Arizona Department of Transportation
INITIAL TRANSPORTATION ASSET MANAGEMENT PLAN

APRIL 2018 Rev. September 2018
### Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADOT</td>
<td>Arizona Department of Transportation</td>
</tr>
<tr>
<td>AMS</td>
<td>Arizona Management System</td>
</tr>
<tr>
<td>ARFC</td>
<td>Asphalt rubber friction course</td>
</tr>
<tr>
<td>CGR</td>
<td>Compound Growth Rate</td>
</tr>
<tr>
<td>COG</td>
<td>Council of Governments</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
</tr>
<tr>
<td>ECD</td>
<td>Enforcement and Compliance Division</td>
</tr>
<tr>
<td>FAST</td>
<td>Fixing America’s Surface Transportation</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>FMS</td>
<td>Financial Management Services</td>
</tr>
<tr>
<td>FY</td>
<td>Fiscal Year</td>
</tr>
<tr>
<td>HPMS</td>
<td>Highway Performance Monitoring System</td>
</tr>
<tr>
<td>HURF</td>
<td>Highway User Revenue Fund</td>
</tr>
<tr>
<td>IRI</td>
<td>International Roughness Index</td>
</tr>
<tr>
<td>LCCA</td>
<td>Life Cycle Cost Analysis</td>
</tr>
<tr>
<td>LCP</td>
<td>Life Cycle Planning</td>
</tr>
<tr>
<td>MAP-21</td>
<td>Moving Ahead for Progress in the 21st Century Act of 2012</td>
</tr>
<tr>
<td>MPD</td>
<td>Multimodal Planning Division</td>
</tr>
<tr>
<td>NBI</td>
<td>National Bridge Inventory</td>
</tr>
<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization</td>
</tr>
<tr>
<td>NBIAS</td>
<td>National Bridge Investment Analysis System</td>
</tr>
<tr>
<td>NHS</td>
<td>National Highway System</td>
</tr>
<tr>
<td>OA</td>
<td>Obligation Authority</td>
</tr>
<tr>
<td>P2P Link</td>
<td>Planning to Programming Process</td>
</tr>
<tr>
<td>PCI</td>
<td>Pavement Condition Index</td>
</tr>
<tr>
<td>SHS</td>
<td>State Highway System</td>
</tr>
<tr>
<td>SOGR</td>
<td>State of Good Repair</td>
</tr>
<tr>
<td>STBGP</td>
<td>Surface Transportation Block Grant Program</td>
</tr>
<tr>
<td>STIP</td>
<td>Statewide Transportation Improvement Program</td>
</tr>
<tr>
<td>TAMP</td>
<td>Transportation Asset Management Plan</td>
</tr>
<tr>
<td>TIP</td>
<td>Transportation Improvement Program</td>
</tr>
</tbody>
</table>
TSMO  Transportation System Management & Operations
U.S.   United States
WIM    Weigh-in-motion
WMYA   What Moves You Arizona
# Table of Contents

1. EXECUTIVE SUMMARY ................................................................. 1-1

2. INTRODUCTION AND ASSET MANAGEMENT OBJECTIVES ............ 2-1
   2.1 Introduction ............................................................................... 2-1
   2.2 Asset Management Objectives ................................................ 2-4
   2.3 Asset Management Oversight and Operating Structure .................. 2-6
   2.4 Asset Management and the Planning Process ............................... 2-7
   2.5 Public Support for Highway Preservation .................................. 2-8
   2.6 Arizona Management System .................................................. 2-9

3. SUMMARY OF NHS BRIDGE AND PAVEMENT CONDITION ............... 3-1
   3.1 Introduction ............................................................................... 3-1
   3.2 Bridge Condition ....................................................................... 3-1
   3.3 Pavement Condition ................................................................... 3-7

4. PERFORMANCE MEASURES AND TARGETS ........................................ 4-1
   4.1 SHS Performance Goals ............................................................. 4-1
   4.2 Pavement Performance .............................................................. 4-1
   4.3 Bridge Performance ................................................................. 4-2
   4.4 Federal Performance Measures – Bridges and Pavements .......... 4-2

5. PERFORMANCE GAP ANALYSIS ...................................................... 5-1
   5.1 Projected Traffic Growth ........................................................... 5-1
   5.2 Infrastructure Age .................................................................... 5-2
   5.3 Infrastructure Condition Trends ................................................. 5-3
      5.3.1 BridgeCondition ................................................................ 5-3
      5.3.2 Pavement Condition .......................................................... 5-4
   5.4 Long-term Outlook ................................................................... 5-6
   5.5 Performance Gap Analysis Process ......................................... 5-7

6. RISK MANAGEMENT ANALYSIS ..................................................... 6-1
6.1 Risk Factors .......................................................................................................... 6-1
6.2 Risk Policy and Procedure .................................................................................... 6-2
6.3 Risk Analysis ......................................................................................................... 6-3
   6.3.1 Risk Register .................................................................................................. 6-4
   6.3.2 Mitigation for High Priority Risks .......................................................... 6-8
      6.3.2.1 Changing Legislation ........................................................................ 6-8
      6.3.2.2 Extreme Weather ............................................................................ 6-9
      6.3.2.3 Rising Interest and Inflation Rates ................................................. 6-9
      6.3.2.3 Revenue Variations ....................................................................... 6-10
      6.3.2.4 Liability Losses .......................................................................... 6-10
      6.3.2.5 Asset Obsolescence .................................................................... 6-11
      6.3.2.6 Construction/Materials Price Volatility ...................................... 6-11
      6.3.2.7 Flood Damage Including Scour .................................................... 6-11
      6.3.2.8 Collision Damage to Bridges ....................................................... 6-12
      6.3.2.9 Non-permitted Overweight Load Related Damage ..................... 6-13
      6.3.2.10 Inadequate Maintenance Budget ............................................... 6-14
6.4 Risk Monitoring .................................................................................................. 6-14
6.5 Facilities Repeatedly Damaged by Emergency Events ....................................... 6-15

7 LIFE CYCLE PLANNING ............................................................................................ 7-1
   7.1 Traditional Process ........................................................................................... 7-1
   7.2 Life Cycle Planning Process ............................................................................ 7-2

8 FINANCIAL PLAN ..................................................................................................... 8-1
   8.1 Financial Planning Team ............................................................................... 8-1
   8.2 Asset Valuation .............................................................................................. 8-1
   8.3 Financial Plan Components .......................................................................... 8-3
   8.4 Available Revenue ....................................................................................... 8-4
      8.4.1 Federal Funding ............................................................................... 8-4
      8.4.2 State Funding .................................................................................... 8-6
      8.4.3 Regional Funding ............................................................................. 8-8
      8.4.4 Local Funding ................................................................................. 8-8
   8.5 Economic Outlook ......................................................................................... 8-9
8.6 Estimate Funding Needs ................................................................. 8-10
8.7 Funding Gaps .................................................................................... 8-11
8.8 Investment Strategies ...................................................................... 8-12
  8.8.1 Performance Gap Analysis ...................................................... 8-12
  8.8.2 Life Cycle Analysis ................................................................... 8-12
    8.8.2.1 Bridge ............................................................................. 8-13
    8.8.2.2 Pavement ........................................................................ 8-13
  8.8.3 Risk Management Analysis .................................................... 8-14
  8.8.4 Increased Funding for Asset Preservation ............................ 8-15
  8.8.5 Selection of Bridge and Pavement Investment Strategies in the Final TAMP .............................................................................. 8-15

9 REFERENCES ............................................................................................... 9-1

10 GLOSSARY OF TERMS ............................................................................. 10-1

11 ACKNOWLEDGEMENTS ........................................................................... 11-1

Appendices

Appendix A - Documents Referenced
## Tables

Table 2-1  
Asset Management Committees ................................................................. 2-6

Table 3-1  
Arizona Highway System Bridges* ................................................................. 3-1

Table 3-2  
2017 Lane Mile Break Down for Paved Roads* ................................................... 3-7

Table 3-3  
Pavement Types ............................................................................................... 3-8

Table 3-4  
Pavement Condition Rating Metrics .................................................................. 3-9

Table 3-5  
Federal Thresholds for Pavement Rating Metrics ............................................. 3-10

Table 4-1  
Present Serviceability Rating ........................................................................... 4-2

Table 5-1  
Performance Gap Analysis Using State Metrics Based on ADOT’s State of Good Repair (SOGR) Targets ................................................................. 5-1

Table 5-2  
2016 and Projected 2035 Daily Vehicle Miles Traveled ....................................... 5-1

Table 6-1  
Risk Type .......................................................................................................... 6-3

Table 6-2  
Automobile Risk Register Example* .................................................................. 6-4

Table 6-3  
Asset Management Risk Register ...................................................................... 6-6

Table 6-4  
Insurance Recovery Metrics – December 2017* ............................................. 6-11

Table 6-5  
Life Expectancy of Pavement Surface Treatments ............................................ 6-14

Table 7-1  
Condition-based Life Cycle Treatment Regime (Concrete Bridge – Low Desert)* ................................................................. 7-5

Table 7-2  
Preventative Maintenance Life Cycle Treatment Regime (Concrete Bridge – Low Desert) * ................................................................. 7-5

Table 8-1  
Undepreciated Value of Transportation Infrastructure (dollars in billions)........ 8-1

Table 8-2  
Historical Asset and Maintenance Programming (dollars in millions) ............... 8-2

Table 8-3  
Estimated Federal Aid (dollars in millions) ....................................................... 8-5

Table 8-4  
Projected Revenue available for Preservation and other Transportation Purposes (dollars in millions) ................................................................. 8-8

Table 8-5  
Arizona Demographic and Economic Statistics .................................................. 8-9

Table 8-6  
Official HURF Forecast – FY 2018 Official Forecast (dollars in millions) .......... 8-10
Figures

Figure 2-1  State Highway System .......................................................... 2-2
Figure 2-2  National Highway System ..................................................... 2-3
Figure 2-3  ADOT’s Mission, Vision and True North .................................. 2-4
Figure 2-4  Investment Priority Survey Results ........................................ 2-8
Figure 3-1  Bridge Cross Section .............................................................. 3-2
Figure 3-2  Box Culvert ........................................................................... 3-2
Figure 3-3  Pipe Culverts ........................................................................ 3-3
Figure 3-4  NBI Bridge Rating Scale ......................................................... 3-4
Figure 3-5  Cracking and Spalling on a Bridge Deck ................................. 3-5
Figure 3-6  Scaling on a Bridge Deck ....................................................... 3-6
Figure 3-7  Scour at a Bridge Pier ............................................................ 3-6
Figure 3-8  2017 Bridge Conditions ......................................................... 3-7
Figure 3-9  2016 Pavement Conditions .................................................... 3-11
Figure 5-1  Bridge Age (SHS and local NHS) ........................................... 5-2
Figure 5-2  Pavement Age – State Highway System ............................... 5-3
Figure 5-3  NHS Bridge Condition ........................................................... 5-4
Figure 5-4  Interstate Pavement Condition .............................................. 5-5
Figure 5-5  Non-Interstate NHS Pavement Condition ............................. 5-5
Figure 5-6  Projected Pavement Condition .............................................. 5-6
Figure 5-7  Projected Bridge Deterioration .............................................. 5-7
Figure 6-1  Five Ts ................................................................................. 6-5
Figure 7-1  Pavement Condition Index .................................................... 7-1
Figure 8-1  Federal Fiscal Year 2017 Apportionments (dollars in millions) . 8-5
Figure 8-2  FY 2017 HURF Revenue Distribution Flow (dollars in millions) . 8-7
Figure 8-3  Linking Planning to Programming .......................................... 8-17
1 EXECUTIVE SUMMARY

Moving Ahead for Progress in the 21st Century Act of 2012 (MAP-21), identified the following national transportation system goal areas (Figure 1-1):

Transportation asset management regulations associated with the Infrastructure Conditions goal require the development of a risk-based Transportation Asset Management Plan (TAMP) covering National Highway System (NHS) bridges and pavements.

The regulations are implemented in two stages:

1) Development of an initial TAMP, due April 30, 2018, that includes some plan elements plus a description of the processes and methodologies that will be used to develop a final TAMP.

2) Development of a final TAMP, due June 30, 2019, containing all required plan elements.

This initial TAMP contains Arizona Department of Transportation (ADOT) asset management objectives; a summary listing of NHS bridges and pavements, including current condition; performance measures and targets; performance gap analysis; risk management analysis; investment strategies and a description of the processes and methodologies to perform life cycle planning and prepare a financial plan.
2 INTRODUCTION AND ASSET MANAGEMENT OBJECTIVES

2.1 Introduction

ADOT is responsible for the construction, operation, management and maintenance of the State Highway System (SHS) which comprises more than 21,000 lane miles and is valued at more than $20 billion. The dependable and efficient operation of this transportation network is vital to Arizona’s economic competitiveness and quality of life. Moreover, the safety and welfare of the travelling public depends on the successful management of the transportation assets on the SHS (Figure 2-1) and the NHS (Figure 2-2).

The majority of ADOT’s bridge and pavement infrastructure will reach the end of its normal lifecycle over the next 10 years. With proper preservation treatments, the life of this infrastructure can be extended. However, as Arizona’s highway system ages, the resources needed to maintain it will increase. This makes the identification and implementation of strategies that preserve existing assets while controlling costs essential to sustaining a balanced, fiscally sound state highway program.

Like most other state Departments of Transportation (DOTs), ADOT uses a common asset management strategy that ranks assets by condition and prioritizes repair, rehabilitation and reconstruction primarily on a “worst first” basis. This reactive approach tends to focus on expensive rehabilitation and reconstruction projects, rather than applying preservation treatments before deterioration is noticeable, which can extend asset lifespans at lower costs. Recently, DOTs are determining that a strategy that optimizes the application of maintenance, preservation, rehabilitation and replacement throughout an asset’s lifecycle is a more cost effective way to manage highway infrastructure. Managing assets throughout their lifecycle with an increased emphasis on preservation treatments is a proactive approach, requiring a long-term perspective and significant planning. It is becoming a standard practice for DOTs to address this planning need by the development of a TAMP.
Figure 2-1  State Highway System
Figure 2-2 National Highway System
2.2 Asset Management Objectives

ADOT’s final TAMP will be a comprehensive blueprint for extending the life of Arizona’s highway system while maintaining reliable performance and minimizing long-term costs. This approach aligns well with ADOT’s mission and vision (Figure 2-3).

![Figure 2-3 ADOT’s Mission, Vision and True North](image)

ADOT objectives for transportation asset management are to:

- Develop a collaborative process that integrates the efforts of data managers, engineers, maintenance personnel, planners, financial specialists and executives in the management of ADOT’s transportation assets.
- Improve ADOT’s asset management business practices to support safe, efficient, reliable, resilient and sustainable highway infrastructure.
- Maintain the fundamental function and reliability of the as built highway system (state of good repair).
- Factor risk into asset management planning.
- Manage transportation assets throughout their lifecycle in the most cost-effective manner, with a focus on low cost maintenance and preservation treatments.
- Maintain the reliability of ADOT’s bridges and pavements by identifying gaps in asset condition performance and investment strategies that could narrow or close those gaps.
- Communicate financial needs for maintaining the highway system in a state of good repair to ADOT’s stakeholders.
- Improve transparency, accountability and decision-making in the management of ADOT’s transportation infrastructure.
• Incorporate Arizona Management System (AMS) principles in ADOT’s management of transportation assets. See Subsection 2.6.

Maintaining the highway system in a state of good repair has also become a goal of Congress, as illustrated in MAP-21 that was signed into law on July 6, 2012. This legislation requires state DOTs to develop a risk-based TAMP, which is required to include:

• Asset management objectives;
• A summary description of the condition of NHS pavements and bridges, regardless of ownership;
• Asset management performance measures and state DOT targets for asset condition;
• Performance gap analysis;
• Risk management analysis, including an evaluation of facilities repeatedly damaged by emergency events;
• Network life cycle planning;
• A financial plan; and
• Investment strategies.

The asset management regulations allow the development of an initial TAMP which contains some plan elements and describes the processes and methodology that will be used to develop a final TAMP. The initial TAMP may exclude analysis for risk, life cycle and financial planning. ADOT’s initial TAMP includes final TAMP elements to the extent completed. The initial TAMP is limited to two asset classes: bridges and pavements. A description of bridge and pavement condition will be limited to NHS assets in the initial TAMP; but, the final TAMP will contain a condition description of all SHS bridge and pavement assets.

In future years, TAMP updates may include other assets, such as pump stations, tunnels and signs. To effectively include other assets in the TAMP, it will be necessary to develop comprehensive inventory and condition data sets for these assets, which may take several years. The initial TAMP is due to FHWA by April 30, 2018. A final TAMP containing all required elements will be due to FHWA by June 30, 2019. The initial and final TAMPs cover a 10-year planning horizon.
2.3 Asset Management Oversight and Operating Structure

Developing and implementing transportation asset management within ADOT is a major undertaking and requires involvement of staff throughout the agency. Table 2-1 lists the committees responsible for implementation of this effort. Numerous specialists from ADOT’s planning, data management, risk management, finance and other areas also participated in the development of this initial TAMP.

Table 2-1 Asset Management Committees

<table>
<thead>
<tr>
<th>Committee</th>
<th>Purpose</th>
<th>Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Management Steering Committee</td>
<td>Sets the general direction for the TAMP, including ensuring that transportation asset management is integrated across the appropriate levels of the organization; approving policies, programs, processes and performance targets necessary for the implementation of transportation asset management; approval of the final TAMP.</td>
<td>ADOT Director, Chair&lt;br&gt;FHWA Arizona Division Administrator&lt;br&gt;Deputy Director for Transportation&lt;br&gt;Deputy Director for Policy&lt;br&gt;Deputy Director for Business Operations&lt;br&gt;Chief Financial Officer&lt;br&gt;Secretary (Transportation Asset Manager and/or Assistant Director for Multimodal Planning Division)</td>
</tr>
<tr>
<td>Asset Management Working Group</td>
<td>Supports the implementation of the TAMP, including developing performance measures and state targets to be reviewed for approval by the steering committee; identifying and prioritizing risks to ADOT’s transportation infrastructure; recommending changes to policies, procedures and processes to improve transportation asset management at ADOT; ensuring different groups and sections within ADOT work together to accomplish the development and implementation of the TAMP; review the draft TAMP.</td>
<td>Transportation Asset Manager, Facilitator&lt;br&gt;FHWA Arizona – Division Representative&lt;br&gt;Assistant Director for Transportation Systems Management and Operations Division&lt;br&gt;Assistant Director for Infrastructure Delivery and Operations Division&lt;br&gt;Assistant Director for Multimodal Planning Division&lt;br&gt;Assistant Director for Communication&lt;br&gt;Deputy State Engineer – Operations&lt;br&gt;Deputy State Engineer – Design&lt;br&gt;Federal Aid Administrator – Financial Management Services&lt;br&gt;Chief Economist – Financial Management Services</td>
</tr>
</tbody>
</table>
2.4 Asset Management and the Planning Process

Over the last decade, long-range transportation planning in Arizona evolved from an emphasis on individual projects to a focus on overall system performance. ADOT’s long-range transportation plan, What Moves You Arizona 2040 (WMYA 2040) (Appendix A), uses performance measures and data-driven analysis to evaluate different investment scenarios to recommend the most realistic allocation of resources for the expansion, modernization and preservation of Arizona’s highway system. To channel these high-level investment choices into the selection of specific projects, ADOT adopted a new planning-to-programming process known as P2P Link. P2P Link combines performance criteria with professional judgement to select and prioritize projects for ADOT’s Five-Year Transportation Facilities Construction Program within the Statewide Transportation Improvement Program (STIP).

The ability to implement performance-based planning is being enhanced by improvements in the collection of asset condition data combined with the availability of sophisticated analytical tools that model future asset performance. In the final TAMP, these developments will come together making it feasible to evaluate a range of asset management planning scenarios to identify one that best meets agency goals at a minimum practical cost. Thus, the TAMP is expected to provide the analytical basis to support both high level resource allocation decisions in long-range transportation plan updates, and the development of asset specific investment strategies to guide project selection under the P2P Link process. Over time, the incorporation of TAMP findings in ADOT’s performance-based planning process is expected to improve accountability and decision-making by:

<table>
<thead>
<tr>
<th>Committee</th>
<th>Purpose</th>
<th>Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Management Technical</td>
<td>Support the development of performance targets and the TAMP, including compiling and analyzing data to support the development of performance targets; use bridge and pavement management systems to perform gap and lifecycle analysis that cover a range of funding scenarios; identifying investment strategies for the cost-effective management of these assets; assist with the development of the TAMP.</td>
<td>Bridge Technical Team</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transportation Asset Manager, Facilitator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>State Bridge Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FHWA Arizona-Division Representative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assistant State Bridge Engineer – Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assistant State Bridge Engineer – Operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bridge Management Systems Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial Management Services Staff</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multimodal Planning Staff</td>
</tr>
<tr>
<td>Pavement Technical Team</td>
<td></td>
<td>Transportation Asset Manager, Facilitator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>State Maintenance Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FHWA Arizona-Division Representative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pavement Management Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pavement Design Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial Management Services Staff</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multimodal Planning Staff</td>
</tr>
</tbody>
</table>

ADOT
• Providing feedback on progress towards performance targets; and
• Increasing transparency by showing how data and analysis informs funding recommendations.

Local governments who own and operate NHS bridges and pavements are also involved in asset management planning through participation in the development of Metropolitan Transportation Plans and Transportation Improvement Programs (TIPs), and/or by working directly with ADOT to incorporate asset improvement projects in the STIP. ADOT is currently working with Arizona’s Metropolitan Planning Organizations (MPOs) and Councils of Government (COGs) to develop a planning agreement that identifies how data collection, performance targets and asset management planning will be coordinated and how each party will contribute. The planning agreement will be completed by May 27, 2018, and included with the final TAMP.

2.5 Public Support for Highway Preservation

During the development of WMYA 2040, ADOT worked collaboratively with Arizona’s MPOs and COGs to implement an extensive public involvement process that included outreach sessions, workshops, a plan website and the use of social media. The outreach effort included an interactive online survey that asked for input on future investment priorities, funding allocation strategies and preferred trade-offs. As illustrated in Figure 2-4, Arizona’s citizens place the highest priority on preserving and maintaining the existing highway system (WMYA 2040, 2018).

<table>
<thead>
<tr>
<th>How Stakeholders Think ADOT Should Allocate Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>PER $100</td>
</tr>
<tr>
<td>Preservation &amp; Maintenance</td>
</tr>
<tr>
<td>Expansion</td>
</tr>
<tr>
<td>Safety</td>
</tr>
<tr>
<td>Technology</td>
</tr>
<tr>
<td>Accessibility</td>
</tr>
</tbody>
</table>


Figure 2-4 Investment Priority Survey Results
2.6 Arizona Management System

AMS is a people-centered, results-driven approach to continuously improving state government with a focus on customer service, transparency and accountability to the citizens of Arizona. AMS intends to streamline state government operations and is based on principles of Lean management; the essence of the Lean principles is to foster respect for people and to continuously improve by understanding customer needs, identifying problems, improving processes and measuring results. AMS intends for the state government to operate at the speed of business through structured problem solving and data-driven decision making.

Arizona’s TAMP aligns well with this performance-based approach. The final TAMP will outline the steps and resources needed to preserve both bridge and pavement conditions, supporting the achievement of agency performance targets. Moreover, the TAMP will be the focal point of an on-going effort to make ADOT’s transportation infrastructure more reliable while using state resources in the most cost effective manner. The TAMP is a living document that will be updated at least every four years. Initial and on-going improvements to ADOT’s Asset Management program will utilize AMS principles, practices and tools (https://ams.az.gov).
3 SUMMARY OF NHS BRIDGE AND PAVEMENT CONDITION

3.1 Introduction

To effectively manage assets at a network level, it is necessary to have an accurate account of inventory and condition of bridges and pavement. ADOT technical experts regularly perform condition inspections of state-owned and, in some cases, locally-owned roadway assets. The summary results of this information for bridges and pavements for the 2017 reporting year\(^1\) are shown below.

3.2 Bridge Condition

ADOT owns and operates all of the bridges and culverts on the SHS, and the majority of these structures on the NHS. Local governments also own and operate bridges and culverts on the NHS (Table 3-1).

<table>
<thead>
<tr>
<th>Bridge Owner</th>
<th>Number of Bridges</th>
<th>Bridge Deck Area (square feet)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>All State-owned Bridges***</td>
<td>4,813</td>
<td>43,338,110</td>
</tr>
<tr>
<td>State-owned NHS Bridges</td>
<td>3,070</td>
<td>31,679,297</td>
</tr>
<tr>
<td>Locally-owned NHS Bridges</td>
<td>310</td>
<td>3,175,826</td>
</tr>
<tr>
<td>Total NHS Bridges</td>
<td>3,380</td>
<td>34,855,123</td>
</tr>
</tbody>
</table>

* Includes culverts. Culverts that have an opening that is less than or equal to 20 feet in length are not included in this tally or in the TAMP.

** System-wide bridge condition ratings are typically reported by cumulative deck area since this metric accounts for the variance in bridge size throughout the state.

*** Includes state-owned NHS bridges.


ADOT inspects most of Arizona’s publicly owned bridges, including all of the bridges on the SHS and the majority of the bridges owned or operated by local governments. Routine bridge inspections occur every two years and assess the condition of a bridge’s primary components: deck, superstructure and substructure (Figure 3-1).

\(^1\) A reporting year is defined as the 2017 NBI submittal or the 2017 Highway Performance Monitoring System Submission. These reports reflect 2016 data.
Culverts that are greater than 20 feet in length are inspected every four years with a few exceptions. Culverts in Arizona are typically either a reinforced concrete box structure that supports the pavement or steel pipes embedded in soil or concrete (Figures 3-2 and 3-3).
Figure 3-3  Pipe Culverts
ADOT’s bridge inspection guidelines are presented in Appendix A. These guidelines, along with bridge inspector training for ADOT staff and consultants, provide consistent inspections which results in accurate, reliable data.

Three local government agencies perform their own bridge inspections: Maricopa County DOT, Pima County DOT and City of Phoenix. Appendix A contains an intergovernmental agreement between the State of Arizona and the City of Phoenix outlining bridge inspection standards, protocols and coordination. Intergovernmental agreements outlining bridge standards, protocols and coordination are being developed between the State of Arizona and Maricopa and Pima counties and will be included in the final TAMP. For an agency to perform their own bridge inspections, it must demonstrate compliance with the National Bridge Inspection Standards, and submit quarterly progress reports and an annual electronic National Bridge Inventory (NBI) record to the ADOT Bridge Inspection Program Manager. Jointly-owned border bridges with the City of Needles and the states of California and Nevada are inspected by Caltrans or the Nevada Department of Transportation under intergovernmental agreements with the State of Arizona.

The NBI rating system is used to assess bridge general condition ratings for deck, superstructure and substructure. The culvert condition rating is based on the same scale, but rather than a component rating, there is one rating for the entire culvert. This rating system contains a scale from 0 to 9 that is subdivided into good, fair and poor categories (Figure 3-4).

<table>
<thead>
<tr>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All bridge components rated good.</td>
<td>The lowest rated bridge component is fair</td>
<td>One of the bridge components is rated poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Generally, these categories are defined as follows:

- **Good**: Primary structural components exhibit a range from no problems to some minor deterioration.
- **Fair**: Primary structural components are sound, but may have deficiencies such as minor concrete deterioration (cracking, spalling, scaling) or scour (erosion around piers or abutments caused by flowing water).
- **Poor**: Advanced concrete deterioration, scour or seriously affected primary structural components (Figures 3-5 through 3-7). A poor condition bridge may be referred to as “structurally deficient” if the load-carrying elements are in diminished condition due to deterioration and/or damage, or if the structure could create an obstruction to the free

---

2 ADOT is temporarily performing bridge inspections for the City of Phoenix.
flow of water. Bridges in poor condition are in need of repair, maintenance and monitoring. The poor condition label does not necessarily mean that a bridge is unsafe and needs to be closed. Bridges that are considered unsafe are closed until they can be repaired or replaced.

Figure 3-5  Cracking and Spalling on a Bridge Deck
Figure 3-6  Scaling on a Bridge Deck

Figure 3-7  Scour at a Bridge Pier
The majority of bridges on the Arizona NHS are in good condition. In fact, Arizona ranks in the top 10 in the nation for having the fewest poor condition bridges. This is primarily due to the relatively young age of the bridge infrastructure and temperate climate. Figure 3-8 shows NHS bridge conditions based on deck area overall, state NHS only and local NHS only.

![2017 Bridge Condition](image)

### 3.3 Pavement Condition

ADOT maintains all of the pavement on the SHS, which includes the State-owned NHS. Local governments own and maintain pavement on about 13 percent of the NHS. The estimated 2017 lane mile break down for paved roads is shown in Table 3-2. A Data Quality Management Plan outlining pavement data collection and processing standards and procedures is located in Appendix A.

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Lane Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHS* Lane Miles</td>
<td>21,372</td>
</tr>
<tr>
<td>Interstate Lane Miles (NHS)</td>
<td>5,198</td>
</tr>
<tr>
<td>State-owned, Non-Interstate NHS Lane Miles</td>
<td>5,673</td>
</tr>
<tr>
<td>Locally-owned NHS Lane Miles</td>
<td>1,647</td>
</tr>
<tr>
<td>Total NHS Lane Miles</td>
<td>12,518</td>
</tr>
</tbody>
</table>

* Includes ramps, frontage, auxiliary and passing lanes.

Historically, ADOT has performed annual pavement condition evaluations for state highways using in-house staff and equipment. ADOT used FHWA Highway Performance Monitoring System (HPMS) Field Manual (2014) methodology to collect pavement data. Local governments
were expected to collect pavement condition data for the NHS routes they own. However, ADOT was unable to consistently obtain this data. To resolve this problem for 2017, ADOT hired a contractor to perform automated pavement data collection for the entire SHS and the locally-owned NHS. It is ADOT’s intent to continue to collect pavement data for locally-owned NHS routes in future years. This data will be made available to local NHS asset owners. Fully automated pavement data collection is new to ADOT; however, the data is collected in accordance with HPMS methodology and is subject to a rigorous quality control review by ADOT’s Pavement Section.

Arizona has asphalt, concrete and composite pavements. Each pavement type has a different life cycle and is managed differently (Table 3-3).

### Table 3-3 Pavement Types

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>Constructed with petroleum-based bituminous materials. Commonly referred to as flexible pavement due to its low flexural strength. It can last 50+ years if properly maintained with periodic preservation and rehabilitation treatments. More than 90 percent of the pavement on the SHS is asphalt.</td>
</tr>
<tr>
<td>Concrete</td>
<td>Constructed of Portland cement concrete. It may be constructed with joints to control cracking or without joints. Concrete pavement is either reinforced with steel or unreinforced (plain). The majority of the concrete pavement on the SHS is jointed and unreinforced and called Jointed Plain Concrete Pavement. Concrete pavement is commonly referred to as rigid pavement due to its high flexural strength and can last 60+ years.</td>
</tr>
<tr>
<td>Composite</td>
<td>Consists of a foundation of concrete pavement overlaid with asphalt. On the SHS, the asphalt layer typically consists of a 1-inch-thick open-graded asphalt rubber friction course (ARFC). ADOT’s open-graded asphalt is designed to have a high amount of air voids making the pavement water permeable, reducing splash and spray during wet weather. A high amount of air voids and the addition of ground tire rubber to the asphalt reduce road noise. An additional benefit of the ARFC layer is that it improves the smoothness of the pavement while maintaining an acceptable level of friction for stopping, resulting in better ride quality than a concrete surface. Typically, the overlay on a composite pavement lasts 10 to 15 years before it needs to be removed and replaced. About 7 percent of the pavement on the SHS is composite.</td>
</tr>
</tbody>
</table>

Asphalt and composite pavement condition is evaluated using three metrics: International Roughness Index (IRI), percent cracking and rutting (Table 3-4). Concrete pavement condition is evaluated using IRI, percent cracking and faulting metrics.
### Table 3-4 Pavement Condition Rating Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRI</td>
<td>International method for measuring the smoothness (or roughness) of pavements. This measure is strongly correlated to ride quality.</td>
<td><img src="image1.jpg" alt="Example Image" /></td>
</tr>
<tr>
<td>Cracking</td>
<td>A fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement. Cracking is generally caused by repeated traffic loads or pavement shrinkage due to low temperatures.</td>
<td><img src="image2.jpg" alt="Example Image" /></td>
</tr>
<tr>
<td>Rutting</td>
<td>Surface depressions that run length-wise, usually in the wheel path, in an asphalt pavement. Rutting results from permanent deformation of any of the pavement layers or the subgrade. It is usually caused by the consolidation or lateral movement of the pavement materials due to heavy traffic loads.*</td>
<td><img src="image3.jpg" alt="Example Image" /></td>
</tr>
</tbody>
</table>
### Metric Description

**Faulting***

An elevation difference between two concrete slabs typically caused by poor load transfer between slabs, slab settlement or movement induced by erosion of material beneath the slab.

* Photo taken from the 2016 HPMS Field Manual.

If the condition for all three applicable metrics is good, then the pavement section is rated in good condition. If two or more metrics are rated poor, then the pavement section is rated in poor condition. All other rating combinations are considered to be fair condition. **Table 3-5** shows the federal thresholds for these metrics.

**Table 3-5 Federal Thresholds for Pavement Rating Metrics**

<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRI (inches/mile)</td>
<td>&lt;95</td>
<td>95-170</td>
<td>&gt;170</td>
</tr>
<tr>
<td>Cracking percent</td>
<td>&lt;5</td>
<td>5-20 (asphalt)</td>
<td>&gt;20 (asphalt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-15 (jointed concrete)</td>
<td>&gt;15 (jointed concrete)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-10 (continuously reinforced concrete)</td>
<td>&gt;10 (continuously reinforced concrete)</td>
</tr>
<tr>
<td>Rutting (inches)</td>
<td>&lt;0.20</td>
<td>0.20-0.40</td>
<td>&gt;0.40</td>
</tr>
<tr>
<td>Faulting (inches)</td>
<td>&lt;0.10</td>
<td>0.10-0.15</td>
<td>&gt;0.15</td>
</tr>
</tbody>
</table>

The results of the 2017 automated pavement data collection effort were not ready for inclusion in the initial TAMP, so 2016 data is presented (**Figure 3-9**). The 2016 non-Interstate NHS pavement condition metric does not include local NHS pavements. Local NHS pavements will be included in the final TAMP.
Figure 3-9  2016 Pavement Conditions
4 PERFORMANCE MEASURES AND TARGETS

4.1 SHS Performance Goals

Performance measures and targets are the foundation on which state agencies do business under the AMS. The four key steps to implement AMS are:

1. Identify what we do – the core processes that most impact our agencies’ missions and deliver customer value.
2. Set targets and standards for doing this work well.
3. Measure how we’re actually doing relative to the targets and standards.
4. Where performance comes up short, use disciplined problem solving to implement counter measures to get our performance back on track [1].

Following these steps defines the standard to be achieved, promotes transparency and accountability, and provides feedback for making improvements. Transportation asset management is a core part of ADOT’s mission and the performance-based TAMP is carried out in accordance with AMS principles.

A performance measure is an objective expressed as a metric that when linked with a target, can be used to measure progress and evaluate strategies for improvement. Targets are quantifiable values of achievable performance, stated as fixed benchmarks, which may be modified over time to match available funding or changes in priorities. Performance targets differ from aspirational goals because targets are constrained by available funding.

ADOT uses the performance measures and targets identified below to manage its bridges and pavements on the SHS in a state of good repair. ADOT’s definition of a state of good repair is to maintain the fundamental function and reliability of the as built highway system.

4.2 Pavement Performance

ADOT’s Pavement Management Section developed a performance measure for the condition level of the pavement on the SHS. This measure is called “serviceability,” which is defined as the ability of a pavement to serve the traveling public. The metric associated with this measure is referred to as the Present Serviceability Rating. This rating is predominantly based on a measurement of pavement smoothness and is expressed as a five-point scale (Table 4-1). ADOT’s target is to maintain a condition level (Present Serviceability Rating) rating of 3.23 or better for all roads in the SHS.
### 4.3 Bridge Performance

ADOT has a performance target of maintaining the percentage of bridges rated in fair condition (NBI Rating System) at 37 percent or less, measured by the total number of state-owned bridges.

### 4.4 Federal Performance Measures – Bridges and Pavements

In the final TAMP, federally-required performance measures and targets for managing bridges and pavements will be the basis for assessment, analysis and planning. The federal performance management rules for bridges and pavements (23 Code of Federal Regulations Part 490.105) require state DOTs to establish targets for the following measures:

- Percent of Interstate pavements in good condition (four-year target required).
- Percent of Interstate pavements in poor condition (four-year target required).
- Percent of non-Interstate NHS pavements in good condition (two- and four-year targets required).
- Percent of non-Interstate NHS pavements in poor condition (two- and four-year targets required).
- Percent of NHS bridges classified as in good condition (two- and four-year targets required).
- Percent of NHS bridges classified as in poor condition (two- and four-year targets required).

The performance management rule also sets minimum condition requirements for pavements and bridges:

- The percentage of Interstate pavement lane-miles in poor condition shall not exceed 5 percent.
- The percentage of the deck area of NHS bridges classified in poor condition shall not exceed 10 percent.

Arizona currently meets the minimum condition requirements for Interstate pavements and NHS bridges.

<table>
<thead>
<tr>
<th>Table 4-1 Present Serviceability Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>
Since the two- and four-year bridge and pavement performance targets are not due until May 20, 2018, ADOT is not required to include these targets in the initial TAMP. The targets will be included in the final TAMP.

Effective life cycle planning also requires the establishment of long-term (10-year) performance targets. Bridge and pavement management analytical software systems are invaluable tools for predicting long-term asset deterioration and future funding needs. Since these software systems are under development at ADOT, the identification of long-term targets also will be deferred until the final TAMP.
5 PERFORMANCE GAP ANALYSIS

ADOT currently meets its performance targets for SHS bridges and pavements (Table 5-1). From September 2017 to February 2018, 35.7 percent of the bridges (target: ≤37%) on the SHS were in fair condition. In 2017, the Present Serviceability Rating for pavements was 3.67 (target: ≥3.23). Although ADOT’s bridges and pavements are currently in good condition overall, future travel growth, infrastructure age and asset deterioration will make sustaining a state of good repair an increasing challenge.

Table 5-1 Peformance Gap Analysis Using State Metrics Based on ADOT’s State of Good Repair (SOGR) Targets

<table>
<thead>
<tr>
<th>Category</th>
<th>Metric</th>
<th>SOGR Target</th>
<th>Current Condition</th>
<th>Gap Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHS Pavement</td>
<td>Present Serviceability Rating</td>
<td>≥3.23</td>
<td>3.67</td>
<td>Long-term spending increases on pavements approved in WMYA 2040 indicate the potential to meet the target for the ten-year horizon of the TAMP.</td>
</tr>
<tr>
<td>SHS Bridge</td>
<td>% Fair</td>
<td>≤37%</td>
<td>35.7%</td>
<td>Long-term spending increases on bridges approved in WMYA 2040 indicate the potential to meet the target for the ten-year horizon of the TAMP.</td>
</tr>
</tbody>
</table>

5.1 Projected Traffic Growth

Arizona has experienced strong population growth for the past several decades. From 1970 to 2010, the state grew from a population of 1.77 million to 6.39 million. The rate of growth slowed during the Great Recession, but population is still expected to grow another 81 percent to 11.56 million by 2050 [2].

This growth will lead to increased highway travel. Table 5-2 shows the projected increase in daily vehicle miles traveled for the SHS (including the State-owned NHS) and locally owned NHS routes between 2016 and 2035.

Table 5-2 2016 and Projected 2035 Daily Vehicle Miles Traveled

<table>
<thead>
<tr>
<th>Network</th>
<th>2016 Vehicle Miles Traveled</th>
<th>2035 Vehicle Miles Traveled</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Highway System</td>
<td>84,239,889</td>
<td>120,547,062</td>
<td>43.1</td>
</tr>
<tr>
<td>Locally-owned NHS</td>
<td>10,810,354</td>
<td>12,599,256</td>
<td>16.6</td>
</tr>
</tbody>
</table>

NOTE: Projections from the Arizona Statewide Travel Demand Model 2016.

Rising population and the corresponding rise in travel is outpacing the growth of the highway network, resulting in an increased traffic burden on existing roadways. Growing trade with Mexico and freight traffic from Los Angeles ports is contributing to higher truck volumes on key
commerce corridors throughout the state. Increased highway utilization, particularly by commercial trucks, accelerates the deterioration of pavements and bridge decks requiring more frequent maintenance, preservation, rehabilitation and reconstruction. Although traffic growth will be gradual, keeping up with impacts will require a substantial investment in infrastructure preservation; it also will make improvements to network-wide asset conditions more challenging.

5.2 Infrastructure Age

Over the 10-year horizon of this plan, the advancing age of state highway assets will be one of the primary challenges facing ADOT. Approximately 54 percent of the bridges on the SHS and the local NHS are more than 50 years old; by the end of the TAMP planning horizon, more than 60 percent of bridges will exceed this age (Figure 5-1). Until 2007, ADOT designed bridges to have a 50-year lifespan; however, these bridges may last significantly longer with the proper care. After 2007, new bridges were designed with a service life of 75 years.

![Figure 5-1 Bridge Age (SHS and local NHS)](image)

Approximately 63 percent of the pavements on the SHS are more than 50 years old; by the end of the TAMP planning horizon, more than 70 percent of pavements will exceed this age (Figure 5-2). Asphalt pavements are designed to last 20 years before an initial rehabilitation is needed. Rehabilitation treatments typically last 10 to 15 years. After two rehabilitation treatments, it is likely to be more cost-effective to reconstruct the pavement making the optimum lifecycle of asphalt pavements 40 to 50 years.
5.3 Infrastructure Condition Trends

5.3.1 Bridge Condition

From 2008 to 2013, aging bridges steadily deteriorated (Figure 5-3). The most noticeable change was the percentage of bridges that worsened from good to fair condition, indicating insufficient spending on preventative maintenance.

This downward trend stabilized over the past few years due to increased spending on bridges, particularly on rehabilitation and reconstruction. The number of poor and fair condition bridges has decreased during the last 3 years.
5.3.2 Pavement Condition

ADOT makes a significant investment in maintaining interstate pavements. Historically, interstate pavements have been in good condition; although, the amount of fair condition interstate pavement has increased in recent years (Figure 5-4).

Arizona’s non-interstate NHS pavements get less funding than the interstates and a higher percentage of them have deteriorated to fair condition in recent years (Figure 5-5).
Figure 5-4  Interstate Pavement Condition

Figure 5-5  Non-Interstate NHS Pavement Condition
5.4 Long-term Outlook

The majority of the bridges and pavements on Arizona’s highway network were added after the establishment of the interstate freeway system in the mid-1950s (Figures 5-1 and 5-2). The wear and tear of these assets is showing and increasing the number of fair condition assets in the state.

Figure 5-6 was developed by ADOT’s Multimodal Planning Division by carrying forward the SHS pavement deterioration trends from 2010-2016 to 2044, assuming investment levels remain consistent with ADOT’s previous Long-Range Transportation Plan What Moves You Arizona, 2010 – 2035 (WYMA 2035) [3].

Assets deteriorate slowly and can accumulate in the fair condition category over a long period. Without adequate preventative maintenance, these assets can deteriorate to the point where costly rehabilitation or replacements are the only options. Over time, the costs to fix the accumulation of deteriorated assets could outpace ADOT’s asset management budget, accelerating the decline and making it difficult to restore the network to a state of good repair.

A similar situation is projected for bridges. Bridge improvement needs were analyzed in WMYA 2040 using FHWA’s National Bridge Investment Analysis System (NBIAS), an analytical software tool. Projected bridge deterioration from this analysis, assuming investment levels for preservation and rehabilitation remain consistent with WMYA 2035, is summarized in Figure 5-7. The graph shows that the percentage of structurally deficient bridges will increase with WMYA 2035 investment levels and will remain high even as the trend begins to improve.
The analysis in WMYA 2040 concluded that more resources would be required to maintain ADOT’s bridges and pavements in a state of good repair and recommended that $326 million per year be devoted to preservation. The State Transportation Board approved WMYA 2040 on February 16, 2018. Although it will take about eight years to phase the full $326 million into the STIP, the long-term increase in preservation spending is expected to arrest the decline in bridge and pavement condition over the next decade.

5.5 Performance Gap Analysis Process

The following steps will be taken to conduct a performance gap analysis in the final TAMP:

- **Establish a Performance Gap Analysis Team** – A Performance Gap Analysis Team for each asset class, consisting of the TAMP Manager and representatives from the Bridge Group or Pavement Management Section, will be established to identify performance gaps and the technical needs to close gaps. Local government technical staff will be consulted if performance gaps are identified for the assets in their jurisdiction.

- **Identify performance gaps** – ADOT will evaluate the results of annual bridge and pavement inspections using the criteria described in Section 3 of this TAMP. The results will be compared with performance targets to determine if gaps exist. Since ADOT is collecting all of the pavement data and most of the bridge data on behalf of local NHS owners, a complete and up-to-date condition dataset will be available for performance gap analysis in the final TAMP. The potential for future performance gaps will be predicted using bridge and pavement management systems analysis of planned funding and the effects on asset deterioration.
• **Factor in risk** – Consider risk data and mitigation cost estimates from agency-initiated vulnerability assessments, geotechnical surveys and evaluations of repeated emergency events when predicting future performance gaps.

• **Analyze causes of existing or predicted gaps** – ADOT will analyze asset sub-classes and different networks to determine if deficiencies causing gaps can be isolated. ADOT’s Bridge Group and Pavement Section will identify whether deficiencies are primarily in the good, fair or poor category so that work types and management strategies can be customized to efficiently close gaps. The performance of bridges and pavements on the NHS, regardless of physical condition, will be part of this analysis. Coordination will be undertaken with local NHS owners regarding asset conditions and causes of performance gaps on NHS assets.

• **Identify gaps in the effectiveness of the NHS in providing safe and efficient movement of people and goods** – If performance gaps are identified on NHS routes, the impacts to freight movement, safety and congestion will be evaluated and described.

• **Identify strategies to address gaps** – The Performance Gap Analysis Team and the Life Cycle Planning Team (see page 7-3) will meet to identify the most feasible long-term management strategy for addressing gaps. Alternative management strategies will be assessed using bridge and pavement management systems to determine the most effective combination of work types needed to close performance gaps. Factors that will be considered when evaluating different strategies include:
  - Life cycle costs
  - Feasibility
  - Importance of the asset/route
  - Susceptibility to extreme weather events and other risks
  - Effectiveness of the strategy to provide the safe and efficient movement of people and goods

In the final TAMP, this analysis will be undertaken for the NHS and SHS. The resources needed to close long-term performance gaps also will be discussed during long-range transportation plan updates so that investment choices can be adjusted accordingly. The Performance Gap Analysis and Life Cycle Planning teams will provide data and analysis to support the need for additional investments in asset preservation in the TIPS, the STIP, the Metropolitan Transportation Plans and the Long-Range Transportation Plan.
6  RISK MANAGEMENT ANALYSIS

6.1  Risk Factors

It is becoming more common for state DOTs to factor risk into the prioritization of transportation projects since risk analysis clarifies the uncertainties and trade-offs agency officials need to consider when making difficult decisions regarding the allocation of limited resources.

The importance of risk analysis is highlighted by the MAP-21 requirement to develop a risk-based asset management plan for the NHS. FHWA defines risk as “the positive or negative effect of uncertainty or variability on agency objectives.” An example of how transportation agencies have historically prioritized risk is the use of the functional classification system to categorize highway routes. Smaller, less-traveled routes have lower classifications, meet lower design standards and are typically lower priorities for investment. Major routes provide greater benefits, increasing the risks associated with failure, but these routes also have greater opportunities for improvements and tend to be where investment is focused [4].

ADOT has long considered the importance of a route/asset for the purposes of prioritizing rehabilitation or replacement projects. Due to geographical constraints, Arizona has many highways without efficient alternatives to re-route traffic should an asset failure require a closure. Thus, it is critical that these highways be maintained in good condition to minimize closures and impacts to travelers and freight. ADOT accounts for the relative importance of a route/asset by considering the following network strategic factors when prioritizing projects:

- Number of lanes
- Functional classification of the route
- Current average annual daily traffic volume
- Future average annual daily traffic volume
- Percent truck traffic
- Route on the National Truck Network
- Existence of a parallel bridge
- Defense highway
- Designated emergency route
- Detour length
- Border crossing affected
- Historical significance

Although the consideration of these factors in the project prioritization process has been largely informal, the practice has broadened the scope of decision-making from one that is solely “condition-based” to one that considers risks to the agency’s mission.
6.2 Risk Policy and Procedure

The foundation of risk-based asset management is an agency commitment to adopt policies and procedures that support the identification, analysis and treatment of risks.

An ADOT-FHWA sponsored Transportation Asset Management Implementation Plan prepared by Cambridge Systematics concluded that while “ADOT considers risk management concepts in some of its business practices....the agency does not have a systematic, formal process for evaluating risks associated with its asset management programs.” The Plan also indicated that, “longer term, ADOT should develop a more comprehensive approach for considering risk in the asset management process.”

By formally adopting a risk management process, ADOT could potentially reap the following benefits in the management of assets:

- Reduce crisis management by anticipating likely risks and developing strategies to avoid or mitigate them.
- Enable risk to be factored into the selection of an asset improvement alternative or investment option.
- Identify the positive aspects of risk so that the agency can prepare to benefit from potential opportunities.
- Aid communication with stakeholders regarding the risks and uncertainties associated with different asset management solutions, including no action alternatives.
- Facilitate the assignment of risk management duties to the appropriate parties.
- Help make the case for allocating adequate resources to asset preservation in a transportation plan or program.

To develop a formal asset risk management strategy, ADOT conducted an Asset Management Risk Workshop on January 8, 2018, which was attended by key agency personnel, including subject matter experts who:

- Established a context and identified agency objectives for risk-based asset management; and
- Identified, evaluated and prioritized risks associated with asset management.

Further coordination with subject matter experts on this committee resulted in the identification of mitigation measures and a monitoring plan for high priority risks. The committee approved the final risk plan and the outcome of this effort is described below.
6.3 Risk Analysis

ADOT seeks for its risk-based asset management to:

- Be comprehensive.
- Be easy to understand.
- Prioritize risks.
- Identify long-term vulnerabilities.
- Identify strategies for the prevention and avoidance of risks.
- Inform decision-making.
- Identify the appropriate party to manage the risks.
- Monitor top priority risks.
- Aid in the prioritization of projects in the STIP.
- Support communication regarding asset management with stakeholders, including the public.

To be comprehensive, this plan will consider several levels of risk (Table 6-1).

<table>
<thead>
<tr>
<th>Risk Type</th>
<th>Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency Risk</td>
<td>Risk to the agency that affects the implementation of the strategic goals of the asset management plan. Examples include changes in leadership, legislative actions, unfunded mandates and the ability to convey the importance of asset management to decision-makers and the public.</td>
</tr>
<tr>
<td>Financial Risk</td>
<td>Affect the availability of adequate funding or accurate prediction of future funding needed to implement the TAMP. Examples include inflation, unexpected funding shortfalls, solvency of the Highway Trust Fund, financial markets, interest rate increases and inaccurate predictions in financial plans.</td>
</tr>
<tr>
<td>Program Risk</td>
<td>Affect the ability to deliver a program of projects in a timely manner and meet performance targets. Risks may include the inability to effectively manage data, the loss of institutional knowledge via attrition, competing spending priorities, inaccurate cost-estimates and construction/materials price volatility.</td>
</tr>
<tr>
<td>Asset Risk</td>
<td>Affect individual assets, such as structural deterioration, extreme weather and obsolescence. Assets risks include flooding, landslides, hazardous materials spills, collisions with bridge elements and assets that do not meet current design standards.</td>
</tr>
<tr>
<td>Project Risk</td>
<td>Associated with projects to restore or replace individual assets. An example of a project risk is the impacts associated with lengthy construction detours in areas where redundant, alternative routes don’t exist. Project delivery risks include delays caused by environmental, utilities, right-of-way, geotechnical, procurement, scope creep and inter-governmental agreements.</td>
</tr>
<tr>
<td>Activity Risk</td>
<td>Associated activities like routine maintenance, including slow or inadequate response to damaged assets (e.g., pothole or guardrail repair) or extreme weather events (e.g., clearing blocked drainage structures, repairing scour weakened bridge foundations or risks to workers such as heat, fires, etc.).</td>
</tr>
</tbody>
</table>
6.3.1 Risk Register

An easy to understand and commonly used tool to identify, evaluate and prioritize risks is known as a risk register. Using a risk register, the significance and priority of a risk event (R) is determined by considering both the seriousness of the consequences (C) if the event occurs and the likelihood (L) that it will occur; in other words, L x C = R. A color-coded “heat” scale assists in the evaluation of risks.

An abbreviated illustration of this tool applies it to a risk that most people are exposed to — owning an automobile (Table 6-2).

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Risk Event</th>
<th>L x C = R</th>
<th>Risk Mitigation</th>
<th>Heat Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident</td>
<td>Collision, no injury</td>
<td>4 x 4= 16</td>
<td>Collision insurance</td>
<td>High</td>
</tr>
<tr>
<td>Accident</td>
<td>Collision, serious injury</td>
<td>4 x 5 = 20</td>
<td>Auto + medical insurance</td>
<td>Very High</td>
</tr>
<tr>
<td>Accident</td>
<td>Collision, liability</td>
<td>4 x 5 = 20</td>
<td>Liability insurance</td>
<td>Very High</td>
</tr>
<tr>
<td>Travel</td>
<td>Flat tire</td>
<td>5 x 2 = 10</td>
<td>Spare, tools, air pump</td>
<td>Medium</td>
</tr>
<tr>
<td>Travel</td>
<td>Dead battery</td>
<td>3 x 3 = 9</td>
<td>Jumper cables, phone</td>
<td>Medium</td>
</tr>
<tr>
<td>Travel</td>
<td>Stuck in cold or hot weather</td>
<td>3 x 4 = 12</td>
<td>Water, coat, snack, phone</td>
<td>Medium</td>
</tr>
<tr>
<td>Travel</td>
<td>Overheating</td>
<td>3 x 3 = 9</td>
<td>Carry extra coolant</td>
<td>Medium</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Engine wear</td>
<td>3 x 4 = 12</td>
<td>Regular oil changes</td>
<td>Medium</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Poor performance</td>
<td>2 x 2 = 4</td>
<td>Regular tune ups</td>
<td>Low</td>
</tr>
</tbody>
</table>

* Fictitious – For illustrative purposes.

This intuitive tool enables the quick prioritization of the multiple risks associated with complex activities. The risk register also can be used to communicate strategies to mitigate risks. As shown in Table 6-2, risks are ranked by multiplying a likelihood scale by a potential consequences scale to obtain a risk rating.

The Risk Register also contains a summary of mitigation steps to address risks. The “five Ts” (Figure 6-1) is a commonly used way of describing the options for the treatment of asset risk.
Figure 6-1  Five Ts

Some risks, like volatile construction prices, have either positive or negative potential. Increasing prices erode purchasing power, impacting the ability to afford an adequate level of preventative maintenance. Falling prices provide opportunities to increase investments, which can improve both the level of service and the service life of assets [5].

The following Risk Register contains the risks, ratings, risk owner and a high-level summary of the recommended risk mitigations that were identified at the Asset Management Risk Workshop (Table 6-3) along with a corresponding heat scale color. Although this initial TAMP focuses on bridges and pavements, the risk analysis was not limited to these assets. More
detailed descriptions of the mitigations for the high and very high priority risks (>14) are presented beneath the Risk Register.

**Table 6-3  Asset Management Risk Register**

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Risk Event (ADOT Ownership)</th>
<th>L x C = R</th>
<th>Risk Mitigation/Treatment</th>
<th>Heat Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency</td>
<td>Changing legislation (Government Relations)</td>
<td>5 x 4 = 20</td>
<td>Monitor, communicate impacts to governor and legislature.</td>
<td>Very High</td>
</tr>
<tr>
<td>Agency</td>
<td>Effectively communicating asset needs (Asset Groups, Multimodal Planning Division [MPD])</td>
<td>3 x 4 = 12</td>
<td>Share the output of the TAMP with decision-makers.</td>
<td>Medium</td>
</tr>
<tr>
<td>Agency</td>
<td>Extreme weather trends (Environmental Planning Resilience Program, Districts, Transportation System Management &amp; Operations [TSMO])</td>
<td>5 x 4 = 20</td>
<td>Develop an adaptation plan.</td>
<td>Very High</td>
</tr>
<tr>
<td>Agency</td>
<td>Ability to accurately forecast asset performance (MPD, Asset Groups)</td>
<td>3 x 4 = 12</td>
<td>Develop a feedback loop for testing forecasts and calibrating performance models.</td>
<td>Medium</td>
</tr>
<tr>
<td>Agency</td>
<td>Expansion without new maintenance funding (MPD, TSMO)</td>
<td>1 x 2 = 2</td>
<td>Consider more design-build-maintain contracts. Communicate impacts to Transportation Board.</td>
<td>Low</td>
</tr>
<tr>
<td>Financial</td>
<td>Rising interest rates and inflation (Financial Management Services [FMS], MPD)</td>
<td>4 x 4 = 16</td>
<td>Prepare financial forecasts, fiscally-constrained programming, monitor and address.</td>
<td>High</td>
</tr>
<tr>
<td>Financial</td>
<td>Revenue variations (FMS, MPD)</td>
<td>3 x 5 = 15</td>
<td>Prepare revenue forecasts, fiscally-constrained programming, monitor and address.</td>
<td>High</td>
</tr>
<tr>
<td>Financial</td>
<td>Liability losses associated with assets (Risk Management)</td>
<td>5 x 3 = 15</td>
<td>Self-Insurance. Improve insurance loss recovery for collisions involving assets.</td>
<td>High</td>
</tr>
<tr>
<td>Program</td>
<td>Ability to collect accurate asset and performance data (MPD)</td>
<td>2 x 3 = 6</td>
<td>Invest in data management and automated data collection.</td>
<td>Low</td>
</tr>
<tr>
<td>Risk Category</td>
<td>Risk Event (ADOT Ownership)</td>
<td>L x C = R</td>
<td>Risk Mitigation/Treatment</td>
<td>Heat Scale</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------------</td>
<td>----------</td>
<td>---------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Program</td>
<td>Obsolete infrastructure (Asset Groups, MPD)</td>
<td>5 x 3 = 15</td>
<td>Evaluate obsolete asset features during project scoping and recommend cost effective improvements.</td>
<td>High</td>
</tr>
<tr>
<td>Program</td>
<td>Staff attrition (State Engineer’s Office)</td>
<td>5 x 2 = 10</td>
<td>Cross-training, succession plan.</td>
<td>Medium</td>
</tr>
<tr>
<td>Program</td>
<td>Construction/materials price volatility (FMS, Contracts and Specifications)</td>
<td>5 x 4 = 20</td>
<td>Price adjustments for volatile commodities – contingency fund.</td>
<td>Very High</td>
</tr>
<tr>
<td>Program</td>
<td>Competing spending priorities (MPD, FMS)</td>
<td>5 x 2 = 10</td>
<td>P2P process to prioritize projects.</td>
<td>Medium</td>
</tr>
<tr>
<td>Project</td>
<td>Scope creep (MPD, Project Review Board, PPAC,FMS)</td>
<td>5 x 2 = 10</td>
<td>Planning-level scoping to provide clear definition to the project needs. Control at Project Review Board and the Priority Planning Advisory Committee.</td>
<td>Medium</td>
</tr>
<tr>
<td>Asset</td>
<td>Flood damage including scour (Bridge Group, TSMO, Environmental Planning Resilience Program)</td>
<td>5 x 4 = 20</td>
<td>Statewide scour evaluation; scour-counter measures program. Pump station improvements. Extreme weather adaptation plan.</td>
<td>Very High</td>
</tr>
<tr>
<td>Asset</td>
<td>Collision damage to bridges (Bridge Group, Risk Management)</td>
<td>5 x 4 = 20</td>
<td>Raise low bridges. ADOT seeks reimbursement, insurance.</td>
<td>Very High</td>
</tr>
<tr>
<td>Asset</td>
<td>Permitted over-weight load related damage (TSMO, Enforcement and Compliance Division [ECD], Asset Groups)</td>
<td>3 x 2 = 6</td>
<td>Monitor impacts of overweight loads and adjust permitting accordingly.</td>
<td>Low</td>
</tr>
<tr>
<td>Asset</td>
<td>Non-permitted overweight load related damage (MPD, ECD)</td>
<td>5 x 3 = 15</td>
<td>More weigh-in-motion infrastructure; increased resources for enforcement.</td>
<td>High</td>
</tr>
<tr>
<td>Asset</td>
<td>Landslides and/or slope failures (Geotechnical Section)</td>
<td>2 x 5 = 10</td>
<td>Identify unstable areas, remediate storm water infiltration, re-contour or stabilize slopes, install monitoring devices.</td>
<td>Medium</td>
</tr>
<tr>
<td>Asset</td>
<td>Rock Fall (Geotechnical Section, District Maintenance)</td>
<td>1 x 5 = 5</td>
<td>Identify unstable areas, rockfall mapping, monitoring, rockfall prevention projects. Consider creating a fund for this ongoing challenge.</td>
<td>Low</td>
</tr>
</tbody>
</table>
### Risk Category

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Risk Event (ADOT Ownership)</th>
<th>L x C = R</th>
<th>Risk Mitigation/Treatment</th>
<th>Heat Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset</td>
<td>Retaining Wall Failures (Geotechnical Section)</td>
<td>1 x 5 = 5</td>
<td>Screen wall products in the Product Evaluation Program. Perform routine retaining wall inspections and maintenance, identify failing walls, initiate repair or replacement projects.</td>
<td>Low</td>
</tr>
<tr>
<td>Asset</td>
<td>Events inside tunnels resulting in loss of service (Bridge Group, TSMO)</td>
<td>1 x 5 = 5</td>
<td>Routine, comprehensive tunnel inspections and maintenance. Emergency response plan.</td>
<td>Low</td>
</tr>
<tr>
<td>Asset</td>
<td>Failure of small (&lt;20 feet in length) culverts (TSMO)</td>
<td>1 x 5 = 5</td>
<td>Statewide small culvert evaluation, consider culvert upgrades when developing pavement projects.</td>
<td>Low</td>
</tr>
<tr>
<td>Asset</td>
<td>Lack of redundant routes if an asset fails (TSMO, Asset Groups)</td>
<td>2 x 4 = 8</td>
<td>Update emergency detour plans, electronic signage, identify vulnerable assets and maintain in good condition.</td>
<td>Medium</td>
</tr>
<tr>
<td>Activity/Operations</td>
<td>Inadequate maintenance budget (TSMO, FMS)</td>
<td>5 x 4 = 20</td>
<td>Defer maintenance, inform legislators of impacts.</td>
<td>Very High</td>
</tr>
</tbody>
</table>

### Table Legend:

<table>
<thead>
<tr>
<th>Likelihood(L)</th>
<th>Consequence(C)</th>
<th>Risk Rating(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare=1</td>
<td>Negligible=1</td>
<td>Low = 1 - 6</td>
</tr>
<tr>
<td>Unlikely=2</td>
<td>Low=2</td>
<td>Medium = 7 - 13</td>
</tr>
<tr>
<td>Possible=3</td>
<td>Medium=3</td>
<td>High = 14 - 19</td>
</tr>
<tr>
<td>Likely=4</td>
<td>Very high=4</td>
<td>Very High = 20- 25</td>
</tr>
<tr>
<td>Almost certain=5</td>
<td>Extreme=5</td>
<td></td>
</tr>
</tbody>
</table>

### 6.3.2 Mitigation for High Priority Risks

Many of the risks identified are known to the agency and have formal or informal strategies in place for mitigation. Others were identified as part of this Risk Analysis effort. ADOT’s risk mitigation strategies for high priority risks follow.

#### 6.3.2.1 Changing Legislation

The Government Relations Office is responsible for coordination and oversight of ADOT legislative initiatives, rules and policies. The office provides a proactive process through which ADOT communicates with and serves Arizona’s congressional delegates, state legislators, governor’s office and the people of Arizona as the central communication point to ensure the priority of ADOT’s mission is reflected in state and federal legislation, rules and policies.
During federal and state legislative sessions, the office tracks bills and informs ADOT’s executive team of issues that may affect the agency. The office works closely with ADOT staff to gather information to assist the governor’s office and legislators to assess the impacts of proposed legislation/rules on the agency, highway system or revenues available for transportation purposes. Identifying potential legislative issues early provides the agency an opportunity to comment and potentially influence the outcome.

6.3.2.2 Extreme Weather

ADOT prepared a Preliminary Study of Climate Adaptation for the Statewide Transportation System in Arizona (March 2013) [6] (Appendix A) and an Extreme Weather Vulnerability Assessment (January 2015) [7] (Appendix A). Study findings include:

- **Extreme Heat**: The number of days exceeding 100°F annually is predicted to double in low desert areas by 2080. Impacts could include pavement deformation, shorter pavement construction windows, heat-related worker safety issues and public safety issues during lengthy delays. Higher temperatures would stress vegetation, thereby reducing ground cover contributing to increased dust storms. Wildfires also would be more likely and larger in mountainous areas where temperatures are expected to increase as well. Burned areas are subject to increased runoff potentially overwhelming roadway drainage structures. Benefits include less freeze-thaw impacts to pavement and less snow removal in the high country.

- **Extreme Precipitation**: Increases in yearly rainfall are expected to be modest, but there is the potential for more intense individual precipitation events which may damage or overwhelm drainage structures and pump stations. Soils that are saturated during intense rain events contribute to an increased risk of rock fall or landslides.

The Extreme Weather Vulnerability Assessment recommended the systematic integration of extreme weather risks into the TAMP as well as the incorporation of cost-effective adaptation strategies. To accomplish this, ADOT is finalizing a programmatic framework for integrating extreme weather risk into engineering design and asset management practices, including the development of a whole life cost management plan for assets that are subject to these risks through a grant from FHWA. This effort includes the development of a Risk Register that specifically addresses extreme weather risks. ADOT’s Environmental Planning Group is currently managing this project, which should be completed in time for inclusion in the final TAMP.

6.3.2.3 Rising Interest and Inflation Rates

Rising inflation rates erode the purchasing power of all revenues available to ADOT and could make future projects more expensive. If the Federal Reserve continues to raise interest rates to curb inflation, ADOT’s cost to finance capital assets using municipal bonds will increase. ADOT’s ability to meet performance targets could be impacted. ADOT actively monitors its forecasts and makes adjustments to its STIP as necessary to ensure fiscal constraint.
6.3.2.3 Revenue Variations

The Great Recession of 2007-2009 impacted ADOT’s ability to fund asset preservation contributing to a deterioration of asset condition. Although the economy has improved, future economic downturns could have even a bigger effect as legacy assets will require more and more funding to preserve as they age. Transportation revenues are not keeping pace with needs, making it difficult to adequately fund expansion, modernization and preservation. The solvency of the Highway Trust Fund and the availability of federal funds in future years may create a revenue risk. In addition, stagnant gas taxes and more fuel efficient vehicles may have a negative impact on future revenues. If reduced revenues occur, ADOT’s ability to meet performance targets could be impacted.

ADOT’s Long-Range Transportation Plan process evaluates different revenue and investment scenarios and considers revenue variations when recommending investment choices. Additionally, ADOT’s planning and programming process is putting an increasingly high priority on preservation projects for bridges and pavements. FHWA’s decision to allow federal funds to be used on certain types of preservation activities has increased the state’s flexibility to adjust to funding shortfalls. ADOT actively monitors revenues and prepares monthly financial reports for management and Transportation Board review.

6.3.2.4 Liability Losses

ADOT’s 2017 Comprehensive Financial Report states that, “The Department is exposed to various risks of loss related to torts; thefts of, damage to, and destruction of assets; errors and omissions; injuries to employees; and natural disasters. The Department is a participant in the State’s self-insurance program and, in the opinion of the Department’s management, any unfavorable outcomes from these claims and actions would be covered by the self-insurance program. Accordingly, the Department has no risk of loss beyond adjustments to future years’ premium payments to the State’s self-insurance program.” It should be noted that while premiums paid to the State’s self-insurance program have not increased in recent years, transportation liability losses have caused the State’s insurers to increase retention amounts (deductibles) and premiums for excess coverage.

One way to reduce direct property loss (state highway items not covered by the State’s self-insurance program) is to increase the amount recovered from the responsible party (Table 6-4). In 2014, ADOT initiated an effort to improve the recovery process and increase the insurance recovery rate. The process improvement drove the recovery rate from 63 percent in fiscal year (FY) 2014 to 97 percent so far in FY 2018.
Table 6-4  Insurance Recovery Metrics – December 2017*

<table>
<thead>
<tr>
<th>Year</th>
<th>Recoveries</th>
<th>Repairs</th>
<th>Recovery Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY14</td>
<td>$3,084,575</td>
<td>$4,860,045</td>
<td>63%</td>
</tr>
<tr>
<td>FY15</td>
<td>$2,800,930</td>
<td>$5,061,118</td>
<td>55%</td>
</tr>
<tr>
<td>FY16</td>
<td>$4,938,565</td>
<td>$5,945,449</td>
<td>83%</td>
</tr>
<tr>
<td>FY17</td>
<td>$5,341,978</td>
<td>$5,399,292</td>
<td>99%</td>
</tr>
<tr>
<td>FY18**</td>
<td>$2,837,260</td>
<td>$2,931,038</td>
<td>97%</td>
</tr>
</tbody>
</table>

* SOURCE: ADOT Administrative Services Division.

** Year to date.

6.3.2.5 Asset Obsolescence

A cost-effective way to accommodate increased travel and freight demand is to improve obsolete asset infrastructure. Low bridge clearances and outdated roadway geometry may prevent highways from being used as truck routes and require lower speed limits, ultimately diminishing system efficiency. To address this issue, obsolescence will be evaluated during project scoping. Reasonable upgrades that improve roadway operating efficiencies will be considered for inclusion in the recommended project.

6.3.2.6 Construction/Materials Price Volatility

Construction contractors are allowed to make adjustments to volatile commodities, like asphalt, if the market price varies from the bid price by a specified percentage. This eliminates the need to adjust bids to hedge for price volatility.

ADOT monitors construction and materials prices so that programming adjustments can be made to adapt to volatile prices. ADOT maintains a contingency fund that can be used to make adjustments for short-term price volatility.

6.3.2.7 Flood Damage Including Scour

Scour around bridge piers can lead to bridge failure if not addressed. In 1992, as a result of bridges lost due to scour during the 1970s and 1980s, a statewide scour evaluation work plan was developed for all bridges located over water ways. Inspections during the 1990s identified several hundred bridges as at high risk of scour. Many of these bridges were constructed before 1980 when the adoption of more stringent design criteria improved scour resistance. In the mid-1990s, a fund was set up to implement scour counter measures for high-risk bridges. On-going inspections since then have identified additional bridges at high risk for scour.
Currently, there are about 100 bridges that fit in this category. The scour counter measures fund is still in place and new improvement projects are developed yearly.

Culverts are subject to blockage, which can lead to flooding of the roadway. Steel pipe culverts can corrode, affecting the structural integrity of the pipe. A significant number of culverts in the state are affected by these conditions. The FY 2016 Level of Service evaluation rated drainage structure conditions at a C+.

To address this issue, ADOT requested and received $4.3 million in FY 2018 to begin repair of these culverts. The program will begin by repairing the most severely affected culverts starting with 75 percent blockage and/or 50 percent rusting. ADOT’s intention is to continue the program in future years to repair the remaining drainage structures.

ADOT operates 72 storm water pump stations on 275 miles of urban freeway in the Phoenix Metropolitan area. The ability of these facilities to adequately remove storm water from the freeways is critical to prevent flooding.

Construction of the pump station system began in 1964 and pump stations have been incrementally added over time. According to an ADOT Phoenix District Pump Station Evaluation [8], “The incremental construction of the system, over the long time period, has resulted in a system that lacks uniformity, standardization, and a long-term maintenance and/or replacement plan. This has led to maintenance concerns and issues that have compounded over time and now challenge the System Maintenance Section’s maintenance staff resources to adequately maintain and repair the facilities.” Furthermore, many of the older pump stations weren’t designed to handle the additional storm water generated by the addition of travel lanes to freeways that has occurred.

To address these issues, ADOT is exploring a public-private partnership for the capital improvement and management of the pump station system. The outcome of this effort will be summarized in the final TAMP.

The potential for flooding caused by run off from areas burned by wildfires will be addressed in the Extreme Weather framework that ADOT is developing. See Subsection 6.3.2.2.

6.3.2.8 Collision Damage to Bridges

Vehicle collisions with bridges happen several times per year. Occasionally, these collisions result in partial or complete bridge closures, sometimes affecting both the crossroad and mainline. Since many highways in Arizona lack redundant routes, these closures can cause lengthy delays. ADOT’s bridge clearances are clearly posted and almost all of the collisions are the result of driver error. In addition to insurance, ADOT mitigates for this by seeking reimbursement for damage to bridges subject to collision.

Regularly updated emergency detour plans are an important way to mitigate the impacts of road closures. Some of ADOT’s emergency detour plans are outdated and will need to be
systematically updated. Raising low bridges also could reduce the opportunity for collisions and is considered in the project scoping process.

6.3.2.9 Non-permitted Overweight Load Related Damage

The maximum weight limit for trucks (five axles or greater) in Arizona is 80,000 pounds\(^3\) without a special permit. According to an ADOT research study, “The overloaded truck, whether legal or illegal, contributes to premature pavement fatigue. Pavement deterioration accelerates with axle weight, the number of axle loadings and the spacing within axle groups. The axle loadings and spacing on trucks also affect the design and fatigue life of bridges. Steel bridges and pre-stressed concrete spans, if overloaded, are susceptible to fatigue.”\(^{[9]}\).

Because fatigue from the repeated stress of overweight trucks can shorten the life of bridges and pavements, it is important to ensure that truckers comply with the weight limit. There are numerous opportunities for trucks to “run heavy” without proper permits and a low chance of being identified when:

- Port of entry facilities are closed.
- Trucks enter the state where there are no ports of entry.
- Inspection queues at ports get too long and trucks are waved passed.
- Trucks “run” by ports without stopping for inspection.
- Trucks unload some of the cargo at the border to cross separately, such as sometimes occurs with car trailers.
- Truck trips originate within the state.

A cost effective way to detect unpermitted overweight trucks is the installation of weigh-in-motion (WIM) stations in the roadway. WIM stations measure the weight of a truck as it passes over a device in the pavement. Unlike ports of entry, WIM stations operate 24 hours a day, every day of the year. Data from WIM stations indicate that about 7 to 10 percent of the trucks on Arizona highways run overweight. In recent years, ADOT expanded and upgraded WIM stations with the latest law enforcement grade Piezo-quartz sensors for improved accuracy. ADOT currently operates 18 WIM stations, including four new WIMs recently installed in the White Mountain area.

ADOT will construct 15 new quartz WIMs at 12 sites during calendar year 2018; some locations will have both inbound and outbound travel lanes with WIM stations. The weight measured with the WIM station is confirmed on a static scale before a citation is issued. ADOT also operates static scales at three rest areas (Sakukan westbound, McGuireville southbound, and Canoa Ranch northbound) and portable scales that can be placed at other rest areas to detect overweight vehicles that bypassed the port of entry or originate in Arizona.

\(^3\) This also is the federal limit on Interstate highways.
6.3.2.10 Inadequate Maintenance Budget

There are more than 250 maintenance activities needed on a routine basis to keep the 21,000+ lane-miles of Arizona highways open for business. The maintenance area most challenging to adequately fund is the pavement surface treatment program. Deteriorated roadway surfaces require higher-cost restoration work to re-establish the structural integrity and capacity of the pavement system. This rehabilitation work includes expensive pavement overlays and milling and replacement of existing pavements.

These expensive treatments could be reduced if low cost surface treatments are applied at strategic intervals. For example, the cost of surface treatments like a flush coat is $3,000 per lane mile and a chip seal is $36,000 per lane mile. In comparison, the rehabilitation of roadway surfaces costs ADOT $300,000 to $360,000 for one lane mile on non-interstate and interstate, respectively.

According to the National Cooperative Highway Research Program Report 523, *Optimal Timing of Pavement Preventative Maintenance Treatment Applications* (2004) [10], surface treatments, if applied properly, extend the life of the pavement system as shown in Table 6-5.

<table>
<thead>
<tr>
<th>Type of Surface Treatment</th>
<th>Expected Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fog Seals (Flush)</td>
<td>1 - 2 years</td>
</tr>
<tr>
<td>Slurry Seals</td>
<td>3 - 5 years</td>
</tr>
<tr>
<td>Micro-Surfacing</td>
<td>4 - 7 years</td>
</tr>
<tr>
<td>Chip Seals</td>
<td>4 - 7 years</td>
</tr>
<tr>
<td>Thin Asphalt Overlays (usually 0.75” – 1” thick)</td>
<td>7 - 10 years</td>
</tr>
</tbody>
</table>

The average funding level for pavement surface treatments was about $15 million per year for the last five years, allowing the surface treatment of just 300 to 400 travel lane miles, which is less than 2 percent of the entire system. This level of investment is insufficient to keep pavements on the highway system from deteriorating to the point when expensive rehabilitation and reconstruction are the only options. To prevent this, funding is needed to apply preventative surface treatments to about 14 percent of lane miles, at an estimated cost of $40,600,000 per year. The additional funds are included in Governor Doug Ducey’s executive budget for FY 2019.

6.4 Risk Monitoring

As circumstances change, the agency’s risk profile changes. It is important to monitor high priority risks and make adjustments as needed. ADOT’s monitoring approach will be to hold a yearly risk workshop to receive progress
reports on the status of high priority risks and to update the risk register by removing or adding risks.

6.5 Facilities Repeatedly Damaged by Emergency Events

MAP-21 regulations require that state DOTs “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.” The evaluations must include repeated emergency events on any road, highway or bridge that occurred January 1, 1997, or later.

The statewide evaluation for all NHS roads, highways and bridges must be completed by November 23, 2018. Beginning on November 23, 2020, a state DOT must prepare evaluations covering the affected portion of all other roads, highways and bridges “prior to including any project relating to such facility in its STIP” (23 Code of Federal Regulations Part 667). The statewide evaluation must be updated every four years. State DOT’s must consider the results of the evaluations when developing a TAMP and during preparation of the STIP.

ADOT identified four locations that received emergency funding on at least two occasions for similar events, as listed below. Two of these locations are on the NHS; evaluations are currently being undertaken for these incidents. Evaluations are anticipated to be initiated for the remaining two locations by the end of 2018.

1. State Route 87 in the vicinity of Milepost 224 – landslide and related slope stability issues (NHS).
2. State Route 89A; Mileposts 375 to 399 – erosion due to storm events (NHS).
3. State Route 71; Milepost 86 – scour and embankment repair.
4. Salome Road, Centennial Bridge (La Paz County) – flow over the roadway.
7 LIFE CYCLE PLANNING

7.1 Traditional Process

Although ADOT considers numerous factors such as cost, environmental impacts, traffic volumes, detour length and safety when prioritizing bridge and pavement preservation, rehabilitation or reconstruction projects, the primary strategy for managing these assets is best characterized as worst first.

While maintenance and some preservation treatments are routine, most asset improvement projects are triggered by significant deterioration. Repairs and replacements are generally performed on assets in the worst condition. This approach was economical when Arizona’s highway infrastructure was young as newer assets seldom required expensive rehabilitation or replacement, and minimal spending on preservation treatments saved money. However, over the long-term, this reactive strategy is neither an efficient nor a sustainable way to manage network assets.

The U.S. Army Corps of Engineers developed a pavement condition index chart showing the effects of different pavement treatment options. As shown in Figure 7-1, the application of low cost preservation treatments when a pavement is still in good condition results in the maximum lifespan at the lowest practical cost. Cost effective asset management requires the application of the right treatment at the right time throughout the whole life cycle of an asset. Applying this approach to an entire asset class is known as Life Cycle Planning (LCP).

![Pavement Condition Index](source: Sustainable City Network, Inc. 2018.)
7.2 Life Cycle Planning Process

LCP is a systematic process that identifies the DOT’s best option to preserve or improve the condition of an entire asset class at the minimum practical cost. LCP analysis models different combinations of maintenance, preservation, rehabilitation and reconstruction over the whole life of network assets in order to compare the effectiveness of different management strategies at selected funding levels. This analysis facilitates asset management planning as it estimates network funding needs and identifies the impacts to the asset class if a sufficient investment is not made. The Asset Management Rule requires that LCP for NHS bridges and pavements be included in the final TAMP.

The complexity and iterative nature of this analysis requires the use of bridge and pavement management systems. ADOT has acquired the AASHTOware BrM bridge management system and Deighton Consulting Groups dTIMS pavement management system. These systems meet the requirements of 23 CFR 515.17. Both management systems are currently being configured by selecting inputs and identifying LCP strategies. ADOT staff will undergo training on these management systems in summer and fall of 2018. The bridge and pavement management systems will be used to develop the final TAMP. The schedule for the implementation of dTIMS and BrM are presented in Appendix A.

These management systems use deterioration models to forecast future asset condition and needs. At ADOT, deterioration models are being developed by consulting with bridge and pavement engineers and other subject matter experts and reflect asset deterioration rates observed in Arizona. Deterioration models are being developed for bridge decks, superstructure and substructure and for asphalt, concrete and composite pavements.

Different deterioration rates are being developed for different climate zones. The deterioration models will be refined over time to reflect new traffic levels.

The Bridge Group expressed concern that the one-and-a-half cycles of element-level (e.g., deck girders, etc.) inspection data collected by the agency to date may be insufficient for an accurate analysis. Thus, in the final TAMP, component-level (e.g., deck) deterioration models will be used. However, some trials using element level deterioration models may be run for comparison purposes. ADOT’s long-term goal is to develop and use element-level deterioration models for a refined assessment of bridge condition and needs.

Both ADOT’s Bridge Group and Pavement Section are beginning to incorporate more preservation treatments into their asset management programs. In addition to the other work types, multiple preventative maintenance/preservation practices will be incorporated into the
development of deterioration curves to support the identification of optimum life cycle treatments and costs.

ADOT will use a multi-step process for conducting LCP:

**Form an LCP Team** – For LCP analysis, a team will be created that includes asset class group managers, the TAMP manager, engineers, data managers, planners and representatives from the performance gap analysis team, maintenance, finance and MPO/COGs, as warranted.

**Select the asset classes and networks to be analyzed** – ADOT identified the NHS and the SHS (pavement and bridges) as the networks to be analyzed in the final TAMP. ADOT does not plan to exclude bridge or pavement sub-groups (e.g., concrete pavement, steel bridges) from its LCP.

**Establish short and long term targets for each asset class** – The two- and four-year targets required by the performance rule (23 United States Code 150(d)) and a 10-year planning performance target will be used to conduct LCP analysis.

**Define LCP strategies** – ADOT will formulate LCP strategies from different combinations of treatment options and costs, desired levels of performance and funding scenarios. The LCP strategies will consist of a structured sequence of maintenance, preservation, repair, rehabilitation and replacement work types. ADOT is developing these strategies during the implementation of bridge and pavement management systems. LCP strategies will be identified for each asset class and for asset sub-classes, as warranted.

**Set LCP scenario inputs** – As ADOT configures its bridge and pavement management systems, inputs will include criteria, variables and constraints that are factored into the analysis of each LCP scenario. Some of these inputs will be directly incorporated into the asset deterioration model component of the management system. This information will support the prioritization of asset needs based on condition, benefits and costs. Criteria that ADOT may consider in the analysis include:

- Asset condition data.
- Asset treatment histories and construction dates.
- Elevation.
- Climatic conditions (e.g., potential for freeze-thaw, flooding).
- Planned improvement projects affecting assets and deterioration rates.
- Identification of preservation treatment options and the service interval of each treatment for each work type.
- Unit costs for each treatment option in each work type.
- Expected changes in system demand.
- Potential vulnerabilities to assets due to current or future environmental conditions.
- Risks that could potentially affect the asset class or sub-class.
• Asset deterioration rates based on deterioration histories of asset classes and sub-classes.
• Expected funding levels.
• Estimated inflation and construction cost escalation factors.
• Relative importance of the route or asset in the network.
• Detour length.
• Bridge clearance and obsolescence.
• Desired system performance targets.
• Short- and long-term performance gaps.

Develop LCP scenarios – Bridge and pavement management systems will be used to run repeated simulations of the strategies and inputs on a range of scenarios that aids ADOT to select the strategies that will minimize life cycle costs while achieving performance targets for asset condition. According to FHWA guidance\(^4\) this analysis enables ADOT to:

• Establish a long-term focus for improving and preserving the system.
• Develop maintenance strategies that consider long-term investment needs.
• Determine the funding needed to achieve the desired state of good repair.
• Determine the conditions that can be achieved for different levels of funding.
• Reduce the annual cost of system preservation without impacting asset conditions.
• Provide objective data to support investment decisions.
• Eliminate existing performance gaps.
• Demonstrate good stewardship to internal and external stakeholders.

Potential LCP scenarios that ADOT may consider in its analysis include:

− Worst first
− Minimum maintenance only
− Meet minimum performance requirements
− Current investment levels
− Maintain current conditions or asset value
− Desired state of good repair
− Reduced funding scenarios

Develop life cycle treatment and cost tables for each asset sub-class – LCP outputs will be used to develop tables that include treatment types, service schedules, unit costs and present values. Unit costs will be based on recent average development and construction costs. Each asset sub-class will be evaluated for different Arizona climate zones and functional classifications. The

tables will allow comparison of different life cycle treatment regimens so that the most cost effective option can be identified. Illustrative table examples for a concrete bridge sub-class are presented in Tables 7-1 and 7-2.

**Table 7-1**  **Condition-based Life Cycle Treatment Regime (Concrete Bridge – Low Desert)**

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Service Schedule (Years)</th>
<th>Unit Cost ($ per sq. ft. or linear ft.)</th>
<th>Total Cost $ (20,000 sq. ft.)</th>
<th>Present Value $</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Construction</td>
<td>0</td>
<td>420 SF</td>
<td>8,400,000</td>
<td>8,400,000</td>
</tr>
<tr>
<td>Seal Deck/Replace Joints</td>
<td>15</td>
<td>5 SF/175 LF</td>
<td>131,500</td>
<td>79,638</td>
</tr>
<tr>
<td>Deck Overlay/Replace Joints</td>
<td>30</td>
<td>35 SF/175 LF</td>
<td>731,500</td>
<td>268,286</td>
</tr>
<tr>
<td>Bridge Rehabilitation</td>
<td>50</td>
<td>150 SF</td>
<td>3,000,000</td>
<td>563,760</td>
</tr>
<tr>
<td>Replace Bridge</td>
<td>75</td>
<td>420 SF</td>
<td>8,400,000</td>
<td>684,288</td>
</tr>
</tbody>
</table>

**Net Present Value**  $9,995,972

* Fictitious – For illustrative purposes.

**Table 7-2**  **Preventative Maintenance Life Cycle Treatment Regime (Concrete Bridge – Low Desert)**

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Service Schedule (Years)</th>
<th>Unit Cost ($ per sq. ft. or linear ft.)</th>
<th>Total Cost $ (20,000 sq. ft.)</th>
<th>Present Value $</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Construction</td>
<td>0</td>
<td>420 SF</td>
<td>8,400,000</td>
<td>8,400,000</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>5</td>
<td>5 SF</td>
<td>100,000</td>
<td>84,605</td>
</tr>
<tr>
<td>Seal Deck/Replace Joints</td>
<td>15</td>
<td>5 SF/175 LF</td>
<td>131,500</td>
<td>79,638</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>25</td>
<td>5 SF</td>
<td>100,000</td>
<td>43,350</td>
</tr>
<tr>
<td>Deck Overlay/Replace Joints</td>
<td>30</td>
<td>35 SF/175 SF</td>
<td>731,500</td>
<td>268,286</td>
</tr>
<tr>
<td>Deck Replacement</td>
<td>50</td>
<td>150 SF</td>
<td>3,000,000</td>
<td>563,760</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>55</td>
<td>5 SF</td>
<td>100,000</td>
<td>15,899</td>
</tr>
<tr>
<td>Deck Overlay/Replace Joints</td>
<td>70</td>
<td>35 SF/175 LF</td>
<td>731,500</td>
<td>70,433</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>75</td>
<td>5 SF</td>
<td>100,000</td>
<td>8,146</td>
</tr>
<tr>
<td>Replace Bridge</td>
<td>90</td>
<td>420 SF</td>
<td>8,400,000</td>
<td>414,411</td>
</tr>
</tbody>
</table>

**Net Present Value**  $9,948,528

* Fictitious – For illustrative purposes.

**Provide input to financial planning**  — The output of the analysis will be used to inform investment choices in the long-range transportation plan and project selection in the Five Year Transportation Facilities Construction Program section of the STIP. The financial plan will cover
a 10-year period, but LCP scenarios may need to be run for longer periods of time to reflect the long life cycles of bridge and pavement assets.
8 FINANCIAL PLAN

Bridge and pavements have long, useful lives. To sustain the performance of these assets over time, long-term financial planning is necessary. In the final TAMP, Life Cycle Planning scenarios that close performance gaps and mitigate risk will be analyzed to estimate financial needs and develop long-term (10-year) investment strategies. Since this analysis cannot be performed until ADOT’s bridge and pavement management systems are ready for use, this section will provide a description of ADOT’s financial planning team, an asset valuation, overview of revenue sources available for asset management and a description of the processes to prepare a complete financial plan in the final TAMP.

8.1 Financial Planning Team

A financial planning team will be established to guide the development of the financial plan in the final TAMP. The team will consist of staff representing ADOT’s Financial Management Services, Planning and Programming sections, as well as the TAMP project manager and relevant asset group managers. This team will provide information and analysis pertaining to revenue sources and uses, funding gaps, trade-offs related to closing gaps and select investment strategies. ADOT leadership, including the Chief Financial Officer, will provide direction, oversight and approval of the financial plan.

8.2 Asset Valuation

The undepreciated value of ADOT’s transportation infrastructure as of June 30, 2017, is provided in Table 8-1.

Table 8-1 Undepreciated Value of Transportation Infrastructure (dollars in billions)

<table>
<thead>
<tr>
<th>Pavement</th>
<th>Bridges</th>
<th>Land</th>
<th>Construction in Progress</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$13.521</td>
<td>$2.668</td>
<td>$3.373</td>
<td>$1.880</td>
<td>$21.443</td>
</tr>
</tbody>
</table>

NOTE: Valuation method: Governmental Accounting Standards Board Statement 34 (GASB 34).

This valuation does not represent the cost of replacing existing infrastructure. Unit replacement costs (February 2018) were used to estimate the replacement value of bridges and pavements.

<table>
<thead>
<tr>
<th>Bridge System</th>
<th>2016 Deck Area (ft²)*</th>
<th>Unit Replacement Cost</th>
<th>Replacement Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHS (State only)</td>
<td>31,679,297</td>
<td>$420 per ft²</td>
<td>$13.305 billion</td>
</tr>
<tr>
<td>ADOT Non-NHS</td>
<td>11,658,813</td>
<td>$420 per ft²</td>
<td>$4.897 billion</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>$18.202 billion</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 2017 National Bridge Inventory Submittal.
Estimated historical expenditures to maintain ADOT’s bridges and pavements are presented in Table 8-2.

<table>
<thead>
<tr>
<th>State Fiscal Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Preservation*</td>
<td>29</td>
<td>47</td>
<td>51</td>
<td>47</td>
<td>63</td>
</tr>
<tr>
<td>Pavement Preservation*</td>
<td>150</td>
<td>139</td>
<td>114</td>
<td>145</td>
<td>165</td>
</tr>
<tr>
<td>Maintenance</td>
<td>24</td>
<td>24</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

* STIP programmed amounts. Note – About 10-20 percent of the total maintenance budget is spent on bridges and pavements.

These historical expenditures have been sufficient to maintain ADOT’s bridge and pavement assets in a state of good repair and maintain asset value. ADOT follows the Governmental Accounting Standards Board Statement No. 34, Basic Financial Statements – and Management’s Discussion and Analysis – for State and Local Governments (GASB 34), as amended, to report asset valuations of its roads and bridges using the modified approach.

The modified approach allows asset values to be maintained without depreciation as long as the following required actions are undertaken:

- Maintain an asset management system that includes an up to date inventory of eligible infrastructure assets.
• Perform condition assessments of eligible assets and summarize the results using a measurement scale.

• Estimate each year the annual amount to maintain and preserve the assets at the condition level established and disclosed by ADOT.

• Document that the assets are being preserved approximately at or above the established condition level.

The GASB 34 modified approach will be basis for estimating the investment needed on annual basis to maintain asset value in the final TAMP. The established condition level will be based on ADOT’s performance targets and definition of a state of good repair. LCP analysis will be used to forecast future conditions and the estimated investment needed for each State fiscal year of the 10-year TAMP. Investment strategies will be formulated to maintain asset values.

8.3 Financial Plan Components

ADOT will use a four step process to develop a TAMP financial plan [11]:

1. Identify Available Revenue
   a. Identify revenue sources available for asset management.
   b. Estimate the annual funding available for asset management for the 10-year duration of the TAMP.

2. Estimate Funding Needs
   a. Identify the amount of annual funding needed to meet performance targets, mitigate risk and maintain assets in a state of good repair.
   b. Estimate future preservation funding needs generated by the construction of planned highway expansion projects or by pending regulatory mandates.

3. Quantify Funding Gaps
   a. Use revenue projections and funding needs analysis to demonstrate the agency’s ability to meet performance targets, mitigate risks and maintain assets in a state of good repair.
   b. If funding gaps exist or are predicted, identify the network condition that is expected to be achieved with the available funding.

4. Select an Investment Strategy
   a. Develop funding scenarios that meet asset management objectives.
b. If funding gaps cannot be closed with available revenues, shift resources or use other means to close gaps and best meet performance objectives.

8.4 Available Revenue

Arizona has federal, state and regional sources of revenue that can be used for asset preservation. Local governments also have revenues that are used for asset preservation on the NHS.

8.4.1 Federal Funding

On December 4, 2015, President Obama signed the Fixing America’s Surface Transportation (FAST) Act into law. The FAST Act authorized $305 billion nationally over federal FYs 2016 through 2020 for highway construction; highway and motor vehicle safety; public transportation; motor carrier safety; hazardous materials safety; rail; research, technology and statistics programs. The funding grows two percent annually over the life of the Act.

The Federal Aid program is a reimbursement program. The state or a local jurisdiction funds the cost of the project and is reimbursed a certain percentage (generally 94.3 percent in Arizona) by FHWA. Federal apportionments to the states are allocated to different programs that have specific purposes. Some of the allocations are distributed to the state and some to metropolitan planning organizations to fund local government projects. Figure 8-1 shows the allocations for federal FY 2017.

Only National Highway Performance Program (NHPP) and Surface Transportation Block Grant Program (STBGP) funds may be used for asset preservation. NHPP funds are used exclusively by the state, whereas, STBGP funds are used by both state and local governments.

Each federal fiscal year, Arizona is granted obligation authority (OA) to spend a share of the federal apportionment. OA is traditionally between 90 to 95 percent of the apportionments given to a State, resulting in excess apportionments. Allocated funds not used by FHWA or other states may be redistributed annually (generally in August) to all states. States can use this additional OA to utilize remaining apportionments.
Figure 8-1  Federal Fiscal Year 2017 Apportionments (dollars in millions)

Table 8-3 shows federal apportionments to Arizona for the remainder of the FAST Act. 2020 apportionment levels are carried forward, conservatively assuming no growth, to estimate federal aid beyond the FAST Act. Table 8-3 also includes estimates for OA and future annual redistributions based on ADOT typical receipts. This table shows the estimated amount of funds eligible to be used by ADOT for asset management, although these funds also may be used for other transportation purposes.

Table 8-3  Estimated Federal Aid (dollars in millions)

<table>
<thead>
<tr>
<th>Federal Fiscal Year</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apportionment</td>
<td>758</td>
<td>775</td>
<td>793</td>
<td>793</td>
<td>793</td>
<td>793</td>
<td>793</td>
<td>793</td>
<td>793</td>
<td>793</td>
</tr>
<tr>
<td>OA</td>
<td>674</td>
<td>732</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Redistribution(R)</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Total (OA+R-D)</td>
<td>686</td>
<td>742</td>
<td>760</td>
<td>761</td>
<td>761</td>
<td>761</td>
<td>761</td>
<td>761</td>
<td>779</td>
<td></td>
</tr>
<tr>
<td>National Highway Performance Program</td>
<td>406</td>
<td>414</td>
<td>424</td>
<td>424</td>
<td>424</td>
<td>424</td>
<td>424</td>
<td>424</td>
<td>431</td>
<td></td>
</tr>
<tr>
<td>STBGP</td>
<td>100</td>
<td>101</td>
<td>104</td>
<td>104</td>
<td>104</td>
<td>104</td>
<td>104</td>
<td>104</td>
<td>104</td>
<td>106</td>
</tr>
<tr>
<td>Eligible Amount</td>
<td>506</td>
<td>515</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>537</td>
</tr>
</tbody>
</table>

* Grant Anticipation Notes, Arizona’s GARVEE bond program.
8.4.2 State Funding

State revenues for transportation come from a variety of sources such as motor fuel taxes, a portion of vehicle license tax, vehicle registration fees, driver license fees, dealer fees, permits and other miscellaneous fees. More information about revenue sources and distributions can be found in ADOT’s 2017 Comprehensive Annual Financial Report (2017 CAFR) in Appendix A. The primary state funding source for highways is the Highway User Revenue Fund (HURF). Figure 8-2 demonstrates HURF revenues and distribution for FY 2017.

Statutory distributions from HURF are made to various stakeholders, such as the Department of Public Safety, Motor Vehicles Division, State Highway Fund, and cities, towns and counties. The State Highway Fund is further allocated between Arizona’s two largest metropolitan planning organizations, ADOT and other transfers.
NOTES:
* See notes in Appendix A.
VLT – Vehicle License Tax, Division, DPS – Department of Public Safety
SOURCE: ADOT Financial Management Services

Figure 8-2 FY 2017 HURF Revenue Distribution Flow (dollars in millions)
ADOT’s portion of the HURF is used to fund its operating budget, HURF bond debt service, legislative appropriations to the Department of Public Safety, fees retained by authorized third parties for the collection of the vehicle license tax, highway preservation and construction. In 2017, $60.9 million from the State Highway Fund was available for highway expansion, modernization and preservation. Table 8-4 shows a 10-year estimate of federal and state highway funds that are eligible for asset preservation, although these funds also may be used for other Arizona State Transportation Board approved priorities.

<table>
<thead>
<tr>
<th>State Fiscal Year</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>59</td>
<td>66</td>
<td>66</td>
<td>56</td>
<td>57</td>
<td>44</td>
<td>49</td>
<td>54</td>
<td>50</td>
<td>59</td>
</tr>
<tr>
<td>Federal</td>
<td>506</td>
<td>515</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>537</td>
</tr>
<tr>
<td>Total</td>
<td>565</td>
<td>581</td>
<td>594</td>
<td>584</td>
<td>585</td>
<td>572</td>
<td>577</td>
<td>582</td>
<td>578</td>
<td>596</td>
</tr>
</tbody>
</table>

The maintenance budget is approved annually via the legislative process which makes it difficult to predict. The FY 2019 proposed maintenance budget includes a request for an additional $25.6 million for pavement surface treatments, bringing the program total to $40.6 million. If this funding is maintained in future years, the estimated future maintenance funding for bridges and pavements would be about $41 million annually.

### 8.4.3 Regional Funding

Voters in Maricopa, Pima and Pinal counties approved county excise taxes for transportation purposes which may include expansion and modernization projects on the NHS. In the final TAMP, the preservation needs associated with these projects on NHS routes will be accounted for in the estimation of future investment needs in the financial plan. Additionally, if transportation excise tax funds are planned to be used for NHS bridge and pavement preservation, rehabilitation or reconstruction, those investments will also be identified in the financial plan in the final TAMP.

### 8.4.4 Local Funding

Local government investments in NHS bridge and pavement preservation, rehabilitation and reconstruction are included in Metropolitan Transportation Plans and TIPs for jurisdictions within MPO boundaries and directly in the Five Year Transportation Facilities Construction Program and the STIP for jurisdictions within COG boundaries. In the final TAMP, ADOT will coordinate with the MPOs and COGs to identify available funding, preservation needs and planned outlays for NHS bridge and pavement improvement projects.
8.5 Economic Outlook

After a dip during the Great Recession, Arizona’s population and per capita income have grown steadily since 2011 while unemployment has fallen (Table 8-5).

Table 8-5 Arizona Demographic and Economic Statistics

<table>
<thead>
<tr>
<th>Calendar Year Ended December 31</th>
<th>Population (1)</th>
<th>Personal Income (2) (in thousands)</th>
<th>Per Capita Personal Income (3)</th>
<th>Unemployment Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>6,931,071</td>
<td>278,924,877</td>
<td>40,243</td>
<td>5.3%</td>
</tr>
<tr>
<td>2015</td>
<td>6,828,065</td>
<td>267,361,132</td>
<td>39,156</td>
<td>6.1%</td>
</tr>
<tr>
<td>2014</td>
<td>6,731,484</td>
<td>255,092,928</td>
<td>37,895</td>
<td>6.9%</td>
</tr>
<tr>
<td>2013</td>
<td>6,626,624</td>
<td>245,070,457</td>
<td>36,983</td>
<td>7.8%</td>
</tr>
<tr>
<td>2012</td>
<td>6,553,255</td>
<td>235,780,739</td>
<td>35,979</td>
<td>8.4%</td>
</tr>
<tr>
<td>2011</td>
<td>6,482,505</td>
<td>227,286,519</td>
<td>35,062</td>
<td>9.5%</td>
</tr>
<tr>
<td>2010</td>
<td>6,676,627</td>
<td>223,716,314</td>
<td>33,507</td>
<td>10.4%</td>
</tr>
<tr>
<td>2009</td>
<td>6,587,653</td>
<td>219,026,704</td>
<td>33,248</td>
<td>9.9%</td>
</tr>
<tr>
<td>2008</td>
<td>6,499,207</td>
<td>223,961,131</td>
<td>34,460</td>
<td>6.1%</td>
</tr>
<tr>
<td>2007</td>
<td>6,360,238</td>
<td>218,587,551</td>
<td>34,368</td>
<td>3.9%</td>
</tr>
</tbody>
</table>

NOTES:
(1) The Arizona population data are midyear population estimates of the U.S. Bureau of the Census. Previous years have been revised to reflect revisions made by the U.S. Bureau of the Census.
(2) Personal income estimates for previous years were revised to reflect revisions made by the U.S. Bureau of the Census.
(3) Per capita personal income is total personal income divided by total midyear population estimates of the U.S. Bureau of the Census. Previous years have been revised to reflect revisions in personal income and population estimates.
SOURCE: 2017 CAFR

Since 1986, ADOT has estimated HURF revenues using a comprehensive regression-based econometric model. In order to deal with uncertainty regarding this estimate, ADOT introduced its risk analysis process in 1992. This process relies upon probability analysis and the independent evaluation of the model’s variables by an expert panel of economists. This results in a series of forecasts with specified probabilities of occurrence, rather than a single or “best guess” estimate.

As part of the FY 2018 forecasting process, a panel of thirteen economic and finance experts representing public, private and academic sectors submitted individual estimates of the model’s independent variables as well as comments on the future economic outlook. The information gathered was input into the model to produce a series of forecasts with associated probabilities of occurrence. The panel’s inputs produced a mean forecast of $17,569.1 million for the period FY 2018-2027 with a compound growth rate (CGR) of 3.7 percent.

ADOT’s official forecast for FY 2018-2027 HURF (Table 8-7) amounts to $17,135.2 million with a CGR of 3.4 percent. The forecast incorporates the 50 percent confidence interval for all revenue categories. The FY 2018 forecast of $1,462.5 million was developed in July 2017 by ADOT staff.
using time-series techniques, historical and projected growth rates, and recent legislative changes [12].

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Mean Forecast</th>
<th>Official Forecast</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>$1,475.3</td>
<td>$1,462.5</td>
<td>50%</td>
</tr>
<tr>
<td>2019</td>
<td>1,541.6</td>
<td>1,517.4</td>
<td>50%</td>
</tr>
<tr>
<td>2020</td>
<td>1,603.7</td>
<td>1,572.2</td>
<td>50%</td>
</tr>
<tr>
<td>2021</td>
<td>1,663.7</td>
<td>1,625.9</td>
<td>50%</td>
</tr>
<tr>
<td>2022</td>
<td>1,723.9</td>
<td>1,681.1</td>
<td>50%</td>
</tr>
<tr>
<td>2023</td>
<td>1,784.9</td>
<td>1,736.7</td>
<td>50%</td>
</tr>
<tr>
<td>2024</td>
<td>1,847.0</td>
<td>1,793.5</td>
<td>50%</td>
</tr>
<tr>
<td>2025</td>
<td>1,910.6</td>
<td>1,853.4</td>
<td>50%</td>
</tr>
<tr>
<td>2026</td>
<td>1,975.8</td>
<td>1,914.9</td>
<td>50%</td>
</tr>
<tr>
<td>2027</td>
<td>2,042.5</td>
<td>1,977.7</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>$17,569.1</td>
<td>$17,135.2</td>
<td></td>
</tr>
<tr>
<td>Average CGR</td>
<td>3.7%</td>
<td>3.4%</td>
<td></td>
</tr>
</tbody>
</table>


Risks that could affect state revenues for transportation purposes include:

- State voter, legislative and executive actions, including:
  - Diversions of state transportation funding to other programs.
  - Failure of regional transportation excise tax extension ballot measures.
  - Special distributions to local governments.
  - Legislative proposals not yet known.

- Federal action or inaction regarding the reauthorization of transportation funding legislation, the solvency of the Highway Trust Fund or other infrastructure-related legislative proposals.

- Economic conditions:
  - Five- to seven-year recessionary cycle.
  - Inflation and interest rates.

8.6 Estimate Funding Needs

The following steps will be taken to estimate funding needs in the final TAMP:
• Use desired performance targets for bridges and pavements and a description of what constitutes a state of good repair for the basis for establishing financial needs for asset management. Bridge and pavement management systems will be used to aid in the identification of achievable long-term targets in the final TAMP.

• Review annual asset condition data to determine if performance gaps are emerging. ADOT’s Bridge Group and Pavement Management Section will use bridge and pavement management systems to predict whether future performance gaps will result from current funding and management strategies.

• Evaluate, using bridge and pavement management systems, the impact of different funding scenarios on future asset condition. The funding needed to achieve performance targets will be identified. The costs needed to maintain planned new infrastructure in a state of good repair will be factored into the analysis as will the effects of pending regulatory mandates.

• Include the costs of mitigating high priority risks in the determination of estimated funding needs in the final TAMP. These costs will be determined by the ADOT section or group with the most expertise about each specific risk. The estimated costs to mitigate repeated emergency events on the NHS will be obtained from the evaluations prepared for these facilities.

• Coordinate between ADOT, metropolitan planning organizations, councils of governments and local NHS bridge and pavement owners regarding TAMP performance targets, infrastructure condition and funding needs. Identify anticipated sources of local government revenue available for bridge and pavement management for the 10-year TAMP planning horizon through a coordinated effort with the MPOs and COGs.

• Formulate investment strategies to achieve performance targets for pavements and bridges and mitigate high priority risks.

• Prepare a table showing the estimated annual funding needed to implement investment strategies by work type for the 10-year TAMP planning horizon.

8.7 Funding Gaps

The following steps will be taken to identify and quantify funding gaps in the final TAMP.

• Compare estimated funding needs to implement bridge and pavement investment strategies for each State fiscal year of the 10-year TAMP planning horizon to the available funding for each investment strategy, by work type, for each State fiscal year covered by the TAMP.

• Consider factors such as inflation; pending regulatory mandates; status of funding authorization bills; need for additional preservation and maintenance expenditures for new infrastructure as it ages; and changes in agency priorities in determining whether funding gaps exist.
• Identify potential risks to the asset infrastructure, value and the safe, efficient movement of people and goods associated with long-term funding gaps.

8.8 Investment Strategies

FHWA defines investment strategies as “a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks” [13]. The development of investment strategies for ADOT’s bridges and pavements was influenced by:

• Performance gap analysis
• Life cycle planning
• Risk management analysis
• Anticipated available funding

8.8.1 Performance Gap Analysis

As described in the Performance Gap Analysis section of this report, ADOT currently meets its bridge and pavement targets for a state of good repair. ADOT has historically met these targets even when less bridge and pavement funding was available during the Great Recession. Recently, ADOT increased the long-term funding commitment to bridges and pavements by about 30 percent. This increased financial commitment is expected to enable ADOT to continue to meet these performance targets and maintain a state of good repair for the TAMP planning horizon.

Recently adopted federally-required 2- and 4-year performance targets for bridges and pavements will be a basis for the determination of performance gaps in the final TAMP. When the bridge and pavement management systems are fully implemented at ADOT, we will evaluate the potential for performance gaps in the 2- and 4-year targets and for a 10-year state-of-good repair goal that will be established in the final TAMP.

8.8.2 Life Cycle Analysis

Although life cycle analysis was not performed for this initial TAMP, ADOT concluded that the worst first approach that is currently used for bridge and pavement management is not sustainable over the long term. To address this concern, ADOT has gradually increased the use of low cost preservation treatments to extend asset lifespans and reduce the need for costly rehabilitations. These treatments are applied when bridges and pavements are still in good to fair condition in order to prevent deterioration, maintain the assets in a state of good repair and support progress toward achieving the State’s two- and four-year targets for asset condition.
8.8.2.1 Bridge

ADOT developed a Bridge Preservation Program (Appendix A) that includes cyclical and condition-based preventative maintenance activities to be applied to bridges.

- **Cyclical**
  - Deck washing (1-2 years)
  - Deck sweeping (yearly)
  - Cleaning abutment caps and seats, pier caps and seats, and drains (1-2 years)
  - Cleaning steel girders and truss bridges (5 years)
  - Lubricating bearings and pins (2-5 years)
  - Beam end painting/coating (10-15 years)
  - Installation of thin bonded polymer overlays such as epoxy or polyester concrete (10-15 years)
  - Sealing concrete decks with Methacrylate or other approved sealers (3-5 years)
  - Sealing abutment caps and seats, pier caps and seats, pier columns/walls and barriers (3-5 years)

- **Condition-based**
  - Sealing or replacing leaking deck joints
  - Eliminating deck joints
  - Paint/coating steel bridges
  - Installation of scour countermeasures
  - Removing channel debris
  - Cleaning brush from underneath and around bridges
  - Deck patching and repair
  - Upgrade to deck drains that meet U.S. Environmental Protection Agency standards
  - Repairing slope paving

8.8.2.2 Pavement

As mentioned in the Risk Management Analysis section, ADOT is requesting to more than double the size of the surface treatment program budget to enable a larger percentage of the pavements to receive surface treatments, including:

- Fog coat
- Pre-coated chip seal with terminal blend polymerized asphalt rubber (TR+)
• Crumb rubber asphalt chip seal
• Micro surfacing and slurry seal
• Crack fill, crack seal, wide crack mastic and concrete joint sealing
• Spot repairs and patching
• 1-inch thin bonded overlay
• 2.5-inch Asphalitic Concrete mill and replace surface spot repair
• Asphalt rubber-asphaltic concrete friction course (AR-ACFC or ACFC)

ADOT is currently undertaking a pavement life extension test project in support of a FHWA Every Day Counts 4 initiative to test micro surface cape seal and slurry surface cape seal. The project is being performed on State Route 260 in Heber at an elevation 6,600 feet. Two treatment options are being tested:

• Treatment #1 – Heavy Duty Cape Seal
  – 0.5-inch mill (clean surface)
  – Crack fill – asphalt rubber and mastic (1.5-inch and larger)
  – Type 3 micro surface on a TR+ chip seal

• Treatment #2 – Medium Duty Cape Seal
  – 0.5-inch mill (clean surface)
  – Crack fill – asphalt rubber and mastic (1.5-inch and larger)
  – Type 3 slurry seal on a TR+ chip seal

If successful, these long lasting cape seal treatments will be included in the surface treatment program.

The development of bridge and pavement preventative maintenance programs is a work in progress and will require a long-term commitment to be successful. It is expected that the analysis performed in the final TAMP will more fully integrate these treatments into ADOT’s asset management practices.

8.8.3 Risk Management Analysis

The following investment strategies were adopted by ADOT to address risks associated with bridges and pavements:

• Scour counter measures fund: $2–3 million annually has been allocated to implement scour counter measures on scour critical bridges.

• Culvert repair fund: In FY 2018, $4.3 million was allocated to repair culverts that exhibit significant blockage and rusting.
• **Capital improvement and management of pump stations**: ADOT is exploring a public-private partnership for the improvement and management of Phoenix area pump stations, which would help prevent flood damage on the state’s largest urban freeway network.

• **Installation of weigh-in-motion stations**: In calendar year 2017, approximately $1.3 million was invested for the construction of WIM stations to detect unpermitted overweigh trucks which can damage both bridges and pavements.

• **Increased funding for pavement surface treatments**: In FY 2019, the pavement surface treatment budget was increased from $15 million to $40.6 million to increase the amount of preventative surfaces treatments that can be applied to Arizona highways.

Some of these funds (e.g., scour countermeasures fund) are ongoing and will continue until the risks are mitigated. Risks that have a lower likelihood, such as rock fall remediation, are addressed by the use of contingency funds or the redistribution of program funds.

### 8.8.4 Increased Funding for Asset Preservation

As previously mentioned, ADOT is increasing its investment to preserve Arizona’s highway assets. WMYA 2040 recommends investing $326 million annually for asset preservation, about 30 percent more than current program spending. This type of long-term commitment would make funds available for the preventative maintenance treatments described above while continuing to devote adequate funds to restoration of aging assets that have already undergone significant deterioration. Areas of the network that have traditionally received less funding, such as non-Interstate NHS pavements, would receive more investment. This investment combined with the previously mentioned proposed increases to maintenance budget funding for preventative maintenance would be expected to gradually reverse declining conditions and maintain Arizona’s highway system in a state of good repair for the foreseeable future.

### 8.8.5 Selection of Bridge and Pavement Investment Strategies in the Final TAMP

The establishment of performance targets and LCP will enhance ADOT’s capability to identify and select investment strategies. In the final TAMP, the following steps will be taken to improve or preserve the condition of NHS and SHS assets:

• **Develop investment strategies** – The TAMP financial team will identify the best long-term, fiscally constrained funding strategies that balance maintenance, preservation, rehabilitation and reconstruction to achieve and sustain a state of good repair over the life cycle of assets, support performance targets and national goals, and manage risks. The influence of performance gap analysis, LCP analysis, risk mitigation costs and the available funding to implement work types will be described in the investment strategy section of the Final TAMP.
• **Attempt to close funding gaps** – The consequences of not meeting performance targets due to funding gaps will be identified and documented. Means of closing funding gaps including shifting resources, lowering performance targets, changing LCP strategies or increasing risk tolerance, will be considered. Impacts to other performance areas, from shifting resources to close gaps or changing strategies, will be weighed in the determination of the best investment recommendation for the transportation system overall.

• **Determine the recommended investment strategy** – The financial team will work with agency management, MPOs and COGs to determine the investment strategy and associated funding level that will be recommended in the final TAMP. The process to arrive at this recommendation will be documented in the final TAMP. Risks to implementation also will be described.

• **Incorporate recommended investment strategies into the planning and programming process** – TAMP investment strategies fit into a larger context of transportation performance management and performance-based planning and programming. Safety, mobility and commerce also are important transportation needs that are considered during the long-range transportation planning process. Since transportation needs outpace available funding, ADOT must make difficult choices about where to best spend limited resources. To ensure the best choices, ADOT started using a data driven, performance-based approach to planning, programming and financial decision making that connects the goals of the state’s performance-based Long Range Transportation Plan to the ADOT Five-Year Construction Program and the Statewide Transportation Improvement Program STIP, known as P2P Link. In order to incorporate longer-term planning into the process, ADOT added a development program representing an additional five years (years 6 through 10) of tentative programming that will feed the five-year transportation facilities construction program [14].

Planning documents like the TAMP, Freight Plan and major corridor studies inform the development of high-level recommended investment choices in the Long Range Transportation Plan and support the achievement of performance targets by providing category specific investment strategies that can be used to develop a package of projects for the 10-year Development Program and the STIP (Figure 8-3). For bridges and pavements, the investment strategies recommended in the TAMP will be the primary basis for selecting and prioritizing projects.
Figure 8-3  Linking Planning to Programming

REFERENCES


8. HDR. 2016. ADOT Phoenix District Pump Station Evaluation.


10 GLOSSARY OF TERMS

Asset – A physical component or resource related to the transportation infrastructure.

Asset Class – A grouping of the same type of asset, such as bridges.

Asset Management – A strategic and systematic process of operating, maintaining and improving physical assets, with a focus on engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost. (23 United States Code 101(a)(2))

Asset Sub-class – A subset of an asset class, such as steel bridges.

Bridge component – A major functional unit of a bridge (e.g., deck, superstructure, substructure).

Bridge element – A sub-component of a bridge (e.g., expansion joint, girder).

Deterioration model – A mathematical model that predicts the future condition of an asset, if only minimal or routine maintenance is performed.

Expansion – Increasing transportation system traffic volume capacity by expanding a roadway or constructing a new transportation facility.

Long Range Transportation Plan – Federal regulations (23 United States Code 135) require states to develop a long-range statewide transportation plan that provides for the development and implementation of the intermodal transportation system. The plan must cover a minimum of 20 years and be developed in consultation with local governments and other parties within the state. ADOT’s plan covers 25 years and is updated every five years.

Maintenance – Routine activities that maintain the functional condition of existing roadways.

Modernization – Improvements to address functional, safety and geometric deficiencies.

Performance (transportation asset) – The condition of an asset, specifically how well and safely it fulfills its intended function and lifespan.

Performance Gap – The difference between an asset’s current condition and the desired condition.

Preservation (Work Type) – A program of preventative maintenance that extends asset service life and maintains the functional condition of existing roadways. Repairs and minor rehabilitation that don’t restore or enhance the structural capacity of an asset also are included
in the category. The terms preventative maintenance or preservation treatments may be used convey this meaning in the TAMP.

**Preservation (Planning)** – For planning purposes, ADOT uses this term to describe all the activities and work types needed to maintain transportation infrastructure meeting the functional requirements of the as built highway system. Often this usage will be in conjunction with the terms modernization and expansion.

**Preventative maintenance** – Periodic maintenance that is applied when an asset is in good condition in order to prevent deterioration and extend asset life.

**Rehabilitation** – Treatments that restore or strengthen an asset’s structural capacity in order to extend service life and/or increase load carrying capability.

**Reconstruction or replacement** – Replacement of an entire asset in order to restore or update functionality and/or increase traffic volume capacity.

**State Transportation Implementation Plan (STIP)** – Federal regulations (23 United States Code 135) require that states develop a STIP containing a fiscally-constrained listing of projects covering a minimum of four years and developed in consultation with local governments and other parties in the state. ADOT’s STIP covers five years and is updated annually.

**Work Type** – Means initial construction, maintenance, preservation, rehabilitation and reconstruction (23 CFR 515.5).
11 ACKNOWLEDGEMENTS

The Initial TAMP was prepared by:
Thor Anderson, Asset Manager
ADOT Multimodal Planning Division
206 S. 17th Avenue, Mail Drop 310B
Phoenix, AZ  85007
TAnderson@azdot.gov

Special thanks go to the following people who contributed information and assistance for the development of the TAMP and/or participated in the Risk Workshop:

ADOT
David Eberhart, P.E.
Henry Sung, P.E.
Mafiz Mian, P.E.
Gregory Byres, P.E.
Charla Glendening, AICP
Bret Anderson
Shaun Perfect
Baloka Belezamo, P.E.
Maria Leon
Karuna Ramisettey, CPA
James Meyer, GISP
Christ Dimitroplos, P.E.
Bernadette E. Phelan, Ph.D.
Steve Kalina
Ted Howard
James Windsor, P.E.
Amin Aman, P.E.
Peng Chen, P.E.

AECOM (Document preparation, technical editing, graphics)
Lauren Krepitch, MPA
Randy Sanchez
Sue Coughenour

Thanks to FHWA, Arizona Division, for their support and guidance throughout the preparation of this initial TAMP.

FHWA
Jennifer Brown, P.E.
Ed Stillings, P.E.
Chad Matty, P.E.
Ammon Heier, P.E.
Appendix A

Documents Referenced

All documents listed below may be found at: www.azdot.gov/tamp

1. What Moves You Arizona 2040, Long-Range Transportation Plan
2. Bridge Inspection Guidelines
3. Preliminary Study of Climate Adaptation for the Statewide Transportation System
4. Extreme Weather Vulnerability Assessment
5. dTIMS Implementation Schedule
6. BrM Implementation Schedule
7. ADOT 2017 Comprehensive Annual Financial Report
8. HURF Revenue Distribution Flow Notes
9. Bridge Preservation Program
10. Pavement Data Quality Management Plan
11. ADOT/City of Phoenix Bridge Inspection Intergovernmental Agreement