Office of International Programs, April 2010, pp. 2, 36-38, 44.

<sup>[5]</sup> United States Securities and Exchange Commission, 2009, Study of the Sarbanes-Oxley Act of 2002 Section 404 Internal Controls over Financial Reporting Requirements, Office of Economic Analysis.

<sup>[6]</sup> Coates, J. IV, 2009, The Goals and Promise of the Sarbanes-Oxley Act, *The Journal of Economic Perspectives*, Volume 21, Number 1, Winter 2007, pp. 91-116.

<sup>[7]</sup> Rittenberg, L, 2012, White Paper: COSO 2012—Updated, Principles-Based, and More Guidance, The American Institute of Certified Public Accountants.

<sup>[8]</sup> FHWA, The Asset Sustainability Index, A Proposed Measure for Long-Term Performance, accessed at [http://www.fhwa.dot.gov/planning/processes/statewide/practices/asset\\_sustainability\\_index/assetsustainabilityindex.pdf](http://www.fhwa.dot.gov/planning/processes/statewide/practices/asset_sustainability_index/assetsustainabilityindex.pdf)

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