



ADOT Roadway Maintenance Costs

Summary Report

October 2019

Prepared for:



Prepared by:

Kimley»»Horn

TABLE OF CONTENTS

| | | |
|----------|--|-----------|
| 1 | EXECUTIVE SUMMARY | 1 |
| | 1.1 <i>Purpose</i> | 1 |
| | 1.2 <i>Maintenance Cost Data</i> | 1 |
| | 1.3 <i>Summary of Findings</i> | 1 |
| | 1.4 <i>Funding Implications</i> | 3 |
| | 1.5 <i>Future Spending</i> | 4 |
| 2 | INTRODUCTION | 5 |
| | 2.1 <i>Background</i> | 5 |
| | 2.2 <i>Findings from Current Practices Review</i> | 5 |
| 3 | DATA COLLECTION AND ANALYSIS | 7 |
| | 3.1 <i>Data Received</i> | 8 |
| | 3.2 <i>Supplemental Data</i> | 12 |
| | 3.3 <i>Data Analysis</i> | 12 |
| | 3.4 <i>Data Aggregation</i> | 14 |
| 4 | SUMMARY OF FINDINGS | 17 |
| 5 | FUNDING IMPLICATIONS | 22 |
| | 5.1 <i>ADOT Major Investment Types</i> | 22 |
| | 5.2 <i>Future Preservation Spending in Maricopa County</i> | 24 |

APPENDIX A – Unit Cost Calculations for Bridge Lifecycle Maintenance Costs

LIST OF FIGURES

| | |
|---|----|
| Figure ES-1 – Average Annual ADOT Maintenance Costs in Maricopa County (2015-2049) | 2 |
| Figure ES-2 – Average Annual Per-Lane-Mile ADOT Maintenance Costs in Maricopa County (2015-2049) | 2 |
| Figure ES-3 – ADOT Maintenance Costs in Maricopa County by Category | 3 |
| Figure ES-4 – Historical ADOT Spending on Freeways/Highways..... | 4 |
| Figure ES-5 – Cumulative Gap Between Expected Revenue and Identified Maintenance Costs (2020 – 2049)..... | 4 |
| Figure 1 – ADOT Central Maintenance District Boundaries in Comparison to Maricopa County..... | 7 |
| Figure 2 – Average Annual Per-Lane-Mile ADOT Maintenance Costs in Maricopa County (2015-2049) | 18 |
| Figure 3 – Known and Projected Total and Average Annual ADOT Maintenance Costs in Maricopa County | 19 |
| Figure 4 – Known and Projected ADOT Maintenance Costs in Maricopa County by Category | 20 |
| Figure 5 – Age of ADOT Facility Bridges in Maricopa County (as of 2018)..... | 20 |
| Figure 6 – Bridge Lifecycle Maintenance Cost Projections..... | 21 |
| Figure 7 – Estimated Annual RTP Spending in the MAG Region | 22 |
| Figure 8 – ADOT LRTP Recommended Annual Highway Spending in Arizona Outside of MAG and PAG Programs | 23 |
| Figure 9 – 2020-2024 Statewide 5-Year Construction Program Excluding MAG and PAG Programs | 23 |
| Figure 10 – 2025-2029 Statewide Preliminary 5-Year Construction Program Excluding MAG and PAG Programs.. | 24 |
| Figure 11 – 2020-2024 MAG RTP Freeway Program | 25 |
| Figure 12 – Comparison of Expected Revenue Versus Identified Maintenance Costs Per 5-Year Period | 26 |
| Figure 13 – Cumulative Gap Between Expected Revenue and Identified Maintenance Costs (2020 – 2049)..... | 26 |

LIST OF TABLES

| | |
|--|----|
| Table ES-1 – ADOT Maintenance Costs in Maricopa County (2015-2049)..... | 1 |
| Table 1 – Summary Per-Lane-Mile Cost Estimates for Roadways and Bridges under NJDOT Jurisdiction | 6 |
| Table 2 – Arizona’s Ranking in Highway Performance Categories (2015)..... | 6 |
| Table 3 – Summary of Specific Maintenance Costs and Assumptions Received from ADOT | 8 |
| Table 4 – Bridge Lifecycle Maintenance Activities | 13 |
| Table 5 – Estimated Bridge Lifecycle Maintenance Activity Costs through 2049 | 13 |
| Table 6 – Estimated ADOT AR-ACFC Overlay Replacement Costs through 2049 | 14 |
| Table 7 – Summary of Historical and Projected ADOT Maintenance Costs | 15 |
| Table 8 – ADOT Maintenance Costs in Maricopa County (2015-2049)..... | 17 |
| Table 9 – Average Annual Per-Lane-Mile ADOT Maintenance Costs in Maricopa County (2015-2049)..... | 17 |

1 EXECUTIVE SUMMARY

1.1 Purpose

The Maricopa Association of Governments (MAG) and the Arizona Department of Transportation (ADOT) have partnered on this ADOT Roadway Maintenance Costs study to better understand the long-term maintenance needs on ADOT freeways and highways within Maricopa County. The region’s freeways and highways will be largely built-out by 2025, resulting in hundreds of miles of infrastructure that needs to be properly operated and maintained. To make sure that this infrastructure remains in a state of operation and good repair, a new focus on maintenance and preservation will be important as MAG and its member agencies look forward to the development of the next Regional Transportation Plan.

1.2 Maintenance Cost Data

The following were the main sources of historical (2015-2019), programmed (2020-2024), and projected (2025-2049) maintenance cost information for ADOT facilities within Maricopa County. Through a combination of these sources, along with some data analyses and projections, a comprehensive understanding of current and future maintenance needs on ADOT facilities in Maricopa County was compiled.

- ADOT Bridge Group;
- ADOT Pavement Group;
- ADOT Transportation Systems Management and Operations (TSMO) Division;
- ADOT Central Maintenance District;
- *ADOT Five-Year Construction Program* plans (fiscal year (FY) 2013 through FY 2020);
- *Freeway Life Cycle Program MAG Transportation Improvement Program (TIP) Amendment #23 (FY 2018-2022)*;
- *2018 ADOT Initial Transportation Asset Management Plan*;
- *2016 ADOT Bridge Group Bridge Preservation Program* report; and
- *2011 Arizona Statewide Rest Area Study* and rest area maintenance contract.

1.3 Summary of Findings

Table ES-1 shows the historical, programmed, and projected maintenance costs identified by this study. Costs are shown for each timeframe both as total maintenance costs and average annual maintenance costs.

Table ES-1 – ADOT Maintenance Costs in Maricopa County (2015-2049)

| Timeframe | Type of Cost | Cost |
|-------------------------|---|-----------------|
| Historical (2015-2019) | Total maintenance costs | \$373,258,601 |
| | Average annual maintenance costs | \$74,651,720 |
| Programmed (2020-2024)* | Total maintenance costs | \$505,664,166 |
| | Average annual maintenance costs | \$101,132,833 |
| Projected (2025-2049)* | Total needed maintenance costs | \$8,746,318,082 |
| | Average annual needed maintenance costs | \$349,852,723 |

*2020-2049 costs shown in 2019 dollars

Figure ES-1 graphically shows the *average annual* ADOT maintenance costs for each of the 5-year periods that were considered during this study. The first five years (2015-2019) are considered ‘historical’, the second 5-year period (2020-2024) is considered ‘programmed’, and all of the remaining 5-year periods between 2025 and 2049 are considered ‘projected’. All costs for the ‘programmed’ and ‘projected’ periods are shown in 2019 dollars.

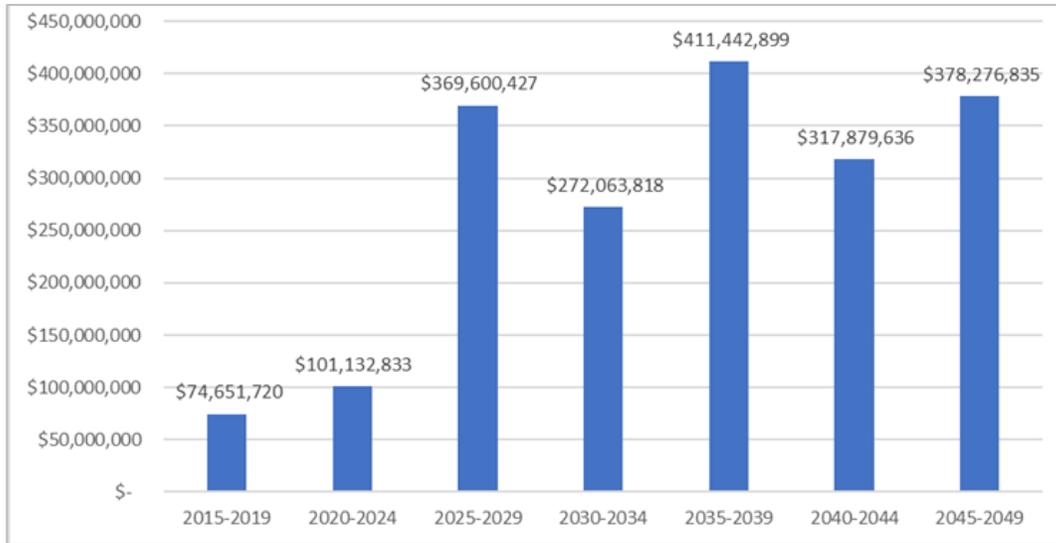


Figure ES-1 – Average Annual ADOT Maintenance Costs in Maricopa County (2015-2049)

Factors contributing to the significant increase between currently programmed (2020-2024) and future projected (2025-2049) costs for maintenance include:

- Infrastructure is aging, requiring more frequent and more expensive maintenance activities; and
- Projected maintenance costs account for all required maintenance, including activities needed in 2020-2024 but that could not be programmed with the available funds and as such were deferred. These costs are instead shown within the next projected 5-year period (2025-2029).

Figure ES-2 shows the *average annual per-lane-mile* costs of maintenance for each of the 5-year periods that were considered during this study.

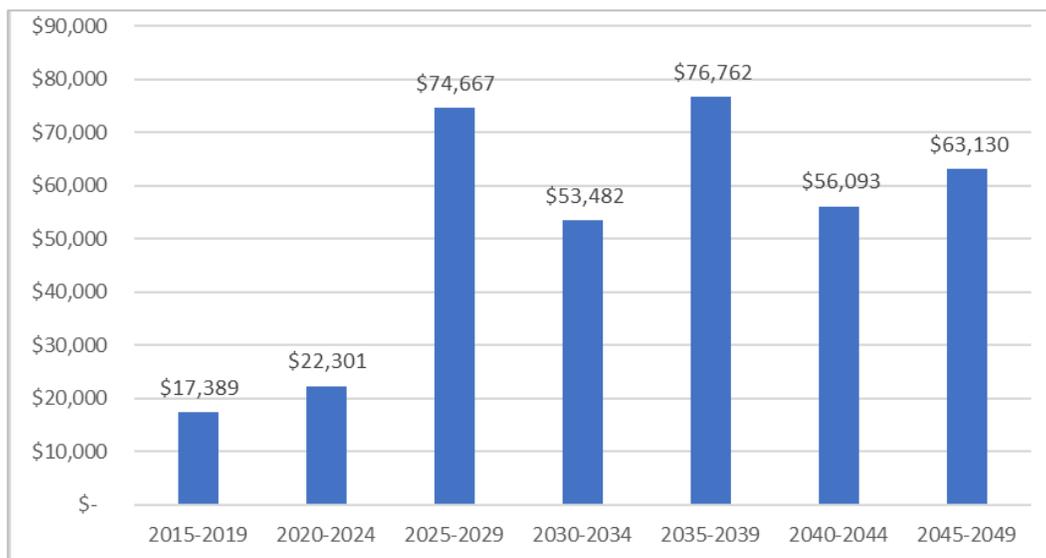


Figure ES-2 – Average Annual Per-Lane-Mile ADOT Maintenance Costs in Maricopa County (2015-2049)

When considering the average annual per-lane-mile cost of maintenance for each of the 5-year periods in the future non-programmed years (2025-2049), the 25-year average annual projected per-lane-mile cost of maintenance is \$64,827. This cost is about 3.7 times higher than the average annual per-lane-mile maintenance cost spent historically (\$17,389 per year between 2015-2019) and 2.9 times higher than the average annual per-lane-mile maintenance cost that is programmed (\$22,301 per year between 2020-2024).

The large increase in maintenance costs is primarily a result of much higher identified maintenance needs for pavement and bridges in Maricopa County than has historically been seen.

- Replacement of “quiet pavement”, currently achieved using Asphalt Rubber – Asphalt Concrete Friction Course (AR-ACFC) overlay, is required every ten years to maintain its effectiveness. The spike seen in 2025-2029 pavement maintenance costs in **Figure ES-3** accounts for deferred quiet pavement overlay activities that are needed but were not able to be programmed in 2020-2024.
- More frequent bridge rehab or replacement will be needed to address aging bridges. Large-scale bridge deterioration is anticipated in years 2035-2039, which is when around 150 bridges built between 1986 and 1990 will require major rehab, as shown in **Figure ES-3**. These major bridge rehabs result in an anticipated cost of more than \$700 million for rehab, which is a large portion of the total maintenance cost of more than \$1.1 billion for bridges in the 2035-2039 timeframe.

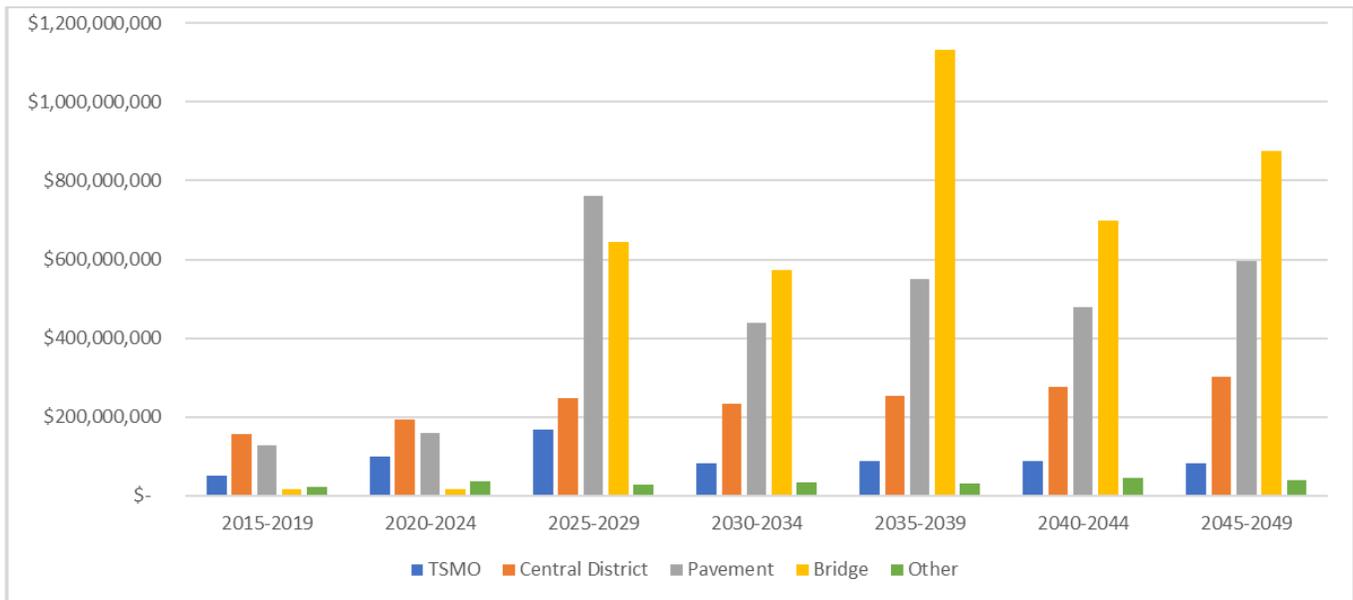


Figure ES-3 – ADOT Maintenance Costs in Maricopa County by Category

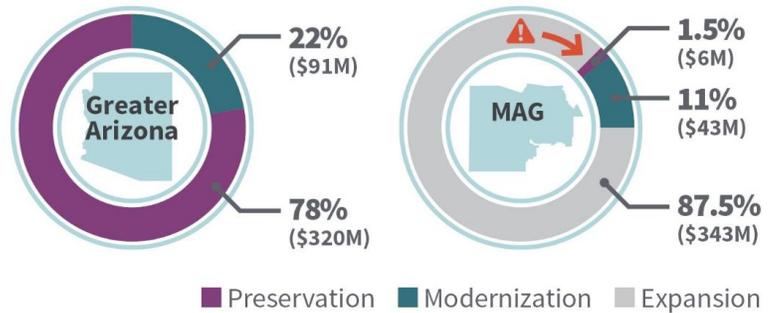
1.4 Funding Implications

The *ADOT 2040 Long-Range Transportation Plan (LRTP)*, completed in 2018, identifies three categories of transportation investments for ADOT:

- **Preservation** – Activities that preserve transportation infrastructure by sustaining asset condition or extending asset service life;
- **Modernization** – Improvements that upgrade efficiency, functionality, and safety without adding capacity; and
- **Expansion** – Improvements that add transportation capacity through the addition of new facilities and/or services.

As seen in **Figure ES-4**, from a statewide perspective, outside of the Phoenix and Tucson regions, ADOT’s 2040 Long-Range Transportation Plan (LRTP) puts a heavy emphasis on funding preservation (78%) and has allocated no state funding to expansion of roadways.

In contrast, the MAG region has historically allocated 87.5% of funds to expansion of the freeway/highway system and only 1.5% to preservation. This is largely due to the fact that voters in Maricopa County approved a dedicated funding source, through Proposition 400, to pay for higher levels of highway system expansion than would be possible through available federal and state funding sources.



Source: ADOT 2040 Long-Range Transportation Plan (2018)

Figure ES-4 – Historical ADOT Spending on Freeways/Highways

1.5 Future Spending

To address the magnitude of maintenance needs identified for Maricopa County starting in 2025, there may need to be a transition from an expansion-focused regional transportation investment strategy to more of a preservation-focused strategy along with an increase in the availability of regional funding.

ADOT maintenance costs calculated in this study were \$1.8 billion for 2025-2029, which exceeds the entire anticipated regional funding available for the freeway/highway program in the MAG region during that period (\$1.6 billion), assuming an extension of Proposition 400 occurs. **If projected maintenance costs on ADOT facilities in Maricopa County are funded entirely by an extension of the county half-cent sales tax, there would be limited regional funding for multimodal modernization or expansion projects, unless additional funding is identified.**

If the level of maintenance spending does not increase from 2015-2019 levels (used as a baseline), **it is expected there will be a cumulative revenue shortfall of more than \$7 billion by 2049 to address expected ADOT maintenance needs in Maricopa County.** This cumulative gap is depicted in **Figure ES-5**.

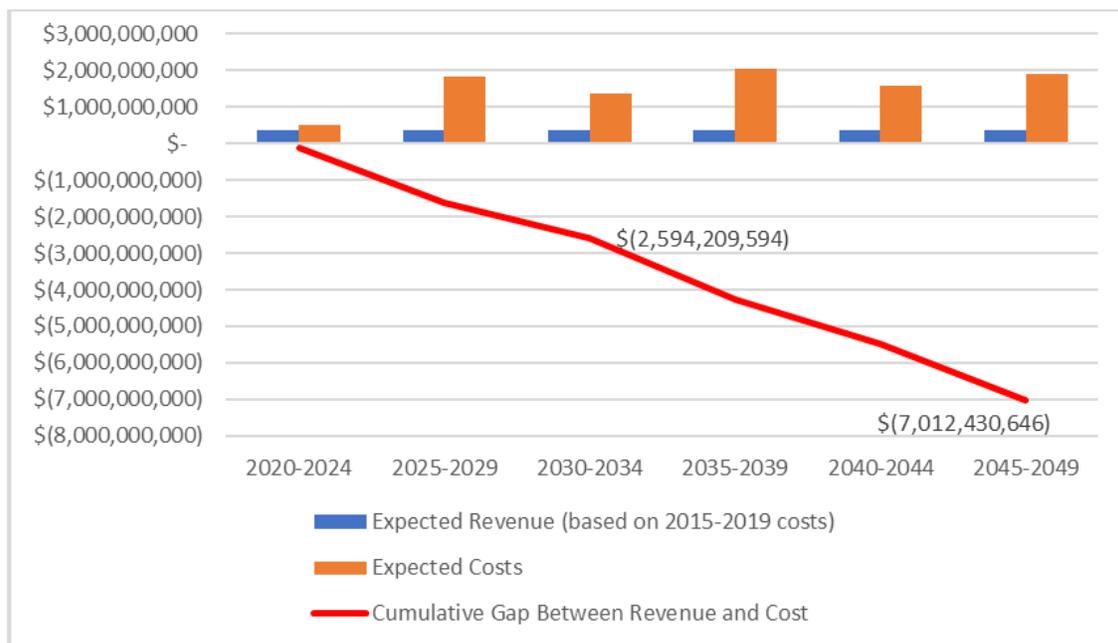


Figure ES-5 – Cumulative Gap Between Expected Revenue and Identified Maintenance Costs (2020 – 2049)

2 INTRODUCTION

2.1 Background

Transportation investments in the Phoenix metropolitan area have historically been primarily focused on constructing new facilities and expanding facilities to provide a robust network of freeways and highways to move people and goods throughout the region. When Proposition 400 was passed by Maricopa County voters in 2004, renewing a half-cent sales tax to fund transportation in Maricopa County, a significant portion of the revenue was allocated to building new freeways and expanding existing ones.

Recognizing the impending sunset of Proposition 400 (at the end of 2025) and the near-term opportunity to bring to Maricopa County voters a case to extend the transportation sales tax (informally known as the extension of Proposition 400), the Maricopa Association of Governments (MAG) has embarked on an effort to identify the transportation and mobility needs for the next 20 years. Much has changed in the last 20 years in terms of transportation trends, technologies, and needs. The region's freeways and highways will be largely built-out by 2025, resulting in hundreds of miles of infrastructure that needs to be properly operated and maintained. To make sure that this infrastructure remains in a state of operation and good repair, a new focus on maintenance and preservation will be important as MAG and its member agencies develop the next Regional Transportation Plan (RTP).

Understanding the need to prepare for a large increase in maintenance needs, MAG and the Arizona Department of Transportation (ADOT) have partnered on this ADOT Roadway Maintenance Costs study to better understand the long-term maintenance needs on ADOT freeways and highways within Maricopa County. This study identifies known and projected maintenance costs – at a planning level – to keep the region's freeways and highways operating in good condition. This information can then be used to assist in identifying the magnitude of funding that may be needed for future roadway maintenance through 2049.

2.2 Findings from Current Practices Review

To support the approach to collection, aggregation, and presentation of the ADOT roadway maintenance costs that were collected for this study, a review was conducted of the current practices of other state transportation agencies (DOTs) throughout the nation. The review focused on ways that agencies identify, calculate, and report roadway maintenance costs. While all DOTs are responsible for conducting roadway maintenance, it is not always a common practice for agencies to aggregate all maintenance costs and it is even less common for agencies to report on those costs in a way that is readily accessible to the public.

The review of available documents on DOT roadway costs resulted in the following four major findings:

1. There is an identified need throughout the nation for governments to put greater investment in maintenance and preservation of the existing highway system;
2. There is minimal reporting done (or made available) on specific highway maintenance costs at a national or state level, and much of the reporting that is available shows historical costs, as opposed to projected, future costs;
3. There is some consistency of maintenance activity categories that make up total maintenance costs, although this is not standardized. Common maintenance activities that are usually included in maintenance budgets are:
 - Pavement;
 - Litter;
 - Vegetation;
 - Guardrails;
 - Bridges;
 - Drainage;
 - Signs; and
 - Pavement markings/stripping.

- There is often a difference between projected maintenance costs that are calculated based on a constrained budget as compared to the actual total costs that are needed to maintain a state highway system.

Based on the review of current practices, the following recommendations have helped guide this study:

- Maintenance costs reported in per-lane-mile costs allows for comparison between agencies or facilities;
- It should be clear what costs are included in the lane-mile costs (e.g., do the costs include administrative costs or fringe benefits, etc.);
- It needs to be clear if future costs account for inflation or are in constant “today’s” dollars, so that projected revenue streams can be correspondingly matched up, as needed; and
- Historical maintenance costs can serve as a base for projecting future maintenance costs, but it is important to understand what costs may be incurred in the future that were not incurred in the past, such as maintenance needs for new roadways or infrastructure that were not previously part of the system (e.g. South Mountain Loop 202), major maintenance needs that are not frequent recurring costs (e.g., bridge replacement, pump station replacement, lighting technology upgrades, etc.), and maintenance needs that are present but have been deferred due to budget/funding constraints.

Below are two sources of costs that were identified during the current practices review that can be used as relative comparisons to the costs identified through this study.

The red outlined number in **Table 1** shows that the New Jersey DOT (NJDOT) spent just under \$65,000 per lane mile in 2014 for operation and maintenance (O&M) of all roadways and bridges under NJDOT jurisdiction.

Table 1 – Summary Per-Lane-Mile Cost Estimates for Roadways and Bridges under NJDOT Jurisdiction

| Cost Per Lane Mile Estimates | 2010 | 2011 | 2012 | 2013 | 2014 | Average |
|-------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Administration, Planning & Research | \$7,282 | \$7,261 | \$8,491 | \$9,167 | \$5,924 | \$7,625 |
| Capital Construction | \$151,756 | \$131,713 | \$101,004 | \$96,305 | \$137,999 | \$123,755 |
| Operations & Maintenance | \$37,567 | \$54,468 | \$47,312 | \$58,072 | \$64,465 | \$52,377 |
| TOTAL | \$196,606 | \$193,442 | \$156,807 | \$163,544 | \$208,388 | \$183,757 |

Source: *The Cost of Roadway Construction, Operations, and Maintenance in New Jersey, Phase 1 Final Report (2016)*

Table 2 shows Arizona’s statewide performance for three criteria relevant to maintenance as found in the 2018 23rd Annual Highway Report on the Performance of State Highway Systems. In this report, the smaller the ranking number, the better. In 2015, Arizona spent an average of \$22,618 per mile of ADOT facilities throughout Arizona for maintenance, which ranked as the 20th largest amount among the 50 states. Using an adjustment factor for Arizona of 2.87 (as listed in the report) to convert per-mile to per-lane-mile costs, the 2015 average per-lane-mile maintenance cost for ADOT facilities in Arizona was \$64,914. Nationwide in 2015, the average per-mile maintenance cost was \$28,020, with the corresponding per-lane-mile maintenance cost being \$67,248.

Table 2 – Arizona’s Ranking in Highway Performance Categories (2015)

| Performance Category | Overall Performance | Maintenance Disbursements per Mile | Urban Interstate Pavement Condition | Deficient Bridges |
|--------------------------------------|---------------------|------------------------------------|-------------------------------------|------------------------|
| Arizona’s Ranking (out of 50 states) | 16 | 20 (\$22,618 per mile) | 4 (0.63% in poor condition) | 1 (9.01% deficient) |

Source: *23rd Annual Highway Report on the Performance of State Highway Systems. Reason Foundation (2018)*

3 DATA COLLECTION AND ANALYSIS

To understand future projected maintenance costs for ADOT facilities (i.e., freeways and highways) within Maricopa County, historical (2015-2019), programmed (2020-2024), and projected (2025-2049) maintenance costs were collected from the following four ADOT divisions and groups responsible for maintenance:

- **Bridge Group** – responsible for the maintenance of bridges and associated structures throughout the state;
- **Pavement Group** – responsible for pavement preservation and rehabilitation throughout the state;
- **Transportation Systems Management and Operations (TSMO) Division** – responsible for maintenance and rehabilitation of lighting, striping and marking, signage, tunnels, traffic signals, intelligent transportation systems (ITS) equipment, and pump stations; and
- **Central (Maintenance) District** – responsible for maintenance and upkeep of pavement, landscaping and irrigation, sweeping, litter control, guardrail, vegetation/weed control, and shoulder condition for the ADOT Central District, which includes the more populated parts of Maricopa County plus portions of surrounding counties. **Figure 1** shows the boundaries of the ADOT Central District in comparison to the Maricopa County boundaries. It should be noted that four other districts have jurisdiction over roadway segments in Maricopa County, although the Central District has the bulk of the mileage of ADOT facilities in Maricopa County.

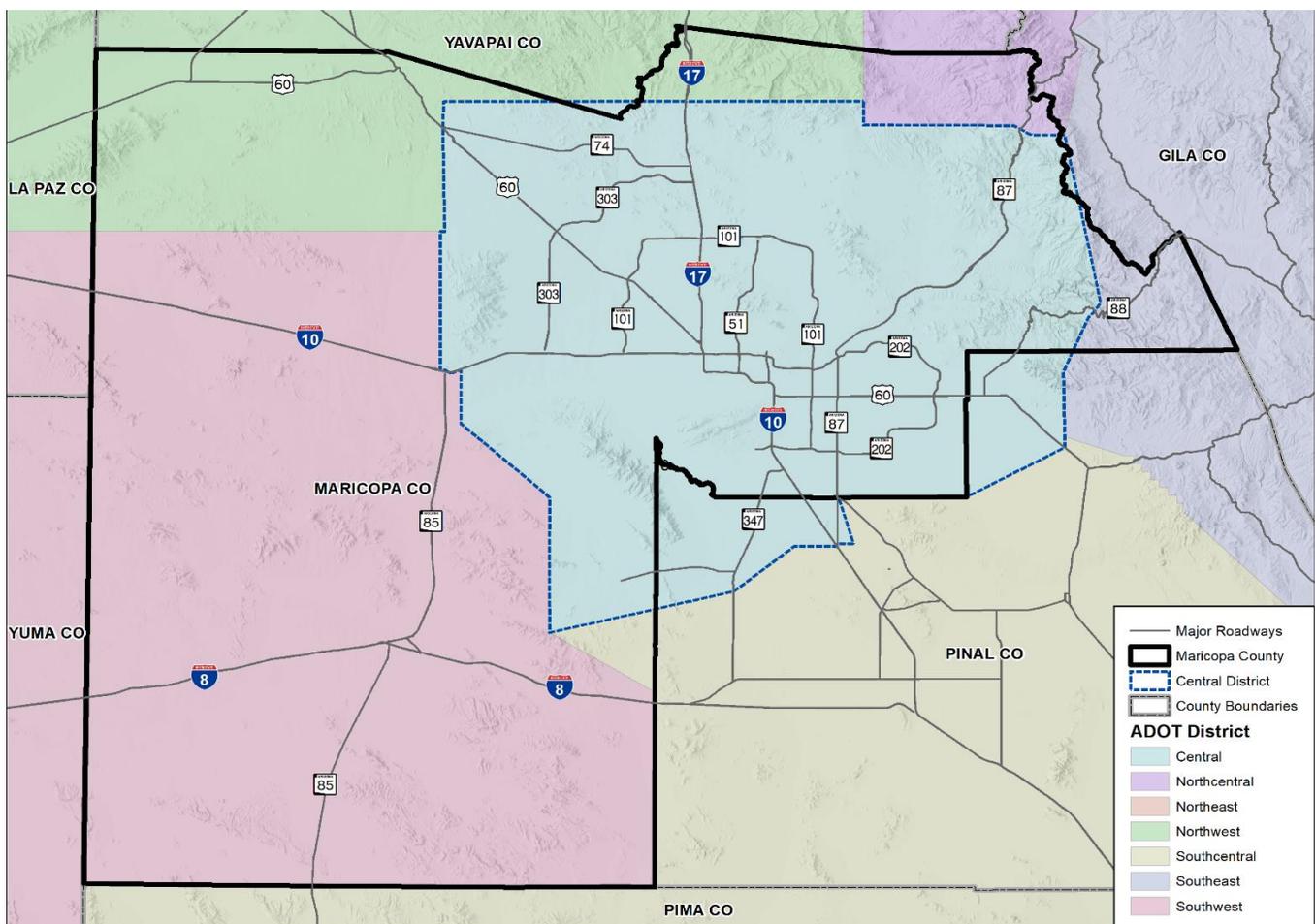


Figure 1 – ADOT Central Maintenance District Boundaries in Comparison to Maricopa County

3.1 Data Received

From each of the identified ADOT groups, maintenance costs were requested in 5-year timeframes (2015-2019; 2020-2024; 2025-2029; 2030-2034; 2035-2039; 2040-2044; and 2045-2049). **Table 3** provides a summary of the data that was received directly from ADOT as part of this study, as well as any assumptions that were used by ADOT to identify costs.

Table 3 – Summary of Specific Maintenance Costs and Assumptions Received from ADOT

| Data | Years | Assumptions/Notes |
|---|--|--|
| Bridge Group | | |
| Programmed bridge projects in Maricopa County and project status | FY 2014-2026 | <ul style="list-style-type: none"> Not all projects had an identified cost at the time of this study |
| Pavement Group | | |
| Total and per lane mile cost for pavement rehabilitation/preservation (1" friction course) expenditures for the MAG System | FY 2015-2019 | <ul style="list-style-type: none"> There were not rehabilitation projects funded in FY 2015, so the costs reflected FY 2016-2019 |
| TSMO Division | | |
| Cost of I-10 Deck Park tunnel operations, including: <ul style="list-style-type: none"> Fan overhauls; Fire line replacements Generator major overhaul; Computer software upgrades; Computer hardware replacements; Security camera system upgrades; and Control room upgrades | FY 2020-2049 (based on 25-year costs) | <ul style="list-style-type: none"> Fan overhauls – 8 units to be replaced every 10 years at a cost of \$400,000 per replacement Fire line replacements – 1 unit to be replaced during 25-year cycle at the cost of \$1,600,000 Generator major overhaul – 1 unit to be replaced every 10 years at a cost of \$200,000 per replacement Computer software upgrades – 1 unit to be replaced every 10 years at a cost of \$10,000 per replacement Computer hardware replacements – 1 unit to be replaced every 10 years at a cost of \$50,000 Security camera system upgrades – 1 unit to be replaced every 10 years at a cost of \$12,000 per replacement Control room upgrades – 1 unit to be upgraded during 25-year cycle at a cost of \$20,000 per replacement |
| Phoenix area pump station rehabilitation and ongoing maintenance needs | FY 2015-2029 (rehab) FY 2015-2049 (maintenance) | Calculated pump station rehabilitation costs for all pump stations in MAG region, per ADOT Phoenix Area Pump Stations Lifecycle Pump Rehabilitation and Replacement Plan (June 2019), prepared for ADOT TSMO Group. Annual maintenance cost for keeping pump stations in working order (in between major rehabs). |
| Costs for maintenance/ replacement of freeway lighting, which includes: <ul style="list-style-type: none"> LED lighting for Deck Park tunnel LED lamp maintenance Meter replacements (upgrading metered to unmetered) Pole replacement-related Unit 6204 staff charges (\$3.56 million) per 5 years | FY 2020-2049 (based on 25-year costs) | <ul style="list-style-type: none"> Current costs high pressure sodium lighting replacement 2-3 years is \$7.5 million per 5 years. However, all lighting is being converted to LED as projects/funding permits. Cost of LEDs every 15 years reduces 5-year costs to \$4.97 million per 5 years. The cost would probably decrease with the improved service life of the LED. Faster conversion to LED will increase cost per 5 years up until all lights are converted. |

| Data | Years | Assumptions/Notes |
|--|--|--|
| Costs for maintenance of signing and striping in Maricopa County | FY 2020-2049 (based on 25-year costs) | <p>The estimated long-term maintenance cost is about \$26 million per 5-year increment</p> <ul style="list-style-type: none"> • Includes 10% of the signs structures that require replacement based on existing condition or service life (50 years), and all signage that will need to be replaced due to service life (15 years). • Signing list of assumptions: <ol style="list-style-type: none"> 1. Each State Route was broken down into three segments with the assumption that one segment will be rehabilitated every 5 years - Assumed a maintenance cost of \$15k per mile for sign panels (flat sheet signing). It will replace all signs in State Route every 15 years. 2. Maintenance for signage on Interstates (extruded panels) was assumed to be \$30k per mile. This frequency is based on the previous sign rehab projects. 3. There are about 900 sign structures within the County that will meet the service life from now to 2049. However, the department has had sign structures that have failed prior to reaching its service life of 50-years, therefore an assumption was made that 10% of the sign structures may need to be replaced. This cost estimate assumes 15 structures may need to be replaced every 5-years at a cost of \$75k per structure. <p>Striping costs in Maricopa County are based on historical spending levels. It should be noted that the majority of the existing striping in Maricopa County utilizes 3M tape for the lane lines and thermoplastic stripe for the edge lines. The 3M tape has required minimal maintenance over the 12-plus years that it has been in service (edge lines are re-striped on an average of every four to five years). Therefore, future striping costs in Maricopa County are highly contingent on the direction taken to rectify the existing AR-ACFC that is failing. Regardless of whether the AR-ACFC is replaced or removed, a durable stripe needs to be utilized for the lane lines that will require the same level of maintenance as the exiting 3M stripe.</p> |
| Costs for traffic signal and ITS maintenance and replacement in Maricopa County, including: <ul style="list-style-type: none"> • Signals <ul style="list-style-type: none"> ○ Wire repulls ○ Controller replacements ○ Signal head replacement sets ○ Pole/mast arm replacement ○ Detection replacement | FY 2020-2049 (based on 25-year costs) | Signals <ul style="list-style-type: none"> • Wire repulls – 175 locations to be repulled every 30 years at a cost of \$35,000 per repull • Controller replacements – 175 controllers to be replaced every 10 years at a cost of \$3,500 per controller • Signal head replacement sets – 175 signal head sets to be replaced every 20 years at a cost of \$5,000 per head set • Pole/mast arm replacement – 175 replacements to be replaced every 40 years at a cost of \$60,000 per replacement • Detection replacement – 175 detectors to be replaced every 6 years at a cost of \$30,000 per detector |

| Data | Years | Assumptions/Notes |
|---|--------------|---|
| <ul style="list-style-type: none"> ○ CCTV ○ Cabinets • Communication network <ul style="list-style-type: none"> ○ Node building overhauls ○ Radio overhauls/ replacement ○ Fiber database • Dynamic Message Signs (DMS) <ul style="list-style-type: none"> ○ Software upgrade/ controller ○ Hardware replacement ○ Pole replacement • CCTV camera <ul style="list-style-type: none"> ○ Software and hardware replacement ○ Pole replacement • Wrong-way detection system <ul style="list-style-type: none"> ○ Software system upgrades ○ Hardware replacements (cameras and signs) ○ Pole replacement • Ramp meters <ul style="list-style-type: none"> ○ Software system upgrades ○ Hardware and software replacement (controller) ○ Ramp meter cabinet ○ Pole replacement | | <ul style="list-style-type: none"> • CCTV – 175 cameras to be replaced every 5 years at a cost of \$5,500 per camera • Cabinets – 175 cabinets to be replaced every 25 years at a cost of \$16,000 per cabinet <p>Communication network</p> <ul style="list-style-type: none"> • Node building overhauls – 22 buildings to be overhauled every 10 years at a cost of \$30,000 per overhaul • Radio overhauls/ replacement – 100 radios to be replaced every 10 years at a cost of \$2,000 per radio • Fiber database – upgrade of fiber database every 10 years at a cost of \$100,000 per upgrade <p>DMS</p> <ul style="list-style-type: none"> • Controller software upgrade – 273 controllers to be upgraded every 15 years at a cost of \$3,000 per upgrade • Hardware replacement – 273 DMS to upgrade every 10 years at a cost of \$40,000 per upgrade • Pole replacement – 273 poles to be replaced every 50 years at a cost of \$45,000 per pole <p>CCTV camera</p> <ul style="list-style-type: none"> • Software and hardware replacement – 440 CCTVs to be replaced every 5 years at a cost of \$5,500 per camera • Pole replacement – 440 poles to be replaced every 25 years at a cost of \$4,200 per pole <p>Wrong-way detection system</p> <ul style="list-style-type: none"> • Software system upgrades – one upgrade every 10 years at a cost of \$100,000 per upgrade • Hardware replacements (cameras and signs) – 30 cameras and signs to upgrade every 5 years at a cost of \$22,000 per upgrade • Pole replacement – 30 poles to upgrade every 50 years at a cost of \$5,000 per pole <p>Ramp meters</p> <ul style="list-style-type: none"> • Software system upgrades – one software upgrade every 10 years at a cost of \$50,000 per upgrade • Hardware and software replacement (controller) – 497 controllers to upgrade every 10 years at a cost of \$3,000 per controller • Ramp meter cabinet – 497 cabinet to upgrade every 25 years at a cost of \$12,000 per cabinet • Pole replacement – 497 poles to replace every 50 years at a cost of \$5,000 per pole |
| Central District | | |
| <p>Costs for maintenance based on historical activities and costs</p> <ul style="list-style-type: none"> • Pavement Maintenance (repair potholes, seal cracks, flush coat, mill & fill) • Unpaved surface (Dust control) • Shoulders (shoulder buildup, repair turnouts and crossovers) | FY 2015-2049 | <ul style="list-style-type: none"> • All costs assume 10% cost escalation every 5-year block based on historical (FY 2015-2019) costs and anticipated exponential maintenance deterioration • Special Line Item (legislative apportionment) – used for small-scale pavement maintenance (flush seals, crack seals, limited micro-seals); assume \$5.2 million per year starting in 2020 |

| Data | Years | Assumptions/Notes |
|--|--------------|--|
| <ul style="list-style-type: none"> • Vegetation control • Roadside (Guardrail, fence repair, cattle guard, removal of dead animal) • Emergency Response (Incident/crash response) • Drainage (drainage maintenance, clean channels, hydro vacuum) • Contracted Roadway Work (seal coat, flushing, Pavement milling, crack filling, remove and installation of guardrail, fence repair and installation, traffic control) • Landscape (Trim, replace and remove trees & shrubs, chipping, herbicide spraying, irrigation repair, weed control) • Contracted Landscape Work (Landscape maintenance, irrigation repair, tree trimming, landscape labor on-call, litter) • Materials (herbicides, Irrigation, patching, guardrail, fence, crash attenuator) • SRP Siphon @ 10% every 5 years • Special Line item (SLI) • RTP landscape/sweeping/litter/graffiti | | |
| <p>Costs for special maintenance needs that are outside of regular maintenance activities</p> <ul style="list-style-type: none"> • Irrigation replacement for 31 miles • Replace irrigation controllers system wide) • Replacing Sweepers (5) every 10 years • Hydrovac 500K per year per crew | FY 2020-2049 | <ul style="list-style-type: none"> • Irrigation replacement for 31 miles – one-time cost • Irrigation communication (replace controllers system wide) – one-time cost • Replacing Sweepers (5) every 10 years – 1 sweeper for FY 2020-24; 4 sweepers for FY 2025-29; 1 sweeper for FY 2030-34; 4 sweepers for FY 2035-49 • Hydrovac 500K per year per crew – 1 additional crew |
| Project costs for maintenance of additional lane miles added to the system | FY 2020-2049 | <ul style="list-style-type: none"> • Assumes 10% growth in lane miles every 5 years |

3.2 Supplemental Data

In addition to specific costs provided by the aforementioned ADOT groups, a few published documents were collected and referenced to help supplement the ADOT group data and identify additional costs that may not have been captured elsewhere.

Publicly available documents that were collected and reviewed included:

- *ADOT Five-Year Construction Program* plans from FY 2013 through FY 2020;
- *Freeway Life Cycle Program MAG Transportation Improvement Program (TIP) Amendment #23 (FY 2018-2022)*; and
- *Arizona Statewide Rest Area Study (2011)* and rest area maintenance contract.

These documents were collected and reviewed to confirm costs as well as identify costs for future years that have been programmed by ADOT. These sources were particularly useful for bridge and pavement projects, as they show the larger rehabilitation projects that have been programmed, meaning that there was specific funding identified for projects. They were also useful for identifying needs related to rest area maintenance.

Findings from the supplemental data included:

- Additional bridge rehabilitation projects;
- Additional pavement preservation and rehab projects;
- Identification of \$6.5 million within a 5-year period for the bridge inspection and minor repair program in Maricopa County, based on statewide costs for the bridge inspection and minor repairs program;
- Identification of \$3.5 million within a 5-year period for annual rest area operations and maintenance in Maricopa County, based on statewide costs for rest area maintenance; and
- Costs for rehab of each of the five rest areas within Maricopa County within the planning horizon (2049) – assuming rest area rehab occurs approximately every 20 years, at a cost of \$5 million per rest area.

3.3 Data Analysis

The maintenance costs identified by the various ADOT groups and ADOT published documents were those that had explicit line items in a budget or that were identified as a specific project cost. However, there are other realistic maintenance costs for ADOT infrastructure that are part of programmatic or preventative maintenance that have not always been explicitly budgeted for, and in some cases, have been deferred due to budget constraints. While these costs have not always historically been acknowledged or budgeted, they are part of the comprehensive maintenance needs for the region through 2049 and beyond.

Bridge Lifecycle Maintenance Activities

There is a series of maintenance treatments for bridges that should be performed based on the age of a bridge to keep it in good operating condition. The importance of these treatment activities, corresponding timeframes, and relative costs are outlined in multiple ADOT documents, including the *2018 ADOT Initial Transportation Asset Management Plan* and the *2016 ADOT Bridge Group Bridge Preservation Program* report. From these documents, the maintenance treatments, the timeframes in which they should be completed, and the estimated unit cost for each treatment are summarized in **Table 4**.

Table 4 – Bridge Lifecycle Maintenance Activities

| Maintenance Treatment | Years Since Bridge was Constructed | Unit Cost per Treatment* |
|-----------------------------|------------------------------------|--------------------------|
| Seal Deck/Replace Joints | 15 | \$220,000 |
| Deck Overlay/Replace Joints | 30 | \$1,210,000 |
| Rehab | 50 | \$4,830,000 |
| Replacement | 75 | \$7,630,000 |

*See Appendix A for how unit costs were estimated.

While there has not historically been an explicit budget to support this maintenance program for all bridges, there is a need to provide this level and program of maintenance to keep bridges in a safe and operational condition for their lifespan. **Table 5** summarizes the future costs of comprehensively completing recommended bridge maintenance that would be required based on the age of bridges in Maricopa County through 2049. The costs identified through 2029 include lifecycle maintenance costs that would be required between 2020 and 2029, while the rest of the columns show a 5-year cost. Costs are shown this way because there is no programmed funding to complete the identified bridge lifecycle maintenance in 2020-2024, so those costs are shown to be deferred until the funding period starting in 2025.

Table 5 – Estimated Bridge Lifecycle Maintenance Activity Costs through 2049

| Maintenance Treatment | 2020-2029* | 2030-2034* | 2035-2039* | 2040-2044* | 2045-2049* |
|-----------------------------|----------------------|----------------------|------------------------|----------------------|----------------------|
| Seal Deck/Replace Joints | \$54,780,000 | \$2,200,000 | \$660,000 | \$1,100,000 | \$4,840,000 |
| Deck Overlay/Replace Joints | \$249,260,000 | \$168,190,000 | \$122,210,000 | \$179,080,000 | \$12,100,000 |
| Bridge Rehab | \$265,650,000 | \$217,350,000 | \$710,010,000 | \$347,760,000 | \$647,220,000 |
| Replace Bridge | \$61,040,000 | \$167,860,000 | \$282,310,000 | \$152,600,000 | \$190,750,000 |
| Total | \$630,730,000 | \$555,600,000 | \$1,115,190,000 | \$680,540,000 | \$854,910,000 |

*Costs shown in 2019 dollars

Quiet Pavement Maintenance

Approximately 277 miles (2,370 lane miles) of freeways in the urban areas of Maricopa County have “quiet pavement” treatments to reduce freeway noise resulting from vehicle tires on pavement. The current treatment for quiet pavement is an Asphalt Rubber – Asphalt Concrete Friction Course (AR-ACFC) overlay. Replacement of the AR-ACFC overlay is estimated to be required every ten years to maintain its effectiveness and is an ongoing maintenance expense that needs to be accounted for in long-term pavement maintenance costs.

Table 6 shows the estimated costs of replacing the AR-ACFC on freeways within Maricopa County per 5-year funding cycle based on the age of the various pavement in the region. ADOT estimates a unit cost for an AR-ACFC overlay is \$171,000 per lane mile, with the unit cost including pavement removal, materials, traffic control, pavement markings, construction administration, and contingency. This data was provided by ADOT Management based on recent historical data from Interstate 17 (I-17) and I-10 AR-ACFC replacement.

Similar to the bridge maintenance costs, the costs identified in the first column include pavement overlay costs that would be required between 2020 and 2029, while the rest of the columns show a 5-year cost. Costs are shown this way because there is no programmed funding to complete the identified pavement maintenance in 2020-2024, so those costs are shown to be deferred until the funding period starting in 2025.

Table 6 – Estimated ADOT AR-ACFC Overlay Replacement Costs through 2049

| Roadway Type | 2020-2029* | 2030-2034* | 2035-2039* | 2040-2044* | 2045-2049* |
|--------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| State Route Lanes | \$338,152,500 | \$170,521,200 | \$167,631,300 | \$170,521,200 | \$167,631,300 |
| U.S. Highway Lanes | \$64,535,400 | \$32,558,400 | \$31,977,000 | \$32,558,400 | \$31,977,000 |
| Interstate Lanes | \$183,004,200 | \$43,331,400 | \$139,672,800 | \$43,331,400 | \$139,672,800 |
| Total | \$585,692,100 | \$246,411,000 | \$339,281,100 | \$246,411,000 | \$339,281,100 |

*Costs shown in 2019 dollars

Other District Maintenance Costs

As noted previously, the Central District is not the only ADOT district that is responsible for maintenance of roadways within Maricopa County. The Southwest District also covers a significant land area within Maricopa County and the Northwest, Northcentral, and Southeast Districts are also responsible for small roadway segments in Maricopa County. To understand the complete picture of maintenance costs for roadways in Maricopa County, a methodology was developed to capture the estimated maintenance costs incurred within Maricopa County by the other districts outside of the Central District.

It was calculated that the Central District is responsible for about 59% of the ADOT facility miles in Maricopa County (468 out of 790 roadway centerline miles), but 75% of the ADOT facility lane-miles in Maricopa County (estimated at 3,225 out of 4,293 lane miles). This is because one roadway mile of freeway within the Phoenix metro area has many more lane-miles than one roadway mile outside of the urban area due to having a greater number of lanes.

With 25% of the ADOT facility lane-miles in Maricopa County being outside the Central District, an additional line item for Other Districts Maintenance was included in the total costs, which was computed as one-third (25/75) of the costs provided by the Central District.

3.4 Data Aggregation

Table 7 shows a summary of costs that aggregate the costs for each of the 5-year timeframes collected from the ADOT groups, the supplemental data, and resulting costs from data analyses.

Five-year estimates are provided in current (2019) dollars for ADOT assets in Maricopa County only and do not include any administrative costs associated with maintenance activities.

Table 7 – Summary of Historical and Projected ADOT Maintenance Costs

| Asset/Activity | 2015-2019 | 2020-2024* | 2025-2029* | 2030-2034* | 2035-2039* | 2040-2044* | 2045-2049* | Notes and Assumptions |
|--|---------------------|---------------------|----------------------|---------------------|---------------------|---------------------|---------------------|--|
| TSMO | | | | | | | | |
| Tunnels | \$4,905,130 | \$6,965,130 | \$6,965,130 | \$6,965,130 | \$6,965,130 | \$6,965,130 | \$6,965,130 | Annual budget multiplied by 5 for 2015-2019, then annual plus deferred for 2020-2049; deferred maintenance estimates and assumptions provided by TSMO |
| Pump Stations - Rehab | \$7,610,000 | \$2,400,000 | \$80,192,872 | \$- | \$- | \$- | \$- | Costs for 2015-2019 and 2020-2024 reflect costs for programmed projects; remaining costs reflect calculated pump station rehabilitation costs for remaining pump stations in Maricopa County, per ADOT Phoenix Area Pump Stations Lifecycle Pump Rehabilitation and Replacement Plan (June 2019), prepared for ADOT TSMO Group |
| Pump Stations - Maintenance | \$3,000,000 | \$3,000,000 | \$3,000,000 | \$3,000,000 | \$3,000,000 | \$3,000,000 | \$3,000,000 | Cost identified for regular, preventative maintenance on pump stations (not just major rehab) |
| Lighting | \$11,065,000 | \$22,295,000 | \$10,531,667 | \$10,531,667 | \$10,531,667 | \$10,531,667 | \$10,531,667 | Current high-pressure sodium (HPS) replacement every 2-3 years is \$7.5m per 5 years. Cost of LEDs every 15 years reduces 5-year costs to \$4.97M per 5 years (both have additional \$3.56M for unit 6204 staff charges per 5 years; this number could decrease with the improved service life of the LED). Faster conversion to LED will increase initial replacement costs |
| Signing/Marking | \$6,879,269 | \$24,995,638 | \$29,151,738 | \$22,812,038 | \$28,774,538 | \$29,158,238 | \$22,812,038 | Estimate includes replacement of sign and sign structure based on service life and existing condition |
| ITS | \$17,745,480 | \$39,271,213 | \$39,271,213 | \$39,271,213 | \$39,271,213 | \$39,271,213 | \$39,271,213 | Annual budget for traffic signals and ITS multiplied by 5 for 2015-2019, then annual plus deferred for 2020-2049; deferred maintenance estimates and assumptions provided by TSMO |
| <i>TSMO Subtotal</i> | <i>\$51,204,879</i> | <i>\$98,926,981</i> | <i>\$169,112,620</i> | <i>\$82,580,048</i> | <i>\$88,542,548</i> | <i>\$88,926,248</i> | <i>\$82,580,048</i> | |
| Central District | | | | | | | | |
| Pavement Maintenance (repair potholes, seal cracks, flush coat, mill & fill) | \$4,691,300 | \$5,160,430 | \$5,676,473 | \$6,244,121 | \$6,868,533 | \$7,555,386 | \$8,310,924 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Unpaved surface (Dust control) | \$301,013 | \$331,114 | \$364,225 | \$400,648 | \$440,712 | \$484,784 | \$533,262 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Shoulders (shoulder buildup, repair turnouts and crossovers) | \$236,075 | \$259,683 | \$285,651 | \$314,216 | \$345,637 | \$380,201 | \$418,221 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Vegetation control | \$2,715,134 | \$2,986,647 | \$3,285,312 | \$3,613,843 | \$3,975,228 | \$4,372,750 | \$4,810,026 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Roadside (Guardrail, fence repair, cattle guard, removal of dead animal) | \$2,953,133 | \$3,248,446 | \$3,573,291 | \$3,930,620 | \$4,323,682 | \$4,756,050 | \$5,231,655 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Emergency Response (Incident/crash response) | \$4,434,541 | \$4,877,995 | \$5,365,795 | \$5,902,374 | \$6,492,611 | \$7,141,873 | \$7,856,060 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Drainage (drainage maintenance, clean channels, hydro vacuum) | \$3,953,134 | \$4,348,447 | \$4,783,292 | \$5,261,621 | \$5,787,783 | \$6,366,562 | \$7,003,218 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Contracted Roadway Work (seal coat, flushing, Pavement milling, crack filling, remove and installation of guardrail, fence repair and installation, traffic control) | \$32,059,497 | \$35,265,447 | \$38,791,992 | \$42,671,191 | \$46,938,310 | \$51,632,141 | \$56,795,355 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Landscape (Trim, replace and remove trees & shrubs, chipping, herbicide spraying, irrigation repair, weed control) | \$16,368,301 | \$18,005,131 | \$19,805,644 | \$21,786,208 | \$23,964,829 | \$26,361,312 | \$28,997,443 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Contracted Landscape Work (Landscape maintenance, irrigation repair, tree trimming, landscape labor on-call, litter) | \$13,951,781 | \$15,346,959 | \$16,881,655 | \$18,569,821 | \$20,426,803 | \$22,469,483 | \$24,716,431 | 10% increase every 5 years to account for anticipated exponential deterioration |

| Asset/Activity | 2015-2019 | 2020-2024* | 2025-2029* | 2030-2034* | 2035-2039* | 2040-2044* | 2045-2049* | Notes and Assumptions |
|--|----------------------|----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|---|
| Materials (herbicides, irrigation, patching, guardrail, crash attenuator, fence) | \$7,500,000 | \$8,250,000 | \$9,075,000 | \$9,982,500 | \$10,980,750 | \$12,078,825 | \$13,286,708 | 10% increase every 5 years to account for anticipated exponential deterioration |
| SRP Siphon @ 10% every 5 years | \$750,000 | \$825,000 | \$907,500 | \$998,250 | \$1,098,075 | \$1,207,883 | \$1,328,671 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Special Line Item (SLI) – small scale pavement maintenance | \$3,100,000 | \$26,000,000 | \$26,000,000 | \$26,000,000 | \$26,000,000 | \$26,000,000 | \$26,000,000 | \$5.2M per year starting in 2020 (legislative apportionment) for small-scale pavement maintenance (flush seas, crack seals, limited micro-seals) |
| RTP landscape/sweeping/litter/graffiti | \$64,200,000 | \$67,800,000 | \$74,580,000 | \$82,038,000 | \$90,241,800 | \$99,265,980 | \$109,192,578 | 10% increase every 5 years to account for anticipated exponential deterioration |
| Irrigation replacement for 31 miles. | \$- | \$- | \$27,000,000 | \$- | \$- | \$- | \$- | Central District Special Needs if funding is available |
| Irrigation communication (replace controllers systemwide) | \$- | \$- | \$3,661,013 | \$- | \$- | \$- | \$- | One-time replacement assumed |
| Replacing Sweepers (5) every 10 years | \$- | \$- | \$1,500,000 | \$- | \$- | \$1,500,000 | \$- | Based on historic replacement interval |
| Hydrovac \$500K per year per crew (1 additional crew) | \$- | \$- | \$3,190,000 | \$2,750,000 | \$3,025,000 | \$3,327,500 | \$3,660,250 | Based on annual cost of existing Hydrovac crew |
| Maintaining additional lanes miles | \$- | \$1,821,576 | \$2,003,734 | \$2,204,107 | \$2,424,518 | \$2,666,970 | \$2,933,667 | 10% increase every 5 years to account for new lane miles added to the system |
| Central District Subtotal | \$157,213,909 | \$194,526,876 | \$246,730,577 | \$232,667,520 | \$253,334,272 | \$277,567,699 | \$301,074,469 | |
| Bridge | | | | | | | | |
| Bridge inspection and minor repair program | \$6,500,000 | \$6,500,000 | \$6,500,000 | \$6,500,000 | \$6,500,000 | \$6,500,000 | \$6,500,000 | 16% of annual \$8 million allocation, since 16% of statewide structures are in Maricopa County |
| Bridge rehab | \$8,760,350 | \$11,005,000 | \$7,500,000 | \$10,000,000 | \$11,000,000 | \$12,100,000 | \$13,300,000 | Includes activities related to minor bridge rehab and bridge reconstruction; 10% increase every 5 years after 2029 based on 2015-2029 average costs to account for anticipated exponential deterioration |
| Bridge rehab and replacement per life cycle treatment regime | \$- | \$- | \$630,730,000 | \$555,600,000 | \$1,115,190,000 | \$680,540,000 | \$854,910,000 | Based on ADOT's Initial Asset Management Plan (Sep. 2018) and average square footage of bridges; maintenance needs for 2020-2024 shown being funded in 2025-2029 because not currently programmed |
| Bridge Subtotal | \$15,260,350 | \$17,505,000 | \$644,730,000 | \$572,100,000 | \$1,132,690,000 | \$699,140,000 | \$874,710,000 | |
| Pavement | | | | | | | | |
| Pavement Preservation/Rehab | \$126,661,000 | \$158,855,000 | \$174,740,500 | \$192,214,550 | \$211,436,005 | \$232,579,606 | \$255,837,566 | Based on 5-year Construction Program documents through 2024 and then 10% increase every 5 years starting in 2025 to account for anticipated exponential deterioration |
| Quiet Pavement (AR-ACFC overlay) | \$- | \$- | \$585,692,100 | \$246,411,000 | \$339,281,100 | \$246,411,000 | \$339,281,100 | Based on spreadsheet from ADOT (AR-ACFC 4-1-2019.xlsx); maintenance needs for 2020-2024 shown being funded in 2025-2029 because not currently programmed |
| Pavement Subtotal | \$126,661,000 | \$158,855,000 | \$760,432,600 | \$438,625,550 | \$550,717,105 | \$478,990,606 | \$595,118,666 | |
| Other | | | | | | | | |
| Rest Area Maintenance | \$3,500,000 | \$3,500,000 | \$3,500,000 | \$3,500,000 | \$3,500,000 | \$3,500,000 | \$3,500,000 | ADOT Rest Area Maintenance Contract currently shows \$17.7M for 25 rest areas for day-to-day operations/maintenance for a 5-year period (comes out to \$3.5M for the 5 rest areas in Maricopa County for 5 years) |
| Rest Area Rehab | \$- | \$10,990,000 | \$- | \$5,000,000 | \$- | \$10,000,000 | \$- | Assumes \$5M per rehab; Burnt Well in 2030-2034 (last rehab in FY 2013, assume 20-year rotation), and Sentinel and Hassayampa in 2040-2044 (Sentinel is programmed for FY 2020 and Hassayampa is programmed for FY 2023) |
| Other Districts: Estimated Maintenance in Maricopa County | \$19,418,463 | \$21,360,309 | \$23,496,340 | \$25,845,974 | \$28,430,571 | \$31,273,629 | \$34,400,991 | Assumes 25% of Central District maintenance costs for: Pavement Maintenance; Unpaved Surface (Dust Control); Shoulders; Vegetation Control; Roadside; Emergency Response; Drainage; Contracted Roadway Work; and Materials; then 10% increase every 5 years starting in 2025 to account for anticipated exponential deterioration |
| Other Subtotal | \$22,918,463 | \$35,850,309 | \$26,996,340 | \$34,345,974 | \$31,930,571 | \$44,773,629 | \$37,900,991 | |
| Combined Total | \$373,258,601 | \$505,664,166 | \$1,848,002,137 | \$1,360,319,092 | \$2,057,214,497 | \$1,589,398,182 | \$1,891,384,175 | |

*2020-2049 costs shown in 2019 dollars

4 SUMMARY OF FINDINGS

Based on the findings from **Table 7**, **Table 8** summarizes the historical (2015-2019), programmed (2020-2024), and projected (2025-2049) maintenance costs. Maintenance costs are shown for each timeframe both as total maintenance costs as well as average annual maintenance costs.

Table 8 – ADOT Maintenance Costs in Maricopa County (2015-2049)

| Timeframe | Type of Cost | Cost |
|-------------------------|---|-----------------|
| Historical (2015-2019) | Total maintenance costs | \$373,258,601 |
| | Average annual maintenance costs | \$74,651,720 |
| Programmed (2020-2024)* | Total maintenance costs | \$505,664,166 |
| | Average annual maintenance costs | \$101,132,833 |
| Projected (2025-2049)* | Total needed maintenance costs | \$8,746,318,082 |
| | Average annual needed maintenance costs | \$349,852,723 |

*2020-2049 costs shown in 2019 dollars

Factors contributing to the significant increase between currently programmed (2020-2024) and future projected (2025-2049) costs for maintenance include:

- Infrastructure is aging, requiring more frequent and more expensive maintenance activities; and
- Projected maintenance costs account for all required maintenance for ADOT facilities in Maricopa County, including activities needed in 2020-2024 but that could not be programmed with the available funds and as such were deferred. These costs are instead shown within the next projected 5-year period (2025-2029).

These total costs equate to the average annual per-lane-mile costs for maintenance for each of the 5-year periods shown in **Table 9** and **Figure 2**.

Table 9 – Average Annual Per-Lane-Mile ADOT Maintenance Costs in Maricopa County (2015-2049)

| Timeframe | Total ADOT lane miles in Maricopa County | Average Annual Maintenance Cost per Lane Mile |
|-----------|--|---|
| 2015-2019 | 4,293 | \$17,389 |
| 2020-2024 | 4,535 | \$22,301 |
| 2025-2029 | 4,950 | \$74,667 |
| 2030-2034 | 5,087 | \$53,482 |
| 2035-2039 | 5,360 | \$76,762 |
| 2040-2044 | 5,667 | \$56,093 |
| 2045-2049 | 5,992 | \$63,130 |

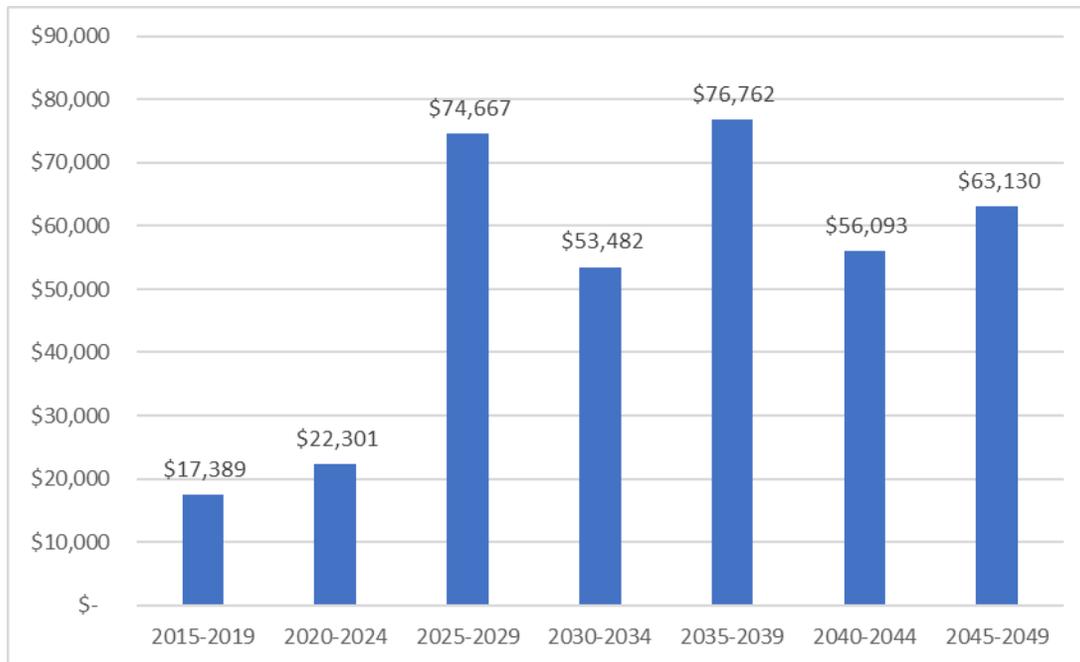


Figure 2 – Average Annual Per-Lane-Mile ADOT Maintenance Costs in Maricopa County (2015-2049)

As noted previously, the significant increase in costs between currently programmed (2020-2024) and future projected (2025-2049) costs is a result of both aging infrastructure in Maricopa County and the fact that the projected costs account for all needed maintenance activities without considering budget constraints that impacted the costs for maintenance that were considered in the historical (2015-2019) and programmed (2020-2024) periods.

When considering the average annual per-lane-mile cost of maintenance for each of the 5-year periods in the future non-programmed years (2025-2049), the 25-year average annual projected per-lane-mile cost of maintenance is \$64,827. This cost is about 3.7 times higher than the average annual per-lane-mile maintenance cost spent historically (\$17,389 per year between 2015-2019) and 2.9 times higher than the average annual per-lane-mile maintenance cost that is programmed (\$22,301 per year between 2020-2024).

This average annual per-lane-mile cost allows comparison of projected maintenance costs to historical costs identified in the current practices review (see *Section 2.2* of this report). The *23rd Annual Highway Report on the Performance of State Highway Systems* reported that ADOT spent an average of \$64,914 per lane-mile statewide on maintenance in 2015. Using the National Highway Construction Cost Index (NHCCI) maintained by the Federal Highway Administration (FHWA), \$64,914 in 2015 dollars is equivalent to \$69,543 in 2019 dollars. This is comparable to the projected 25-year average per-lane-mile cost calculated for the ADOT network within Maricopa County, which equates to \$64,506 per lane-mile in 2019 dollars.

This similarity in magnitude suggests that, within Maricopa County, ADOT’s maintenance needs on a per-lane-mile basis between 2025 and 2049 are anticipated to be similar to ADOT’s historical 2015 statewide maintenance needs on a per-lane-mile basis.

The projected ADOT maintenance costs are also found to be in-line with reported costs from other DOTs throughout the country. Because NJDOT was the only other comparable source of maintenance cost information identified during the current practices review, the ADOT numbers were compared to those identified by NJDOT. The previously referenced nationwide average per-lane-mile cost of \$67,248 in 2015 dollars, which is equivalent to \$72,043 in 2019 dollars, and the NJDOT statewide average per-lane-mile cost of \$64,465 in 2014 dollars, which is equivalent to \$72,964 in 2019 dollars, are of the same magnitude as the projected per-lane-mile cost for ADOT

facilities in Maricopa County. This suggests that the projected maintenance cost for ADOT facilities in Maricopa County is reasonable and comparable to maintenance costs in other parts of the country.

Figure 3 shows the total and average annual maintenance costs based on known (2015-2024) and projected (2025-2049) costs.

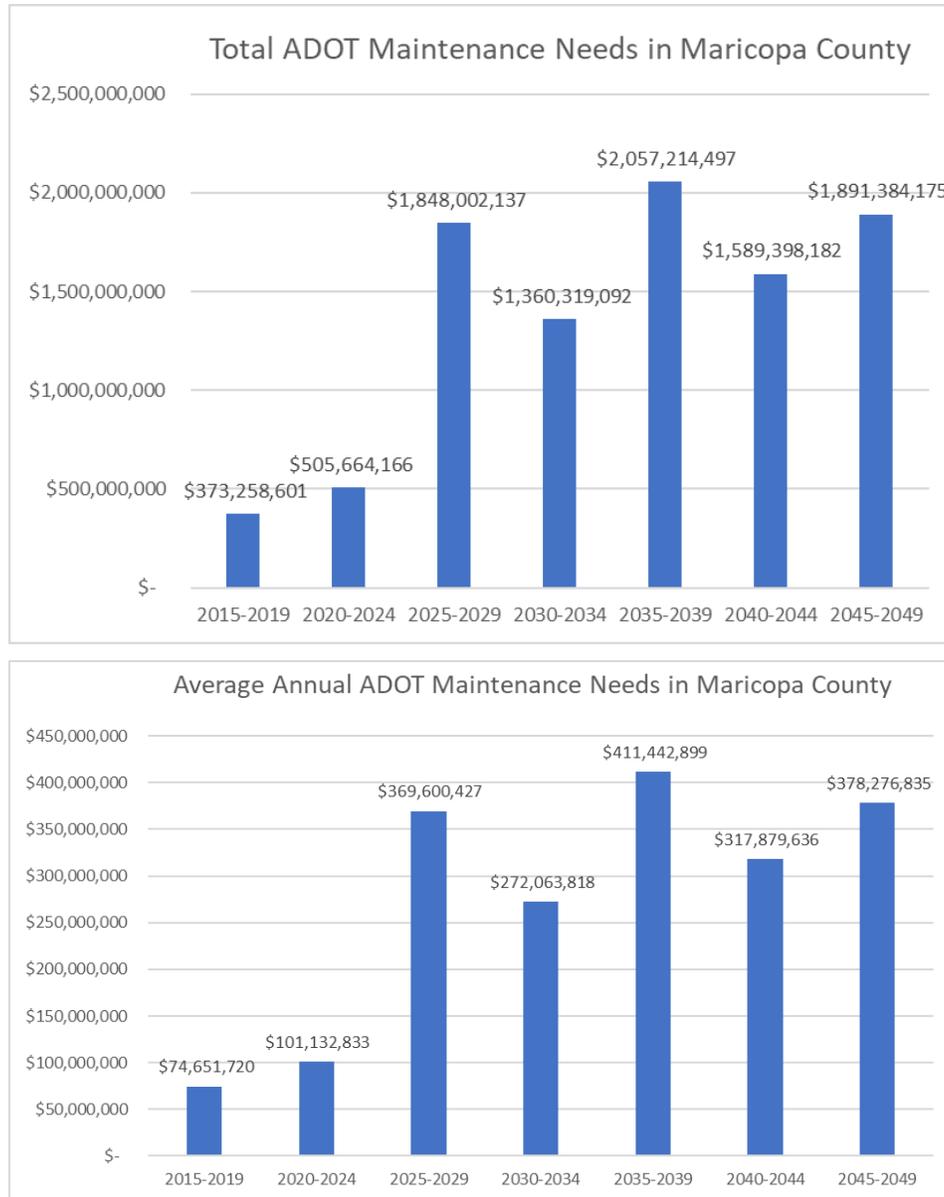


Figure 3 – Known and Projected Total and Average Annual ADOT Maintenance Costs in Maricopa County

The large increase in costs is primarily a result of much higher identified maintenance needs for pavement and bridges in Maricopa County than has historically been seen. This is exemplified by the gray and yellow bars in **Figure 4**. This is largely due to aging infrastructure that requires higher-cost maintenance activities, such as the AR-ACFC pavement overlays to maintain quiet pavement, and more frequent bridge rehab or replacement needs as the bridges constructed in the last few decades begin to deteriorate. The latter condition of large-scale bridge deterioration is clearly seen in years 2035-2039, which is when around 150 bridges built between 1986 and 1990 (see **Figure 5**) will require major rehab, resulting in a cost of more than \$700 million (circled in red in **Figure 6**).

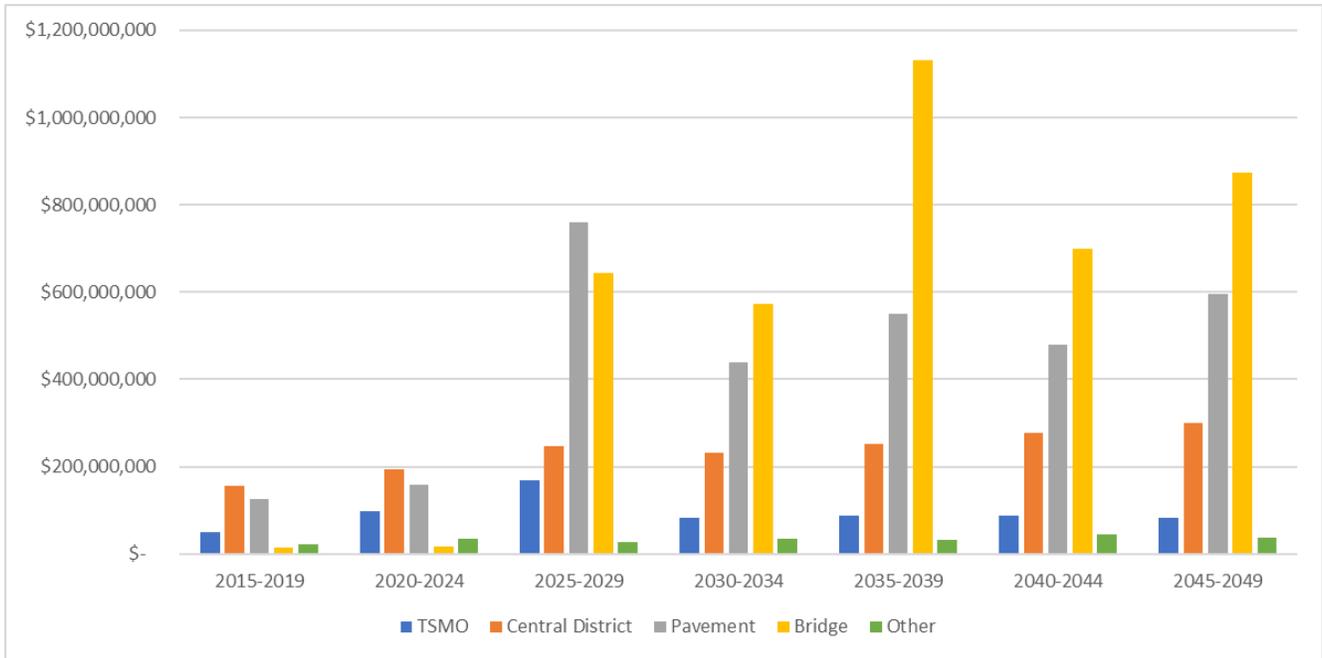


Figure 4 – Known and Projected ADOT Maintenance Costs in Maricopa County by Category

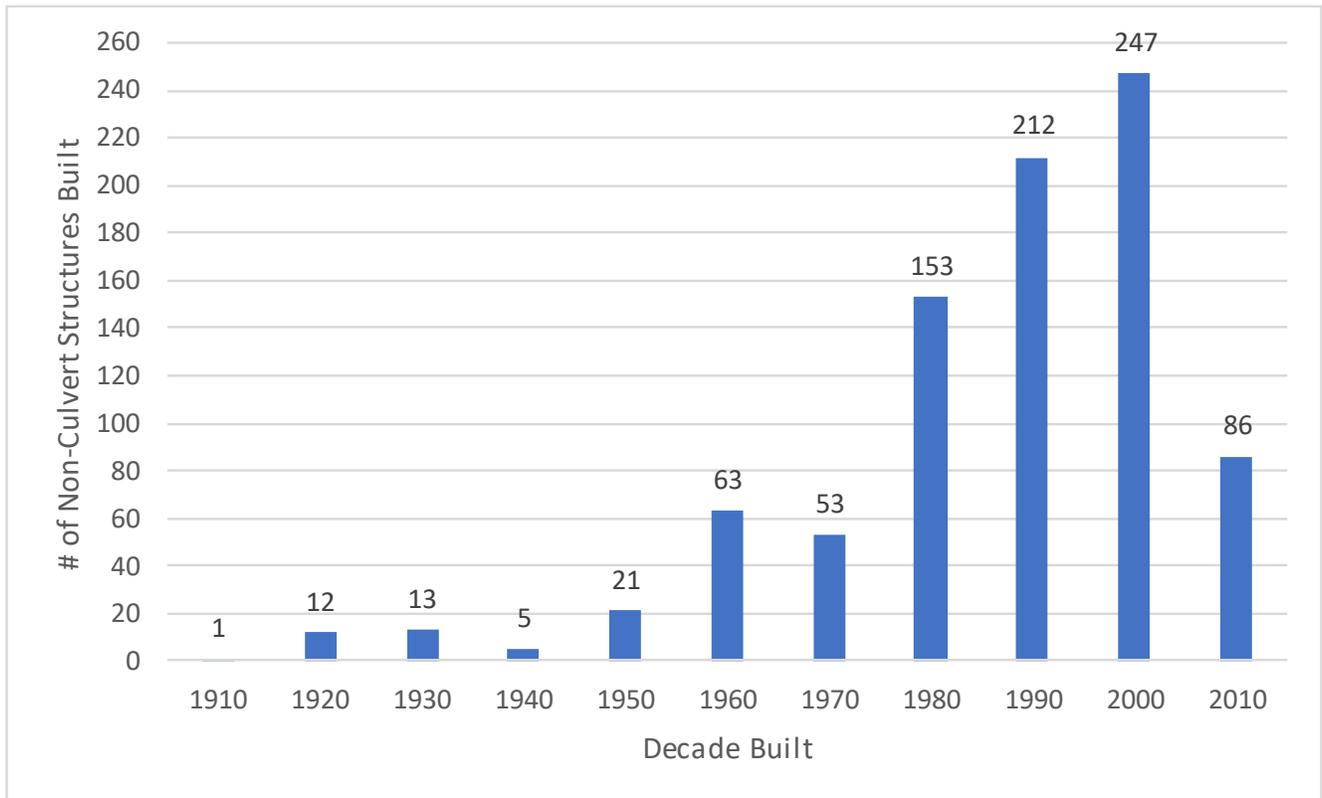


Figure 5 – Age of ADOT Facility Bridges in Maricopa County (as of 2018)

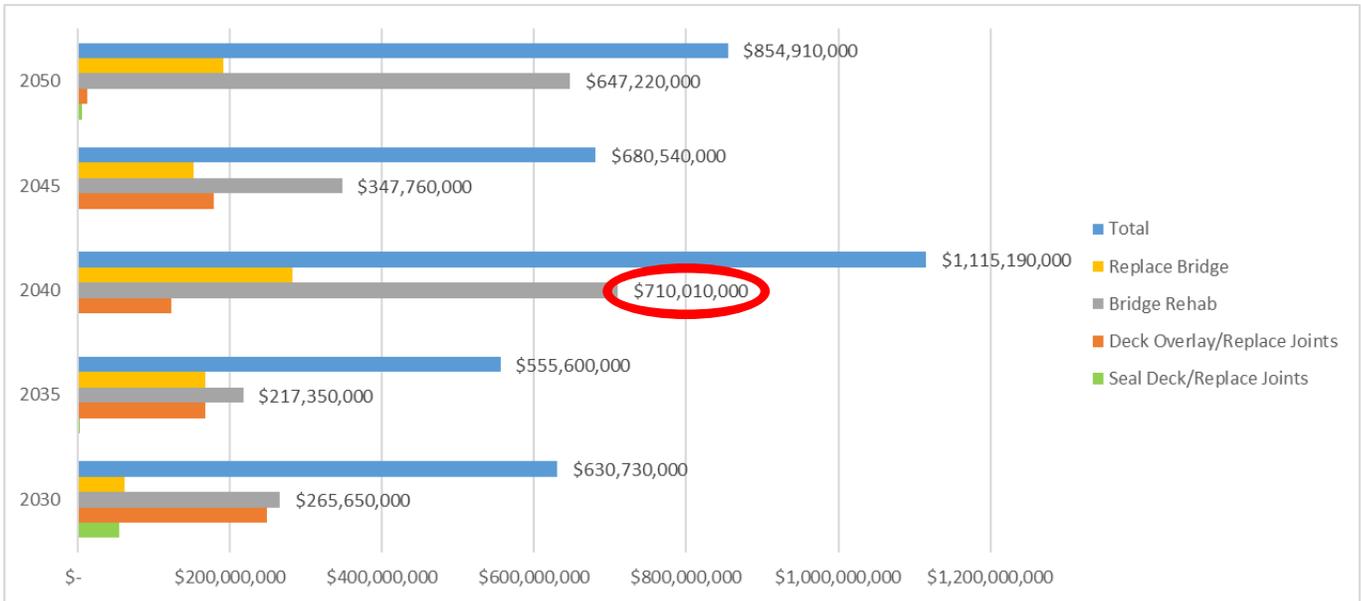


Figure 6 – Bridge Lifecycle Maintenance Cost Projections

Another factor that contributes to the much higher maintenance costs identified for 2025 and beyond is the fact that costs shown before 2025 are those that were actually funded or are programmed to be completed. The costs shown starting in 2025 are unconstrained, and thus reveal the magnitude of actual maintenance needs in Maricopa County, as opposed to the maintenance needs that can be met with available funding.

5 FUNDING IMPLICATIONS

As already noted, maintenance needs for ADOT facilities within Maricopa County are projected to be at levels significantly higher than historical levels (3.7 times higher) and programmed levels (2.9 times higher) starting in 2025. While previous regional transportation planning efforts have emphasized growing and expanding the ADOT network in Maricopa County, the findings from this study indicate a need to re-prioritize and re-allocate future funding (or find new revenue sources beyond the extension of the half-cent sales tax) to ensure existing ADOT facilities can continue to operate safely and efficiently and avoid going into a state of disrepair. This needed recalibration of funding priorities to place more emphasis on maintenance and preservation is similar to what ADOT went through at the statewide level a few years ago when updating the ADOT long-range transportation plan.

5.1 ADOT Major Investment Types

The *ADOT 2040 Long-Range Transportation Plan (LRTP)*, completed in 2018, identifies three categories of transportation investments for ADOT:

- **Preservation** – Activities that preserve transportation infrastructure by sustaining asset condition or extending asset service life;
- **Modernization** – Improvements that upgrade efficiency, functionality, and safety without adding capacity; and
- **Expansion** – Improvements that add transportation capacity through the addition of new facilities and/or services.

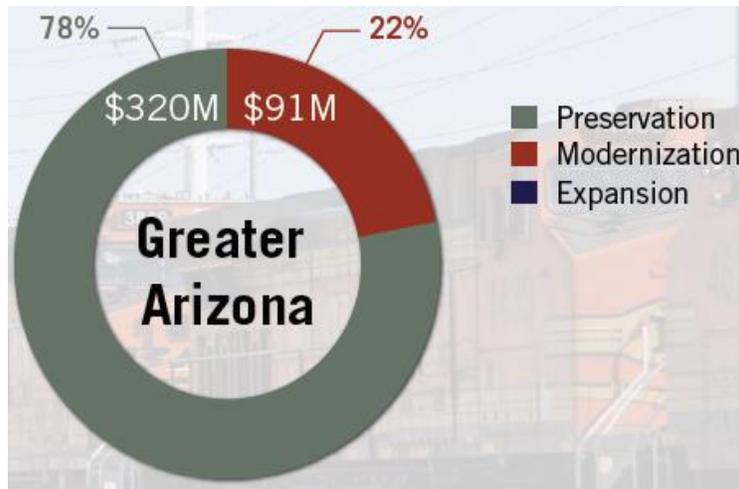
Figure 7 shows the annual allocation of funding in the current MAG RTP for each of these three categories. The MAG region has historically allocated 87.5% of funds to expansion of the ADOT freeway/highway network in the MAG region (which includes all of Maricopa County and portions of Pinal County) and only 1.5% to preservation. This is largely due to the fact that voters in Maricopa County approved a dedicated funding source, through Proposition 400, to pay for higher levels of highway system expansion than would be possible through available federal and state funding sources.



Source: *ADOT 2040 Long-Range Transportation Plan (2018)*

Figure 7 – Estimated Annual RTP Spending in the MAG Region

In contrast, **Figure 8** shows the annual investment spending allocation that is recommended in the 2040 LRTP for ADOT facilities outside of the Phoenix (MAG) and Tucson (PAG) metropolitan areas, where 78% of funds are directed toward preservation (maintenance) activities and no state funding is allocated to expansion of roadways.



Source: ADOT 2040 Long-Range Transportation Plan (2018)

Figure 8 – ADOT L RTP Recommended Annual Highway Spending in Arizona Outside of MAG and PAG Programs

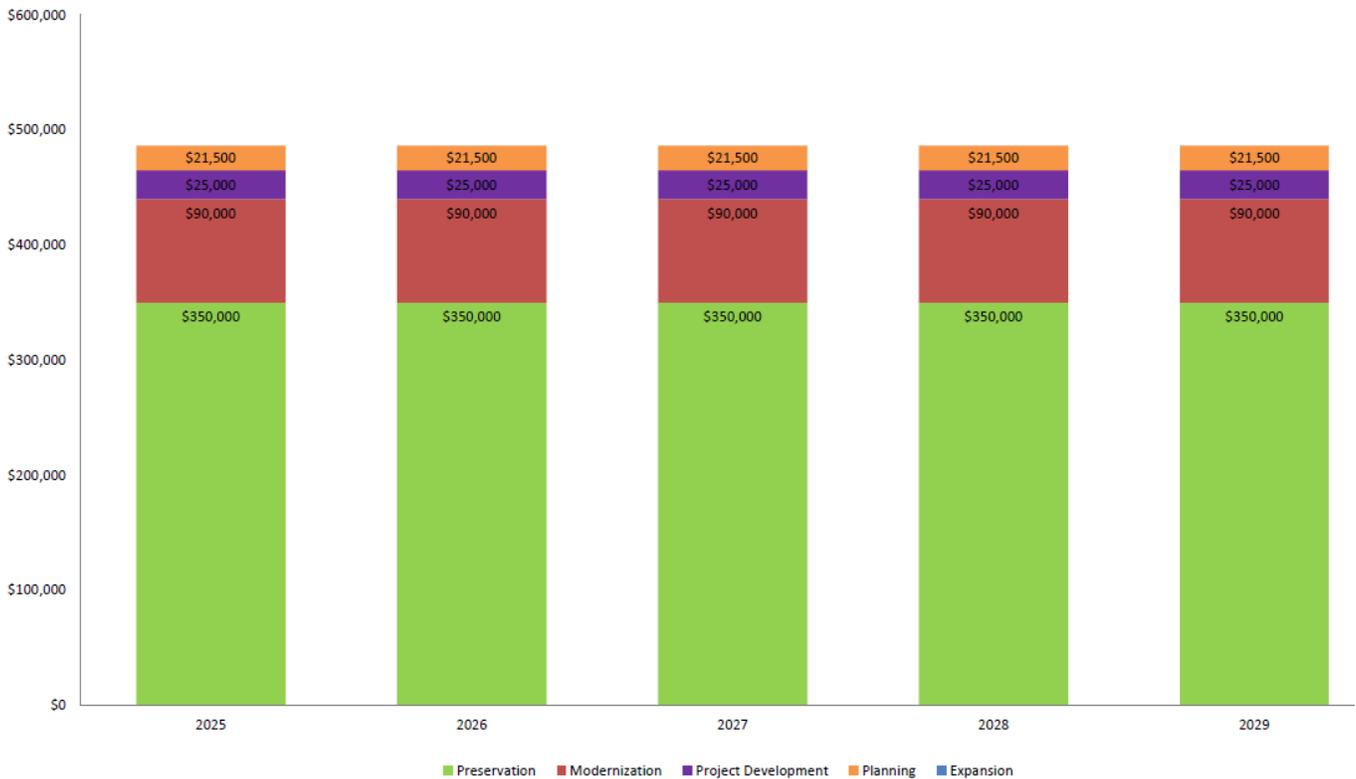
Figure 9 and **Figure 10** are both from the 2020-2024 Statewide ADOT 5-Year Construction Program. **Figure 9** shows a breakdown of 2020-2024 investment spending programmed on ADOT facilities statewide outside of the MAG and PAG programs. **Figure 10** shows the preliminary projected 2025-2029 allocation of funding by investment category for the ADOT facilities statewide outside of the MAG and PAG programs. These figures show ADOT’s focus on system preservation and modernization, with the funding allocated to system expansion generally decreasing over time. This further shows that the focus on expansion that has been seen in the MAG region is a direct result of the use of regional funding mechanisms, largely the Proposition 400 sales tax money, rather than any state-specific funding.

Note: Costs are in Thousands of Dollars

| | | 2020 | 2021 | 2022 | 2023 | 2024 | Total |
|--------------|---------------------|------------------|------------------|------------------|------------------|------------------|--------------------|
| Statewide | Expansion | \$142,875 | \$141,127 | \$110,907 | \$50,000 | \$56,200 | \$501,109 |
| | Modernization | \$58,739 | \$47,994 | \$16,760 | \$4,507 | \$0 | \$128,000 |
| | Preservation | \$210,832 | \$240,146 | \$214,639 | \$60,363 | \$32,900 | \$758,880 |
| | Total | \$412,446 | \$429,267 | \$342,306 | \$114,870 | \$89,100 | \$1,387,989 |
| Subprograms | Modernization | \$21,263 | \$18,560 | \$66,007 | \$81,349 | \$86,456 | \$273,635 |
| | Planning | \$21,500 | \$21,500 | \$21,500 | \$21,500 | \$21,500 | \$107,500 |
| | Preservation | \$16,472 | \$42,833 | \$47,683 | \$248,773 | \$236,693 | \$592,454 |
| | Project Development | \$20,051 | \$23,052 | \$23,422 | \$23,422 | \$22,822 | \$112,769 |
| | Total | \$79,286 | \$105,945 | \$158,612 | \$375,044 | \$367,471 | \$1,086,358 |
| Total | | \$491,732 | \$535,212 | \$500,918 | \$489,914 | \$456,571 | \$2,474,347 |

Source: 2020-2024 Statewide ADOT 5-Year Construction Program (2019)

Figure 9 – 2020-2024 Statewide 5-Year Construction Program Excluding MAG and PAG Programs



Source: 2020-2024 Statewide ADOT 5-Year Construction Program (2019)

Figure 10 – 2025-2029 Statewide Preliminary 5-Year Construction Program Excluding MAG and PAG Programs

5.2 Future Preservation Spending in Maricopa County

To address the magnitude of maintenance needs identified for Maricopa County starting in 2025, there may need to be a transition from an expansion-focused regional transportation investment strategy to more of a preservation-focused strategy along with an increase in the availability of regional funding.

Figure 11 shows the MAG RTP Freeway/Highway Program breakdown for 2020-2024. There are no programmed costs at this time for 2024, thus the table omits 2024. The total cost of the 5-year program is around \$1.6 billion, which includes \$1.5 billion of regional funding (Proposition 400 half-cent sales tax) and \$0.1 billion of statewide funding, with about 95% of the funding dedicated to expansion projects.

By comparison, the projected maintenance cost calculated in this study for ADOT facilities in Maricopa County is \$1.8 billion for 2025-2029, which exceeds the entire anticipated regional funding available for the freeway/highway program in the MAG region during that same 5-year period, assuming an extension of Proposition 400 occurs.

Said another way, if projected maintenance costs on ADOT facilities in Maricopa County are funded entirely by an extension of the county half-cent sales tax, there would be limited regional funding for multimodal modernization or expansion projects, unless additional funding is identified.

Note: Costs are in Thousands of Dollars

| | | 2020 | 2021 | 2022 | 2023 | Total |
|--------------|-----------------------------|------------------|------------------|------------------|------------------|--------------------|
| RTPFP | SR 30, TRES RIOS | \$57,404 | \$0 | \$222,000 | \$0 | \$279,404 |
| | I-10, PAPAGO | \$91,700 | \$0 | \$0 | \$0 | \$91,700 |
| | I-10, MARICOPA | \$15,200 | \$484,000 | \$15,000 | \$12,500 | \$526,700 |
| | I-17, BLACK CANYON | \$76,500 | \$68,850 | \$27,000 | \$68,150 | \$240,500 |
| | SR 24, GATEWAY FREEWAY | \$71,070 | \$0 | \$0 | \$0 | \$71,070 |
| | US 60, GRAND AVENUE | \$0 | \$0 | \$0 | \$3,000 | \$3,000 |
| | US 60, SUPERSTITION | \$30,400 | \$0 | \$0 | \$0 | \$30,400 |
| | SR 85 | \$5,300 | \$0 | \$0 | \$0 | \$5,300 |
| | SR 101L, AGUA FRIA | \$0 | \$1,200 | \$3,800 | \$22,400 | \$27,400 |
| | SR 101L, PIMA | \$60,634 | \$0 | \$0 | \$0 | \$60,634 |
| | SR 202L, RED MOUNTAIN | \$0 | \$1,000 | \$4,000 | \$0 | \$5,000 |
| | SR 202L, SANTAN | \$0 | \$22,162 | \$6,000 | \$0 | \$28,162 |
| | SR 202L, SOUTH MOUNTAIN | \$698 | \$712 | \$6,796 | \$740 | \$8,946 |
| | SR 303L, BOB STUMP MEMORIAL | \$156,300 | \$150 | \$0 | \$1,300 | \$157,750 |
| | Total | | \$538,706 | \$604,574 | \$284,596 | \$108,090 |
| SYSTEMWIDE | SYSTEMWIDE | \$26,062 | \$26,248 | \$26,439 | \$26,665 | \$105,414 |
| | Total | \$26,062 | \$26,248 | \$26,439 | \$26,665 | \$105,414 |
| Total | | \$591,268 | \$604,322 | \$311,035 | \$134,755 | \$1,641,380 |

Source: 2020-2024 Statewide ADOT 5-Year Construction Program (2019)

Figure 11 – 2020-2024 MAG RTP Freeway Program

Figure 12 shows the comparison of expected maintenance costs for each 5-year period between 2020 and 2049, as identified in the study, to the projected revenue available for maintenance (using 2015-2019 costs as the baseline revenue for what would be available to spend on maintenance for ADOT facilities in Maricopa County).

As noted in the graphic, if future revenue levels stay at historical levels, there will be a revenue shortage of as much as \$1.6 billion in each 5-year period based on the projected maintenance needs.

Figure 13 shows the cumulative shortage in projected revenue for maintenance between 2020 and 2049, assuming that no additional revenue becomes available for use on maintenance above the 2015-2019 level.

By 2049, it is estimated that there will be a cumulative revenue shortfall of more than \$7 billion, meaning there will be more than \$7 billion in needed maintenance costs in Maricopa County that cannot be funded if projected revenue available for maintenance stays at historical levels.

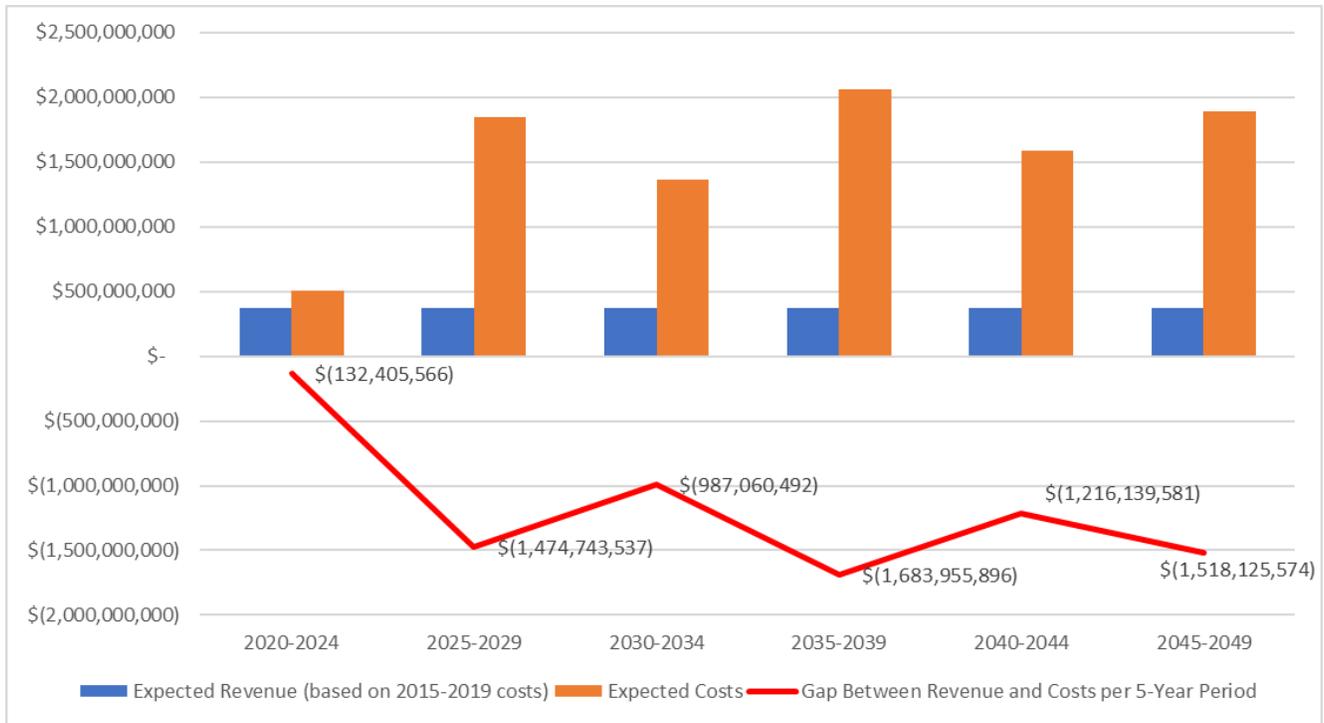


Figure 12 – Comparison of Expected Revenue Versus Identified Maintenance Costs Per 5-Year Period

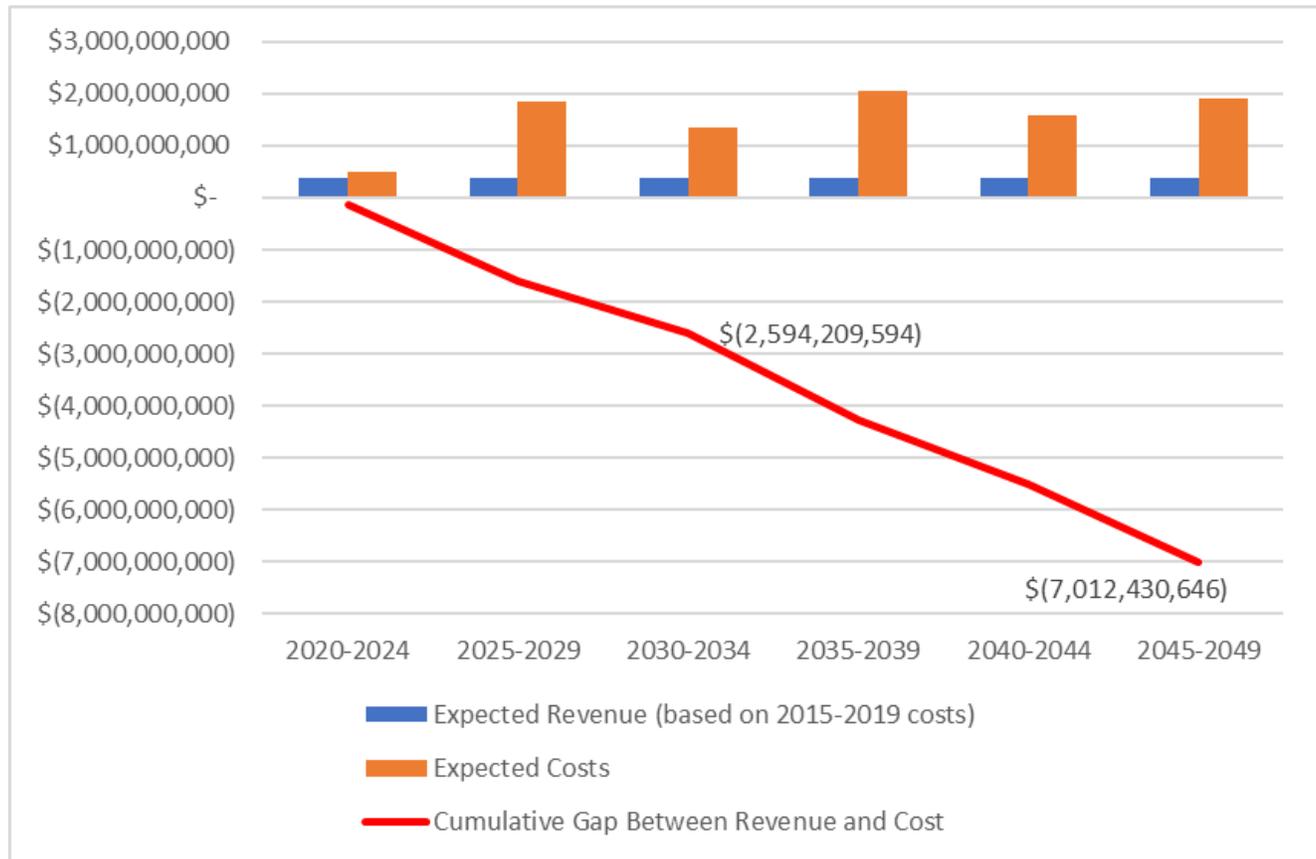


Figure 13 – Cumulative Gap Between Expected Revenue and Identified Maintenance Costs (2020 – 2049)

APPENDIX A – UNIT COST CALCULATION FOR BRIDGE LIFECYCLE MAINTENANCE COSTS

To estimate the cost of different bridge maintenance treatments, a unit cost for each treatment was developed based on a per-square-foot cost of the treatment. Two sources of information from ADOT identified relative per-square-foot costs for different bridge maintenance treatments were referenced – the *2018 ADOT Initial Transportation Asset Management Plan* and the *2016 ADOT Bridge Group Bridge Preservation Program* report. The specific tables from these documents where unit per-square-foot costs are identified are provided below.

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

| Treatment Type | Service Schedule (Years) | Unit Cost (\$ per sq. ft. or linear ft.) | Total Cost \$ (20,000 sq. ft.) | Present Value \$ |
|-----------------------------|--------------------------|--|--------------------------------|--------------------|
| New Construction | 0 | 420 SF | 8,400,000 | 8,400,000 |
| Seal Deck/Replace Joints | 15 | 5 SF/175 LF | 131,500 | 79,638 |
| Deck Overlay/Replace Joints | 30 | 35 SF/175 LF | 731,500 | 268,286 |
| Bridge Rehabilitation | 50 | 150 SF | 3,000,000 | 563,760 |
| Replace Bridge | 75 | 420 SF | 8,400,000 | 684,288 |
| Net Present Value | | | | \$9,995,972 |

* Fictitious – For illustrative purposes.

Source: *ADOT Initial Transportation Asset Management Plan (2018)*

| Type of Activity | Condition Rating Upgrade | Cost in \$ per Square feet |
|------------------------|--------------------------------|----------------------------|
| Preventive Maintenance | Satisfactory (6) to Good (9-7) | 10 - 50 |
| Rehabilitation | Poor/Fair (5-4) to Good (9-7) | 150 – 200 |
| Rehabilitation | Poor (4 or less) to Fair (6-5) | 50 - 150 |
| Replacement | Poor (4 or less) to Good (9-7) | 200 – 300 |

Source: *ADOT Bridge Group Bridge Preservation Program (2016)*

Taking into account the costs in these two sources, plus input from the ADOT Bridge Group on costs, the following per-square-foot costs were developed for the different bridge maintenance treatments:

- \$10/SF for Seal Deck/Replace Joints;
- \$50/SF for Deck Overlay/Replace Joints;
- \$200/SF for Bridge Rehabilitation; and
- \$300/SF for Bridge Replacement.

The average square footage of Maricopa County bridges for the first three maintenance treatments (deck seal, deck overlay, and bridge rehab) was calculated to be 24,126 square feet. This was calculated based on the reported square footage of each Maricopa County structure per the 2018 ADOT Bridge Inventory. The average square footage of Maricopa County bridges for bridge replacement costs was calculated using the following factors:

- The reported width of the bridge or the width of the roadway approach, whichever was larger per the ADOT Bridge Inventory (2018); and
- An additional three feet was included for the barrier on the bridge as it is not accounted for in the width.

Using this information, the average square footage of Maricopa County bridges for bridge replacement treatments was calculated to be 25,423 square feet.

Using the per-square-foot costs from the ADOT documents and the calculated average square footage for bridges in Maricopa County based on bridge inventory data provided by the ADOT Bridge Group, the unit costs for the different maintenance treatments shown previously in **Table 4** were calculated.