Transportation Asset Management Plans

Case Study 1 – Asset Management Practices and Benefits

FHWA-HIF-20-088

FEDERAL HIGHWAY ADMINISTRATION

Office of Stewardship, Oversight and Management

1200 New Jersey Avenue, SE

Washington, DC 20590

May 2020

U.S. Department of Transportation
Federal Highway Administration

Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objective of the document.

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. However, compliance with applicable statutes or regulations cited in this document is required.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Technical Report Documentation Page

1. Report No. FHWA-HIF-20-088

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle: Asset Management Practices and Benefits - Case Study 1

5. Report Date: May 2020

6. Performing Organization Code: None

7. Author(s): Principal Investigators: Shobna Varma, Starisis Corporation, Gordon Proctor, Proctor Associates

8. Performing Organization Report No: Case Study 1

9. Performing Organization Name and Address: Starisis Corporation, 3737 Woodstone Drive, Lewis Center, Ohio 43035; Gordon Proctor & Associates 7825 Wiltshire Drive, Dublin, Ohio, 43017; Greenman Petersen Inc.325, West Main Street, Babylon, NY 11702Greenman-Pedersen Inc. 10977 Guilford Road Annapolis Junction, MD 20701

10. Work Unit No.: None

11. Contract or Grant No.: DTFH61-10-D-00024, Task Order No. T-11-006

12. Sponsoring Agency Name and Address: Federal Highway Administration 1200 New Jersey Ave SE, Washington, DC 20590

13. Type of Report and Period Covered: Case study covering 2019 and 2020

14. Sponsoring Agency Code: FHWA

15. Supplementary Notes: Peter Doan (COR), Nastaran Saadatmand (Technical Lead)

16. Abstract: This is one of seven case studies of practices in the 2019 transportation asset management plans (TAMPs). This case study highlights examples of how State departments of transportation (DOTs) explained their asset management practices, and the benefits from those practices.

17. Key Words: Asset management, transportation asset management plans, life-cycle planning, life cycle plans, state of good repair, managing assets for their whole life.

18. Distribution Statement: No restrictions.

19. Security Classification (of this report): Unclassified

20. Security Classification (of this page): Unclassified

21. No. of Pages: 16

22. Price Free

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**.

Contents

Case Study Introduction

This case study is one of seven that captures good asset management practices documented in the 2019 transportation asset management plans (TAMPs) required by 23 U.S.C. 119(e). This series distills many of the good practices and presents them in a convenient format for use by other transportation agencies. The seven case studies are:

Case Study 1: Asset Management Practices and Benefits

Many of the TAMPs provided comprehensive summaries of their asset management practices and the benefits they received from them. Several examples are highlighted in this case study. These include examples from the DOTs in New Jersey, Pennsylvania, Illinois, and Washington State. These examples illustrate how asset management plans can effectively summarize asset management practices and improvement strategies.

Case Study 2: Linking Asset Management to Planning and Programming

This case study examines how TAMPs documented linkages to the DOT's long-range plan, the State Transportation Improvement Program (STIP), and state planning and programming practices. Examples are selected from the TAMPs in Missouri, Maine, Utah, Ohio, Wyoming, and Montana.

Case Study 3: Supporting Life-Cycle Planning

To develop a life cycle plan, one needs to know how assets deteriorate throughout their life cycle. Several TAMPs were notable in documenting how they manage assets with life cycle plans. Included in this case study are examples from the DOTs in Minnesota, Ohio, Tennessee, and New Jersey.

Case Study 4: Managing Risk to Assets

DOTs embrace risk management to support the long-term performance of assets, and for making risk-based investment tradeoffs. This case study summarizes some of the good risk management practices from Washington State, California, Kansas, South Dakota, Louisiana, Rhode Island, Pennsylvania, Texas, Colorado, and Michigan.

Case Study 5: Developing Financial Plans and Investment Strategies

The financial plans and investment strategies reflect priorities for allocating scarce resources to achieve their highest asset management objectives. This case study examines how several TAMPs described the clear linkages between their asset management objectives, gaps, risks, and investment strategies. Examples are from Kentucky, Michigan, Washington State, New York State, Utah, Vermont, and Illinois.

Case Study 6: Communicating Asset Management Strategies

This case study summarizes examples of communicating asset management strategies with key internal and external stakeholders. Examples are cited from the DOTs in Vermont, California, New Jersey, Washington State, Michigan, Ohio, Colorado, and Nebraska.

Case Study 7: Managing Non-Bridge-and-Pavement Assets

Several State TAMPs included additional assets beyond pavements and bridges. Examples are cited from Minnesota, Connecticut, Utah, and California.

Documenting Asset Management Practices

This case study examines several of the 2019 TAMPs that were notable in detailing agencies' asset management plan development practices or in documenting the benefits the agencies derived from asset management such as cost savings, improved asset conditions, or increased transparency.

These examples summarize only a few of the practices seen in the 2019 TAMPs. All the plans are available on the FHWA's asset management website.

New Jersey Department of Transportation TAMP

Some publications have described asset management plans as opportunities for agencies to coordinate their diverse work units to focus on the common goal of managing assets throughout their life cycle.[1] TAMPs also provide an opportunity to explain the challenges facing bridge and pavement assets and how the agency makes difficult tradeoffs to manage those assets with limited resources. [2,3,4] The New Jersey DOT(NJDOT) asset management plan provided several good practice examples of how a TAMP can summarize the condition of assets, describe risks, and explain how the agency intends to manage the assets.

Broad Agency-Wide Involvement in Asset Management Practices

The NJDOT established a governance structure with high-level leadership and broad agency participation to implement its asset management practices. High-level leadership demonstrated institutional support for asset management while broad engagement encouraged multi-disciplinary coordination to manage assets through every phase of their life cycle.

The NJDOT's Transportation Asset Management Steering Committee provided general direction to the TAMP efforts and assisted in communicating the purpose and progress to other stakeholders. The committee included the deputy commissioner, assistant commissioner for capital program management, the assistant commissioner for transportation operations systems and support, the assistant commissioner for finance and administration, and the assistant commissioner for planning, multimodal, and grant administration.

The committee's key responsibilities included:

- Establishing asset management policy and state of good repair (SOGR) objectives.
- Approving National Highway Performance Program (NHPP) targets addressing bridge and pavement condition preservation.
- Providing oversight in the management of enterprise-level risks to accomplish asset management policy and state of good repair objectives.
- Monitoring and reviewing annually the performance and condition of NJDOT assets and the NHS to evaluate progress toward achieving NHPP targets and the TAMP objectives.
- Monitoring and reviewing annually the status of TAMP strategies and actions to improve NJDOT's asset management business practices.
- Communicating the investment strategies to executive management for consideration during New Jersey's Transportation Capital Program and STIP development procedures.
- Communicating the implications of not addressing performance gaps, such as impacts on other performance areas, and consequences of not meeting NHPP targets.

The Transportation Asset Management Directors Group was comprised of the organizational units responsible for elements of the TAMP development. This group provided general direction to the TAMP

effort, monitored progress, and supported resolution of issues requiring coordination across functional areas. The Directors Group supported change management, organizational development, and the implementation of the TAMP development as an agency-wide, enterprise-wide function. It also provided guidance to both the Transportation Asset Management Steering Committee and the Transportation Asset Management Plan Team.

The Transportation Asset Management Plan Team was a cross-functional team of program managers with responsibilities for agency-wide asset management functions and asset management programs for specific asset classes identified within the TAMP. The team established NJDOT's overall asset management approach. The team coordinated the implementation of enhancements and other modifications to the TAMP approach. Fourteen divisions or bureaus were included on the Asset Management Plan Team.

TAMP Stressed Development of Asset Management Practices, Not Just a Plan

The NJDOT emphasized that the TAMP reflected ongoing, continuous practices to manage assets effectively as opposed to being only a document that will be updated once every four years:

> The TAMP recognizes that improving asset management practices and outcomes is a continuous process that requires top-down leadership, reinforced by policy direction and management actions in concert with bottom-up staff involvement that continually refines practices and processes. [5]

The TAMP discussed how asset management decision making was supported by practices for target setting, data collection, gap analysis, life-cycle planning, risk analysis, engagement with local NHS owners, and program and project development.

Asset Management Supported by Policy

NJDOT's asset management policy said in part:

> Our policy is to employ asset management best practices and data-driven processes to manage New Jersey's infrastructure across the whole lifecycle to maintain assets in a State of Good Repair. In this way, our asset management process is the foundation for cost-effective infrastructure preservation and fulfills the mission of providing a world class transportation system.
>
> We employ our asset management process to manage and monitor State of Good Repair. …..The New Jersey Transportation Asset Management Plan is NJDOT's investment plan for fulfilling the Infrastructure Preservation core mission, and the plan for improving our asset management program and processes so that NJDOT 'achieves consistent progress through focused investments in keeping infrastructure in a State of Good Repair.' The TAMP is also the process through which strategies and plans are developed for the management of NJDOT assets across their lifecycle.[6]

Extensive Outreach to 83 Local NHS Owners

The 2018 and 2019 TAMPs described extensive outreach efforts to engage all 83 local owners of portions of the NHS. The NJDOT managed 61 percent of the NHS lane miles, while 19 percent were managed by the New Jersey Turnpike Authority (NJTA), 16 percent by counties and municipalities, and 4 percent by other authorities. For NHS bridges by area, NJDOT managed 47 percent, the turnpike authority managed 34 percent, other authorities managed 17 percent, and counties and municipalities managed 2 percent.

The aims of the outreach were to:

- Communicate asset management purpose, objectives, and requirements.
- Establish ongoing communication with NHS owners.
- Ensure direct engagement with local NHS owners.
- Ensure quality data about locally owned NHS assets.

Among the data collected were condition information and recent and planned expenditures on NHS assets. Information was collected through face-to-face meetings, workshops and web conferences, and emails. Workshops were held at key points during the TAMP development to engage local owners and to provide opportunities to review and comment on the analysis results.

Objectives Directly Supported a State of Good Repair

The NJDOT TAMP defined the state of good repair in terms of measurable condition objectives that relate to the agency's targets. For pavements, the state of good repair objective was to have more than 80 percent of the lane miles on the State Highway System (SHS) in Good or Fair condition as measured by the NJDOT's Condition Status performance measure and not by the 23 CFR 490.311 and 490.313 performance measures. For bridges, the objective was to have more than 94 percent of State Highway System bridges in Good or Fair condition and more than 95 percent of NHS bridges in Good or Fair condition. For bridges, the NJDOT used the measures defined in 23 CFR 490.407 and 490.409 for setting its SOGR. Those state of good repair objectives then served as the benchmark for other asset management processes such as gap analysis, assessing risks to conditions, conducting life-cycle analyses, and influencing investment strategies. The definition of SOGR is required for the TAMP, but the actual definition is up to the State.

Gap Analysis Conclusions

The NJDOT TAMP summarized the performance gaps both for current and projected conditions. Gaps were illustrated in terms of percentages of the bridge and pavement network that will not meet condition targets or the state of good repair objectives, as well as the investment levels necessary to close the gaps. Gaps also were shown by year, and the magnitude of gaps under different investment levels was shown. The NJDOT TAMP described a four-step gap analysis process. First, asset data are collected. Second, baseline asset performance is determined from calendar year 2017 condition data for both the state highway system and the NHS. Third, a review of historical performance and spending provided guidance in determining the SOGR objectives. Pavement and bridge management systems applied life cycle and risk management strategies to develop projected performance of State Highway System pavement and bridge assets under planned funding levels. Fourth, the gap analysis results identify (1) the difference between baseline performance and projected performance for each asset and the SOGR objectives, (2) the projected performance of select assets and targets, (3) the gaps in system performance revealed through the analysis, and (4) the gaps in funding to achieve the SOGR objectives.

Life-Cycle Planning Strategies Emphasized

The NJDOT TAMP went into considerable detail explaining how the agency used life-cycle planning to extend the life of assets and to lower the life-cycle cost of maintaining them. It emphasized the agency's efforts to achieve the highest overall network conditions through timely maintenance, preservation, rehabilitation, and replacement treatments.

The life-cycle planning chapter appeared to be written for both technical and lay audiences. It explained why life-cycle planning lowers the cost of managing assets by avoiding costly repairs with timely and less costly preservation treatments. It explained the type of treatments that are applied at different times in

the life cycle of bridges and pavements to preserve their condition and to avoid more costly rehabilitation or replacement.

The TAMP provided a brief history of earlier attempts to achieve pavement system condition targets by using only overlays every 10 years and how that strategy was too costly to be implemented. Instead, the agency is relying more heavily on preservation treatments which, if applied at the right point in a pavement's life cycle, can improve overall network conditions.

The TAMP also explained in simple terms how the agency's pavement management system (PMS) analyzes condition data and produces optimized treatment programs based upon the pavement budget. Graphics compared how much better pavement conditions will be through 2029 given the agency's life-cycle approach compared to a strategy of relying only on overlays. The steps were to perform multiple scenarios using the pavement management system to select the scenario which optimized the pavement conditions for the given budget. In addition to four scenarios based upon potential investment strategies, two additional scenarios were run only for illustrative purposes. Those two illustrative scenarios used the same fixed funding level. One scenario allowed the pavement management system to use its decision trees to optimize the treatments. Using the same funding level, the second scenario restricted the treatments the management system could choose to only overlays after pavements had deteriorated. The first scenario that relied on the pavement management system decision trees produced substantially higher conditions through 2029 than did the scenario that allowed only overlays.

Although NJDOT did not have the bridge management system (BMS) fully operational in time for the TAMP, it included highlights of a plan of action to fully deploy the BMS. The TAMP relied on interim analysis to estimate the needed funding levels, and the resulting conditions under different investment scenarios.

The TAMP also listed several life-cycle planning improvement strategies. They include a bridge preventive maintenance program, use of improved materials and systems, improved design details, new bridge condition assessment technologies, and the deployment of the bridge management system.

Risk Roles Assigned and Tools Developed

The NJDOT TAMP described a process that includes the typical steps of risk identification, analysis, evaluation, and treatment but adds three innovations. The first was a NJDOT developed Resiliency Management System to help manage risks from extreme weather events. [7] The TAMP stated this system will when completed intersect data layers such as flood hazard zones, topography, land use, and other environmental and social factors to identify areas vulnerable to extreme weather events. The second was a Resiliency Working Group of asset owners who will collaborate to assess how extreme weather is managed and recommend steps to manage shortfalls. The third innovation was an ongoing Events Database that will record emergency events to keep the 23 CFR Part 667 analysis up to date. Per 23 CFR 667.1, each State shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events. In 23 CFR 667.5 it states that the beginning date for every evaluation shall be January 1, 1997.

Clearly Identified Investment Strategies and Gaps

The two major investment strategies were to increase the amount of pavement preservation expenditures and the amount of bridge preservation expenditures to capitalize upon the long-term benefits of timely preservation. The TAMP showed the pavement preservation annual allocation increasing from $15 million to $100 million by 2029. The bridge preservation allocation increased from

$100 million to $150 million. The amounts to be allocated for rehabilitation and reconstruction each year also were shown. The TAMP did not include amounts for pavement maintenance. It explained maintenance is provided by in-house forces and the amount allocated for it are hard to identify. For bridge maintenance, $70 million was estimated to be allocated per year through 2029.

The TAMP showed year by year how much of a financial gap exists between expected pavement and bridge allocations and the amount needed to achieve a state of good repair. The shortfalls were an average of $255 million annually for State Highway System pavements and $140 million annually for State Highway System bridges through 2029.

Summary

The New Jersey TAMP provided lay and technically trained readers with clear explanations of the condition of the agency's assets, and its objectives and targets. It also clearly explained the risks and gaps affecting those assets, and the agency's investment strategies to manage its bridge and pavement assets with limited resources. The TAMP also informed policy makers and budgeters how much additional revenue would be needed to achieve the state of good repair objectives. The NJDOT TAMP summarized for the public and policy makers how assets are managed and the conditions the public will face in the years ahead.

Pennsylvania DOT Good Practice Examples

One benefit of an asset management plan is the forecasting of future revenue and investment needs to inform decision makers about the financial sustainability of a State's assets. It is helpful for agencies to understand years in advance how they may have to increase revenues or shift expenditures to align their resources with the long-term asset investment needs.[8] It can take several years to develop a project, and even longer to develop an entire program of projects, such as ones to replace aging pavements or to preserve bridges. It also can take several years to convince policy makers of the need to increase investments. Therefore, the 10-year forecasts seen in the Pennsylvania DOT (PennDOT) asset management plan provide an example of how a TAMP can serve as a "heads up" to policy makers that the State's transportation asset conditions are not financially sustainable under current scenarios.

PennDOT Forecasted Future Investment Needs

PennDOT produced 12-year pavement and bridge condition forecasts using its bridge and pavement management systems. The projections were based on current condition data and improved conditions expected as a result of future projects. Planning investments were derived from the financial forecasts and lists of programmed projects. PennDOT's TAMP stated that both the pavement and bridge management systems were new and the agency expected some error in the forecasts. The agency was working to continuously update and improve the forecasts' accuracy.

Although PennDOT forecasted no short-term gaps between bridge and pavement conditions and targets within the first four years, over the longer term significant performance gaps were forecasted. Both Pennsylvania NHS pavements and bridges were expected to deteriorate and significantly increase the amount of Fair pavements. Also, bridge conditions were forecasted to deteriorate and reach the 10 percent Poor threshold by 2023. For both pavement and bridge performance measures, PennDOT's TAMP analysis used the 23 CFR Part 490 performance measures.

PennDOT attributed the deteriorating forecasts to these factors:

- Funding is inadequate to keep pace with rehabilitation and replacement projects that are needed to keep the system in optimal condition.
- The increased age of Pennsylvania's infrastructure minimizes the benefit of continual preservation treatments.
- The results of underinvestment may be slightly exaggerated as the models are not yet precise enough to yield highly reliable forecasts in the 5-to 12-year range.

PennDOT forecasted that its Interstate System pavements will meet the minimum FHWA condition level of no more than 5 percent Poor as specified in 23 CFR 490.315(a) through the forecast period, although the results were not certain. The forecasts were based on surface conditions and did not account for roadway age, the condition of underlying pavement distresses, or the backlog of pavement reconstruction projects. The PennDOT TAMP stated that detailed analysis of pavement history showed that many more pavements require costly reconstruction and that preservation and rehabilitation treatments will perform well for increasingly shorter periods as the underlying pavement structure deteriorates.

PennDOT's TAMP indicated that in 2019 only 1 percent of NHS pavements were Poor, 61.7 percent were Fair, and 37.3 percent were Good. By 2030, the percent Poor is forecasted to rise to 4.8, the percent Fair to 80.3, with the percent Good falling to 14.9. For Interstates only, the amount Poor is forecasted to rise from 0.4 percent to 1.7 percent and the percent Good to decrease from 63.7 percent to 32 percent between 2019 and 2030.

An even greater deterioration occurs on the non-NHS system. Between 2019 and 2030, the percent Poor was forecast to rise from 1.3 percent to 6.1 percent, and the amount Good was forecast to fall from 25.4 percent to 7.2 percent. The percent Fair was forecast to comprise 86.6 percent of the non-NHS system by 2030, according to the TAMP's forecast.

For bridges, the TAMP forecasted similar trends. The percent of Poor NHS bridges was forecast to increase from 4.6 percent to 25.6 percent between 2019 and 2030. The percent of Good was forecast to fall from 29.7 percent to 10.9 percent, although the percent of Fair structures was forecast to decrease slightly from 65.7 percent to 63.5 percent. Non-NHS bridges also were forecast to deteriorate overall. Although the percentage of Good structures was forecast to remain about the same through 2030, the percentage of Poor was forecast to increase from 3.3 percent to 25.5 percent.

Three notable elements of good asset management practice were evident in the PennDOT TAMP with regard to these forecasts.

First, PennDOT acknowledged and plans to focus upon "model risk." Because forecasts are based on PennDOT models, the uncertainty or variability surrounding the forecast represents a risk that agencies can assess and manage.[9, 10] The PennDOT TAMP used the best available data, and while acknowledging the uncertainties in its forecasts, the agency has plans to continually improve the models. Highlighting the uncertainties, the TAMP cautioned decision makers about potential variabilities to expect.

Second, PennDOT's TAMP indicated that the agency will shift its programming to a more life-cycle based approach. Because of the substantial investment made in developing currently programmed projects, it plans to deliver its current program of projects. However, as new projects are developed for later years of the TAMP, they will be more heavily focused on life-cycle strategies. The agency has adopted a life-cycle preservation approach and the slogan, "The right treatment at the right time."

The third element of good asset management was the forecasts themselves. The forecasts indicated that although the minimum Interstate pavement condition levels will be met per 23 CFR 490.315(a),

over the next 12 years the overall condition of the pavement network was forecasted to deteriorate without a significant response strategy to arrest the trends. The forecasts predicted the percentage of Fair Interstate pavements will increase substantially, which will eventually lead to more rapid deterioration and more costly repairs to stabilize the pavements. The non-NHS pavements were forecast to decline substantially with only 7.2 percent of them in Good condition, and the majority of the network forecast to be in marginal, or Fair condition. The overall trend that was forecast was for a pavement network that is less robust, more prone to rapid deterioration, and more costly to restore to a state of good repair.

The PennDOT TAMP forecasts reflected two concepts common in international asset management frameworks. The first is financial sustainability, and the second is "intergenerational equity." Financial sustainability involves managing financial risks and financial shocks in future periods without having to introduce significant and economically destabilizing expenditures or revenue adjustments.[11,12] Intergenerational equity in relation to transportation assets or government operations has been described as not permitting a transportation network to deteriorate to the point that maintenance costs are transferred to a future generation.[13]

The PennDOT TAMP forecasts served as a form of leading indicator that allows policy makers to understand what actions are needed in the short term to prepare for longer-term consequences. Leading indicators are particularly important for long-lived assets such as pavements and bridges for which treatment strategies can stretch over decades.[14]

Objectives Embraced Life-Cycle Planning and Drove Investment Strategies

Another good practice seen in the PennDOT TAMP was the adoption of objectives that support life-cycle planning and then those objectives driving investment strategies.

The PennDOT TAMP included objectives that directly embrace asset management. Objective A is, "Sustain a Desired State of Good Repair over the Life Cycle of Assets." The TAMP stated that a transportation system in good overall condition is a key enabler of economic activity and is central to the quality of life in Pennsylvania. Timely, preservation and rehabilitation treatments are helpful in maintaining roadway pavements, bridges, and other transportation infrastructure in a state of good repair.

Pennsylvania defined its desired state of good repair as meeting the FHWA minimum condition thresholds for pavements and bridges of no more than 5 percent of NHS Interstate lane miles in Poor condition per 23 CFR 490.315(a) and no more than 10 percent of total NHS bridge deck area rated as Poor per 23 CFR 490.411(a). Pennsylvania's desired state of good repair for NHS non-Interstate pavements was also defined as having no more than 5 percent of lane miles rated in Poor condition.

Objective B was, "Achieve the Lowest Practical Life-Cycle Costs for Assets." The TAMP stated that transportation needs have historically and consistently exceeded available funding in Pennsylvania. For this reason, as well as PennDOT's commitment to good stewardship and delivering value, the agency believes it is imperative to derive the greatest value from every infrastructure dollar invested.

The objectives influenced the investment strategies that demonstrated between 2019 and 2030 a steady decrease in capacity-adding allocations and a steady increase in preservation allocations. The two largest allocation categories by far were for preservation and maintenance.

The TAMP stated that in recent years PennDOT successfully reduced its backlog of Poor bridges through prioritizing rehabilitation and replacement of deteriorated structures. It was a "worst-first" approach driven by the State's backlog of Poor structures.

While the strategy was successful in reducing the number of Poor bridges, the approach came at the expense of preventive maintenance on structures that were in better condition. The TAMP stated that PennDOT is transitioning from a focus on Poor structures to an overall risk-based prioritization and selection of bridges based on a lowest life-cycle approach for the entire network.

The TAMP stated PennDOT is enhancing its bridge and pavement management systems and making them available to its Districts, MPOs, and rural planning organizations (RPOs) to allow them to analyze investment decisions using their available funds. PennDOT is developing a guidance document to assist the Districts and MPOs/RPOs regarding the transition to a life-cycle planning approach. The key points will include guidance on:

- Transitioning from "worst-first" to life-cycle programming strategies.
- Considering new asset condition targets and metrics and how to apply them.
- Applying the new methodology to Transportation Improvement Program adjustments.
- Utilizing the Pavement Asset Management System and Bridge Asset Management System tools to assist in project selection.
- Training on the software systems and interim tools.

TAMPs as Templates for Change

While some TAMPs document existing asset management practices, others served as catalysts to explain and document the changes that agencies intend to make. This section summarizes how the Illinois Department of Transportation (IDOT) TAMP served as a pivot point for the agency to make fundamental changes to how it manages its assets.

Illinois DOT "Raising the Bar"

The Illinois DOT (IDOT) 2019 asset management plan used the slogan "Raising the Bar" to summarize the agency's pivot to asset management. The TAMP emphasized the agency is moving away from a "worst-first" approach that did not optimize the agency's limited resources. Repeatedly, the TAMP explained new strategies that will embrace a life-cycle approach to managing its assets.

> Under the previous approach, the implementation of the program varied by districts, funding was minimal, and there was little verification that preservation funds were being used as intended. The revised strategies outlined in this TAMP address those concerns by placing a greater emphasis on the use of improved guidance ensuring that preservation techniques are applied to pavements and bridges before significant deterioration occurs. This is expected to reduce the overall cost of preserving IDOT's pavements and bridges and slow the overall rate of network deterioration.

Integrating Asset Management into the Agency's "Fabric"

The 2019 TAMP stated that IDOT determined early that the TAMP should not be a stand-alone effort but should become part of the fabric of IDOT. To that end, the development of the TAMP and implementation of asset management practices have been guided by a Steering Committee of representatives at the executive level. A Project Management Team was also created that consisted of mid-level managers for each of the areas involved in asset management. Team members also led working groups for each of the specific areas.

The IDOT TAMP stated that a 2015 analysis recommended seven significant changes or steps the agency should take to improve its asset management procedures. In 2017, as it began to develop its asset management plan, it established new targets representing acceptable conditions for its hierarchy of bridges and pavements. The pavement conditions were based upon the agency's Condition Rating Survey (CRS) that it has used as its in-house rating system that pre-dated the FHWA 23 CFR Part 490 performance measures. IDOT set a CRS value of 5.5 or higher for Interstates and 5.0 for the other NHS and non-NHS routes out of a scale of 1.0 to 9.0. Using National Bridge Inventory (NBI) ratings, the minimal acceptable condition for bridges was set at 5 for decks, superstructures, substructures, and culverts on a 0-9 scale.

Focusing Targets on Preservation Opportunities

The 2019 IDOT TAMP stated the significance of those targets is that they represent the lowest value for which preservation activities are effective in extending the life of the assets. In the past, IDOT primarily focused its highway investments on addressing the most pressing needs, such as congestion in the Chicago area, economic development demands, or deteriorated pavements and bridges across the State. Historically, IDOT's pavement and bridge condition assessment procedures have been used to report necessary pavement and bridge improvements in terms of two types, "Backlog" and "Accruing." Accruing segments were those anticipated to deteriorate to the point that they would need improvement within six years of the evaluation, while "Adequate" segments were those expected to need little or no improvement within those same six years. The focus on Backlog prioritized already deteriorated pavements and bridges in significant need of repair and tended to drive investments toward assets that were in unacceptable condition. This focus on deteriorated assets represented a "worst-first" strategy that required substantial funding levels each year. Since money was not available to treat all the Backlog, network conditions declined and desired conditions known as "aspirational goals" were unachievable.

The TAMP stated IDOT is changing the way its CRS ratings are used to monitor pavement performance and identify investment needs. In the past, the CRS was evaluated in conjunction with other data, such as average daily traffic and the roadway functional classification to determine the greatest repair needs. Based on this information, each roadway segment was determined to be in "Acceptable" condition or "in need of repair." Roadway segments in "Acceptable" condition were further divided into either "Accruing" or "Adequate" condition.

If the roadway segment was determined to have "Needs," it was classified in terms of "Critical Backlog" or "Other Backlog." "Critical Backlog" included roadway segments that had deteriorated to a very Poor or unacceptable condition in which case extensive patching and base repair were required before resurfacing. Road segments classified as "Other Backlog" had deteriorated to the point that an improvement was needed immediately and the cost of repairs was expected to increase significantly if the improvement was delayed. Together, roadway segments in those categories were referred to as the "Backlog" of needs.

The TAMP stated IDOT is shifting the pavement metrics to a more proactive approach that recognizes the importance of preservation before pavements deteriorate to the "Backlog" condition. The new approach uses CRS values to determine the percentage of the highway system that is in a "State of Acceptable" condition representing the new values of 5.5 or higher for the Interstates and 5.0 for other NHS and non-NHS routes.

IDOT conducted an analysis of the best way to select treatments throughout an asset's life cycle. The analysis showed that programming appropriate treatments throughout the lives of the assets will lead to higher performance of the highway system overall. As a result, IDOT began programming projects in

five categories: initial construction, maintenance, preservation, rehabilitation, and reconstruction/replacement.

For the 2019-2024 multi-year program, IDOT ended its use of the "Backlog" as a pavement performance metric and replaced it with the State of Acceptable Condition. Pavements in those condition categories are considered to be Fair or better, which means they can be preserved using low-cost preservation treatments.

New Tools Deployed and More Under Development

To begin to implement the new changes, existing tools were enhanced and new tools created to assist the Districts. Treatment criteria were developed by the Pavement Policy Working Group. Pavement performance models were updated, and the Districts were given pavement condition predictions for 10 years and the currently recommended treatments for each pavement section.

The procedures being used to report bridge conditions and to identify, select, and prioritize bridge needs are undergoing similar changes. In the past, bridge investment priorities were identified using a program planning tool called the Bridge Analysis and Monitoring System (BAMS), which categorizes bridges into a hierarchy of deficiency levels. BAMS used 16 categories for bridge conditions, with nine representing "Backlog" condition issues and the remaining seven categories used to identify bridges that would accrue to a "Backlog" condition in the future. As with pavements, bridges in "Backlog" condition had deteriorated to the point where an improvement was needed as soon as practical. Those bridges classified to be in "Accruing" condition were expected to need improvements during or subsequent to the current programming timeframe.

The TAMP stated that now IDOT is focusing on a range of treatments detailed in FHWA's Bridge Preservation Guide over a bridge's life span to sustain the State of Acceptable Condition rather than focusing exclusively on "Backlog" bridges.

In the past, IDOT had developed average primary NBI rates of change in bridge conditions to identify expected changes in terms of the "Accruing" and "Backlog" bridge conditions in developing the program. In 2018, deterioration curves were developed for deck, superstructure, substructure, and culverts based on 20 years of historical inspection data to predict future conditions that will support IDOT's Bridge Management System. Future revisions to the deterioration models will include customizing the models based upon bridge types and the climatic conditions to which each bridge is exposed. In addition, IDOT is in the process of acquiring and will implement a new asset management software that will have enhanced bridge-condition prediction capabilities, including the ability to develop up-to-date deterioration models based on the information and factors mentioned above.

Interim bridge prediction models were developed by the Bureau of Bridges and Structures. Bridge condition predictions for 10 years and recommended treatments were given to the Districts. Additionally, the State Bureau of Bridges and Structures developed a Bridge Preservation Manual, which was close to being finalized. The manual will provide guidance on activities to perform that will maximize the life of IDOT's bridges.

The life-cycle and investment strategies were used to develop ideal mixes of investments for each District to use in developing their multi-year programs. Once the Districts had the new tools in place, the Bureau of Programming began conducting a more focused review of the Districts' programming recommendations to ensure consistency with the TAMP guidelines.

Embracing New Strategies

The IDOT TAMP stated that the agency has developed several additional strategies to improve the stewardship of assets and to manage costs. Among the strategies are:

1. Create a culture through training and communication where asset management is viewed as a way of doing business.
2. Move toward a more performance-based approach to TAM decision making.
3. Find a sustainable balance between proactive, preservation treatments and rehabilitation/reconstruction activities that reduce long-term systemwide preservation costs.
4. Provide IDOT staff with improved access to accurate, timely, consistent, and complete asset data and information.

To implement its asset management philosophy, the TAMP stated IDOT has adopted a TAMP framework that:

- Supports the use of strategic performance objectives that are linked to investments.
- Introduces a systematic procedure for determining pavement and bridge needs over the life of an asset.
- Emphasizes the use of preservation treatments that economically extend the life of the highway system.
- Considers agency risks or exposure in setting investment priorities.
- Uses asset inventory information, asset condition data, and analysis tools to evaluate options for allocating resources and selecting projects.

For managing pavements and bridges in Illinois, this meant:

- Pavement management system acquisition and implementation.
- Bridge management system acquisition and implementation.
- Revisions to pavement data collection deliverables to meet FHWA performance measures.
- Improved coordination between District and Central Office planning and programming activities.

Changes Affecting Programming Amounts

In addition to establishing asset condition targets that encourage preservation, IDOT committed to increased expenditures in pavement and bridge preservation to slow the rate of deterioration and postpone the need for more expensive treatments. The TAMP stated that near-term pavement strategies remain predominately focused on minor and major rehabilitation because of the already programmed projects. The strategy gradually transitions to one based on life-cycle planning. This strategy will first allocate funds based on pavement class and condition, then allocate funding within each class to different pavement condition categories. The first objective was to meet the IDOT and Federal Interstate targets and then allocate funds to other NHS and non-NHS routes. Although the initial strategy remains heavily focused on already programmed minor and major rehabilitation, over time IDOT intends to shift more funding toward preservation and maintenance once the supporting business procedures are in place.

For structures, the TAMP stated that a similar investment strategy is planned. The initial years primarily focus on major rehabilitation and what is called high-cost preservation. That represents the distribution of funding resulting in the highest percentage of deck area in a State of Acceptable Condition. Over time, the emphasis on preservation is expected to increase.

To assist with the development of the Fiscal Year (FY) 2019–FY 2024 program, the nine highway Districts were issued funding targets and technical guidance to use in developing, prioritizing, and submitting projects. For example, Districts were instructed by the State Bureau of Programming to use at least 5 percent of their unrestricted funds on bridge and pavement preservation, although they still retained considerable flexibility in how those funds would be used. Districts were also provided with the number of pavement miles or square feet of bridges that needed to be addressed to meet the IDOT and Federal Statewide targets in place at that time. In addition, the Districts were told which system to prioritize, based on systemwide conditions. However, the funding provided was generally inadequate to achieve the intended targets.

A Roadmap for Further Improvement

The Illinois TAMP described a series of additional enhancements, including:

- It adopted an asset management framework that resides in the Bureau of Programming and is championed by the Illinois Secretary of Transportation and directed by the steering committee. The Asset Management Project Team will report to the Steering Committee on a regular basis and provide updates on actual versus planned progress on the asset management enhancements.
- A funding increase was approved effective for June 1, 2019, and once its full impact is assessed, projected asset conditions will be assessed and the TAMP revised.
- The IDOT will acquire and implement a new Enterprise Asset Management System that contains the software to evaluate long-term impacts and cost effectiveness of different pavement and bridge treatment strategies. A request for proposal has been issued. Implementation once a vendor has been selected is expected to take 18 to 36 months.
- IDOT is developing new guidance for Districts to help them select projects and treatments. General guidance for repairs to respond to the bridge and pavement conditions was established during the development of the spreadsheet tool and the TAMP. A bridge working group is enhancing guidance on bridge improvements. A pavement working group is developing more specific guidance for pavement treatment selection using characteristics such as traffic levels, distress types, and the amount of rutting.
- District training also is being enhanced to incorporate the new guidance for planning and programming aligned with the asset management approach.

A Strong Commitment to Asset Management

The TAMP concluded with a strong commitment to the agency's advancement of asset management.

> As documented in this TAMP, IDOT has made a strong commitment to Raising the Bar through improved asset management practices that make use of new performance metrics to emphasize the importance of preservation treatments, enhanced analytical tools to predict funding needs, stronger guidance to support project and treatment selection, and improved coordination with regional transportation partners. These efforts will continue as IDOT moves forward with implementing its new project and treatment selection procedures to enable the Department to achieve the goals set forth over the coming decade.[15]

Washington State DOT Demonstrated Asset Management Maturity

The Washington State DOT (WSDOT)TAMP was one example of demonstrating asset management maturity through summarizing how multiple iterations of life-cycle planning led to minimizing assets in Poor condition based on State and Federal measures at lower costs. Instead of pivoting to new procedures, the WSDOT TAMP identified existing ones that meet its asset management objectives.

The TAMP stated, "Asset management has been, and will continue to be, a foundational piece of how we, and our partners, manage our transportation network." The WSDOT TAMP did not describe procedures that were developed for the TAMP, or procedures that will be deployed in the future. It described long-standing procedures that have over several years generated substantial savings and minimized assets in Poor conditions. Those procedures were used for the WSDOT TAMP as the processes to satisfy 23 CFR Part 515.

The WSDOT asset management plan stated that the agency's life-cycle planning approach considers the following types of highway asset information:

- Condition information.
- Condition deterioration rates (models).
- Maintenance and rehabilitation intervals and treatment rules.
- Treatment costs.
- Expected condition improvements, new deterioration rates, or new service life estimates.
- Expected changes in system demand.
- Risks associated with current or future conditions.
- Anticipated budgets.
- Inflation and discount rates.
- System hierarchies (high priority routes versus low priority routes).
- Constraints that influence investments.
- Desired state of good repair and any existing performance gaps.

WSDOT's life-cycle planning process for asphalt pavements was to use timely resurfacing to make them, in effect, perpetual pavements that seldom need reconstruction but stay in good repair through timely maintenance and resurfacings. For concrete pavements, WSDOT usually used a crack and seat with asphalt overlay for its approximately 1,000 lane miles of concrete pavements that are more than 40 years old. WSDOT also steadily converted asphalt pavements with average daily traffic of 10,000 or less to chip seals.

Between 2010 and 2017, WSDOT had used chip seal conversion for approximately 2,300 lane miles and the lane mile percentage of chip sealed routes rose from 25 percent to 36.7 percent. Before funding challenges disrupted it plans, WSDOT intended to convert another 700 lane miles over the next five years to chip seals which would have brought the percent of the network treated with chip seals to 40 percent. The effect of this strategy on the annual network cost would have been to shift 3,000 lane miles from asphalt to chip seal by 2024 with an estimated annual cost savings of $40 million.

The TAMP indicated WSDOT also had for several years deployed what it called "strategic maintenance" that included three strategies. One was to identify premature distresses in pavements that otherwise were in good condition and perform maintenance to arrest further premature deterioration. It also deployed short-term maintenance strategies to prolong pavement service life and to postpone the time

until reconstruction was needed. WSDOT also deployed preventive maintenance treatments as part of its strategic maintenance program. The WSDOT TAMP estimated that the strategic maintenance efforts saved the department $15 million annually.

The WSDOT TAMP estimated the agency will save an additional $25 million a year by 2025 through the use of crack, seat, and overlay of concrete pavements that reached the end of their life cycle compared to performing a pavement reconstruction. Combined with the chip seal savings and the strategic maintenance savings, it predicted a total annual savings of $80 million by 2025, if its budget allows it to continue with its chip seal strategy.

WSDOT calculates a value called the Equivalent Uniform Annual Cost (EUAC) for each treatment type expressed in terms of dollars per lane mile per year. EUAC is a metric used by WSDOT to compare the long-term costs of one pavement treatment strategy versus another, and to determine the best management practices relative to the risk of pavement failure. The WSDOT TAMP stated that the significant advantage of using the annual cost as a measure of cost-effectiveness is that it allows direct comparison of multiple treatment alternatives with different service lives.

For example, the TAMP stated at the time of its publication the cost of a chip seal was $45,000 per lane mile compared to $225,000 for an asphalt overlay. The crack, seat, and overlay of concrete cost $1.15 million per lane mile compared to $2.5 million for a concrete reconstruction. These lower cost strategies can be compared to the strategies used before 2010 which was the year when they were first deployed. In 2010, WSDOT had 4,580 lane-miles chip sealed that had an average service life of 6 years and an average lane mile cost of $45,000. The 2025 lane-mile chip seal cost combined with strategic maintenance was estimated to be $47,500 with a 9-year service life. By 2025, WSDOT estimated that it would have 7,580 lane miles chip sealed compared to 4,580 in 2010. The annual cost for all chip seals would be higher in 2025 than in 2010 but the annualized cost overall would have been less because 3,000 fewer lane miles would have been treated with higher cost asphalt. The annual budget for chip sealing would have risen from $34 million per year to $40 million, but the annual asphalt paving costs would have decreased from $186 million to $116 million. Overall, with all the pavement life-cycle strategies deployed, the annual pavement costs were expected to fall from $324 million annually to $244 million, or the $80 million savings previously mentioned. The EUAC for the chip seal was estimated to be $7,497 per year compared to $20,237 for asphalt. The crack, seat, and overlay EUAC was estimated to be $49,330 per lane mile compared to $116,376 for reconstructed concrete. Since the publication of the TAMP, because of budget challenges WSDOT intended to suspend preservation treatments on routes posted at less than 40 miles per hour although the analysis showed that those treatments would be cost-effective.

Conclusion

The asset management plans in this case study provide examples of good practices that are relevant to other State and local agencies at all levels of maturity. The New Jersey and Pennsylvania TAMPs included examples for agencies deploying early-generation asset management programs. The Illinois plan represented an example of an agency in the early stages of using asset management practices but which has identified a road map for improvement. The Washington plan provided an example of how mature asset management procedures allow an agency to document many years of cost savings and asset improvement.

[1] FHWA Transportation Asset Management Expert Task Group, Life Cycle Planning – An Overview, A White Paper Produced by the Federal Highway Administration Transportation Asset Management Expert Task Group, July 2019, p3, accessed at https://www.fhwa.dot.gov/asset/etg/pubs/whitepaper1.pdf.
[2] American Association of State Highway and Transportation Officials (AASHTO) Transportation Asset Management Guide A focus on Implementation, January 2011 p4-3.
[3] International Infrastructure Manual, Version 3.0, 2006 p2.39.
[4] FHWA Financial Planning for Transportation Asset Management: An Overview, FHWA-HIF-15-008, 2015, p3.
[5] New Jersey Department of Transportation 2019 Transportation Asset Management Plan p3-11.
[6] NJDOT 2019 TAMP, p3-11.
[7] NJDOT 2019 TAMP, p6-13
[8] FHWA, Financial Planning for Transportation Asset Management, An Overview, Report 1, FHWA-HIF-15-008, pages 1-6 February 25 https://www.fhwa.dot.gov/asset/plans/financial/hif15018.pdf.
[9] FHWA Risk-Based Transportation Asset Management: Evaluating Threats, Capitalizing on Opportunities, Report 1 Overview of Risk Management, FHWA-HIF-12-035, pp12, 16, 30.
[10] AASHTO Guide to Enterprise Risk Management, 2016. p139.
[11] Austroads, "Guide to Asset Management Part 8: Asset Valuation and Audit," May 2009, p2.
[12] Australian Infrastructure Financial Management Guidelines, version 1.1, 2010, pix.
[13] The Roads Liaison Group Cod of Practice for Highway Maintenance Management, The Roads Liaison Group, London, 2013, p 92.
[14] Kavanagh, S., Han, M., Long-Term Financial Planning for Local Government, Government Finance Officers Association, 2008, p16.
[15] Illinois Department of Transportation 2019 Transportation Asset Management Plan, p103.