Performance Audit

Maricopa Association of Governments
Regional Transportation Plan

November 2016

Submitted To:

Debra Davenport, Auditor General
Office of the Auditor General
2910 N. 44th Street, Suite 410
Phoenix, AZ 85018

Submitted By:

SJOBERG EVASHENK CONSULTING, INC

455 Capitol Mall•Suite 700•Sacramento, California•95814•Tel 916.443.1300•www.secteam.com

STATE OF ARIZONA
OFFICE OF THE
AUDITOR GENERAL

DEBRA K. DAVENPORT, CPA
AUDITOR GENERAL

MELANIE M. CHESNEY
DEPUTY AUDITOR GENERAL

November 23, 2016

The Honorable Andy Biggs, President
Arizona State Senate

The Honorable David Gowan, Speaker
Arizona House of Representatives

Members of the Arizona Legislature

The Honorable Doug Ducey, Governor
State of Arizona

Mr. Dennis Smith, Executive Director
Maricopa Association of Governments

Mr. John Halikowski, Director
Arizona Department of Transportation

Mr. Scott Smith, Chief Executive Officer
Valley Metro

Mr. Roc Arnett, Chairman
Citizens Transportation Oversight Committee

Transmitted herewith is a report, *A Performance Audit of the Maricopa Association of Governments Regional Transportation Plan*. This audit was conducted by the independent firm Sjoberg Evashenk Consulting under contract with the Auditor General and was in response to the requirements of Arizona Revised Statutes (A.R.S.) §28-6313.

Responses to the audit can be found at the end of the audit report. As outlined in their responses:

- The Maricopa Association of Governments agrees with all of the findings and plans to implement or implement in a different manner all of the recommendations directed to it.
- The Arizona Department of Transportation agrees with all but three of the findings and plans to implement or implement in a different manner all but one of the recommendations directed to it.
- Valley Metro agrees with all of the findings and plans to implement or implement in a different manner all of the recommendations directed to it.

In addition, to comply with A.R.S. §28-6313(E), a representative for the Citizens Transportation Oversight Committee (CTOC) indicated that CTOC will provide a written response to the Maricopa Association of Governments Transportation Policy Committee

within 45 days after the audit report is released indicating whether it agrees or disagrees with the findings and whether the recommendations should be implemented, be implemented with modification, or not be implemented.

Sincerely,

Debbie Davenport
Auditor General

DD:ka

cc: The Honorable Michele Reagan, Arizona Secretary of State
Citizens Transportation Oversight Committee Members
Maricopa Association of Governments Regional Council Members
Maricopa Association of Governments Transportation Policy Committee Members
Maricopa County Board of Supervisors
State Transportation Board Members
Valley Metro Rail, Inc. Board of Directors
Valley Metro Regional Public Transportation Authority Board of Directors

Attachment

SJOBERG EVASHENK
CONSULTING, INC

November 14, 2016

Ms. Debra Davenport
Auditor General
Arizona Office of Auditor General
2910 N. 44th Street, Suite 410
Phoenix, Arizona 85018-7243

Dear Ms. Davenport:

Sjoberg Evashenk Consulting is pleased to submit our final report for the *Performance Audit of the Maricopa Association of Governments Regional Transportation Plan* in response to Arizona Revised Statutes §28-6313 and Proposition 400 passed in November 2004. We assessed the performance of the Regional Transportation Plan (RTP) as planned and implemented by the Maricopa Association of Governments, Arizona Department of Transportation, Valley Metro Regional Public Transportation Authority, and Valley Metro Rail, Inc.—together, referred to as the RTP partners. Additionally, we evaluated projects scheduled for funding as well as recommended ways to improve the efficiency and effectiveness of the plan. Within forty-five days after the release of the audit, the Valley Metro Regional Public Transportation Authority, the Citizens' Transportation Oversight Committee, State Transportation Board, and County Board of Supervisors, are responsible for holding a public hearing and submitting written recommendations to the transportation policy committee.

Our report concludes that the RTP partners have planned and implemented many strong activities and strengthened existing processes related to performance measures, project management and delivery, and intelligent transportation system technology and monitoring. Additionally, performance data reveals results that are comparable to or better than peers across the country related to congestion, travel time, crashes, pavement and bridge condition, on-time performance, and transit operating metrics.

With the Prop 400 program halfway through its 20-year duration, the RTP partners have completed many projects and made strides since fiscal year 2004-2005 when the sales tax was extended. We found that most projects reviewed were on schedule—or had reasonable delays that were documented—and were within budget. Moreover, project management techniques used by the RTP partners on freeway, arterial streets, and transit projects aligned with industry best practices. Further, while most RTP projects are specific to individual transportation modes, the RTP partners have also undertaken activities toward moving people and traffic more efficiently on the existing regional multimodal network through the use of intelligent transportation system technology.

Based on the audit work performed, there are no significant changes warranted for the transportation system. However, to enhance the existing solid RTP and Prop 400 framework, we provide several recommendations to help the RTP partners be more efficient and effective in their implementation of the plan as well as demonstrate stronger accountability for the performance goals of the plan.

We appreciate the opportunity to have been of service to the Office of the Auditor General and it has been our pleasure to work with you and your staff. We also appreciate the cooperation we received from all those who assisted us throughout the course of our review including the Maricopa Association of Governments, Arizona Department of Transportation, Valley Metro Regional Public Transportation Authority, and Valley Metro Rail, Inc.

Respectfully Submitted,

Catherine Brady
Director

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Acronym List

AADT – Average Annual Daily Traffic

AASHTO – American Association of State Highway and Transportation Officials

ADOT – Arizona Department of Transportation

ATM – Active Traffic Management

BRT – Bus Rapid Transit

CTOC – Citizens Transportation Oversight Committee

DMS – Dynamic Message Sign

FAST Act – Fixing America's Surface Transportation Act

FHWA – Federal Highway Administration

FTA – Federal Transit Administration

GPL – General Purpose Lane

HOVL – High Occupancy Vehicle Lane

MAG – Maricopa Association of Governments

MAP-21 – Moving Ahead with Progress for the 21st Century

MCDOT – Maricopa County Department of Transportation

PMBOK – Project Management Body of Knowledge

Prop 400 – Proposition 400, passed in 2004

RPTA – Regional Public Transportation Authority

RTP – Regional Transportation Plan

US DOT – United States Department of Transportation

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Executive Summary

Recognizing the continued need for transportation and transit improvement projects in the region, Maricopa County voters passed Proposition 400 (Prop 400) authorizing a 20-year continuation of a countywide, half-cent sales tax in November 2004. With the passage of Prop 400, voters added a significant investment in rail projects, new and improved freeways, street improvement programs, and bus transit features to address regional needs through projects specified and developed as part of the long-range Regional Transportation Plan (RTP).

Statutes enacted by Prop 400's passage included provisions for a performance audit of the RTP every five years focused on project expenditure impacts in relieving congestion and improving mobility, as well as federal criteria related to light rail transit including ridership and costs and whether changes to the overall transportation system are warranted. This report provides the results of the second performance audit of the Prop 400 program focused on project expenditures and activities during the five-year period between fiscal years 2010-2011 and 2014-2015 as well as planned activities for fiscal years 2015-2016 through 2019-2020.

Audit Results

When voters passed Prop 400 in 2004 authorizing additional funding of the RTP, the plan included a variety of transportation choices from new freeways, arterial streets, bus routes, and light rail lines to funding for technology that can be used to optimize the capital construction investments. As such, the transportation and transit entities in Maricopa County have a variety of options at their disposal to address congestion challenges and transportation needs. Yet, it is important to note, that there is no one solution or correct combination of strategies to address a region's transportation needs. Transportation planners, operators, and engineers must work collaboratively with the public to consider and implement the best strategies and techniques as determined through technical study, deliberation, oversight, and public input.

Since the prior audit in 2011, the RTP partners—namely, the Maricopa Association of Governments (MAG), Arizona Department of Transportation (ADOT), and Valley Metro,[1] and local jurisdictions—have planned and implemented many strong activities and strengthened existing processes related to performance measures, project management and delivery, and intelligent transportation system technology and monitoring—although additional improvements could further enhance practices. For instance, the RTP partners have solidified a strong performance-based infrastructure to better track and report performance. Additionally, performance data generally reveals results that are comparable to or better than peers across the country related to congestion, travel time, crashes, pavement and bridge condition, on-time performance, and transit operating metrics.

With the Prop 400 program halfway through its 20-year duration, the RTP partners have completed many projects and made strides since fiscal year 2004-2005 when the sales tax was

[1] Regional Pubic Transportation Authority and Valley Metro Rail, Inc. are together referred to as Valley Metro for purposes of this audit.

extended. We found that most projects reviewed were on schedule—or had reasonable delays that were documented—and were within budget. Moreover, project management techniques used by the RTP partners on freeway, arterial streets, and transit projects aligned with industry best practices.

Further, while most RTP projects are specific to individual transportation modes, the RTP partners have also undertaken activities toward moving people and traffic more efficiently on the existing regional multimodal network through the use of intelligent transportation system technology and various management techniques.[2] As such, the RTP partners should continue the strong practices in place implementing the transportation system.

Specifically, we found:

- ✓ RTP partners addressed many of the 2011 RTP Performance Audit recommendations such as creating a robust performance measurement system, enhancing communication, and developing project cards for freeway and arterial street projects as well as creating project scorecards for transit projects that provide a quick, 1-page description of a project, its benefits, schedule, and costs.[3]
- ✓ One area that remains unaddressed from the 2011 RTP Performance Audit pertains to the Citizens Transportation Oversight Committee. Specifically, the committee still does not function as effectively as peers. In addition, the committee has not met since May 2014.
- ✓ While methodologies and preliminary targets have been created, no formal or official performance targets have been established as suggested by best practices. Consequently, it is not possible at this point to determine whether actual performance met expectations for the region and whether the mix of transportation and transit strategies is accomplishing RTP performance goals.
- ✓ Congestion trends on freeways and arterial streets has generally increased between calendar years 2011 and 2014, although average speeds have slightly increased on freeways and slowed on arterial streets—nonetheless, these trends are better than those reported nationally.
- ✓ Crash data reported by MAG and ADOT in Maricopa County reveals a growth trend with total annual crashes on freeways and arterials growing from 72,800 in calendar year 2011 to nearly 80,000 in calendar year 2014—although statewide fatal and serious injury crashes have decreased.
- ✓ ADOT and local jurisdictions reported that freeway and arterial street pavement and bridges are in good condition.

[2] For purposes of this audit, the regional multimodal network refers to the freeways, arterial streets, light rail lines, and bus transit routes operating in the Maricopa County area.

[3] MAG and ADOT use "project cards," while Valley Metro uses "project scorecards," to report on project status.

- ✓ Light rail and bus transit continue to outperform peer agencies in terms of boardings,[4] farebox recovery,[5] and operating costs; additionally, transit vehicles were on-time at least 92 percent of the time or higher between fiscal years 2010-2011 and 2013-2014 and mechanical failures have been decreasing over the same timeframe.
- ✓ Freeway, arterial streets, and transit projects we reviewed generally were delivered on budget and within schedule, although justifiable variances from schedule existed.
- ✓ Leading project management practices are being employed on freeways, arterial streets, light rail lines, and bus transit routes although some process enhancements could be incorporated. Further, internal project delivery and efficiency metrics are available for all modes.
- ✓ Significant investment has been made in intelligent transportation system technology and the management and use of that technology, but regional operational coordination is still in progress; and
- ✓ Some active traffic management tools, such as traffic signal synchronization and transit signal priority, are in place to enhance mobility. However, the region is still moving toward more active real-time monitoring and dynamic, proactive adjustment of the system to meet traffic conditions on a 24-hour a day basis.

Based on the audit work performed, there are no significant changes warranted for the transportation system. However, to enhance the existing solid RTP and Prop 400 framework, we provide 12 recommendations to the RTP partners as follows:

1. MAG should work with ADOT and the local jurisdictions to enhance freeway and arterial project cards by including baseline budgets and baseline schedules to allow comparisons against actual.
2. Valley Metro should strengthen current capital construction project scorecards by including the initial baseline budget for the project as well as develop consistent project scorecard formats for all transit capital construction projects, regardless of whether Valley Metro oversees the project or a local jurisdiction is managing the project.
3. Valley Metro and MAG should work together to make available transit project scorecards on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.
4. RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance.
5. ADOT should work with the Citizens Transportation Oversight Committee to ensure responsibilities, such as annual reporting, are fulfilled and methods of committee operations are changed to be more effective in meeting statutory requirements.

[4] Transit boarding is the term used in industry to count a passenger of public transit systems.
[5] Farebox recovery refers to the portion of a trip's operating expenses covered by passenger fare revenue.

6. ADOT, as the Citizens Transportation Oversight Committee's administrative support, should encourage the County Board of Supervisors and the Governor's Office to fill vacancies on the Citizens Transportation Oversight Committee and encourage the committee to meet on a regular basis as statutorily required.
7. ADOT should report freeway bridge and pavement condition data at the Maricopa County or Phoenix-Mesa Urbanized Area level, in addition to current statewide data already available.
8. ADOT should track and report internal project delivery performance metrics at the Maricopa County or Phoenix-Mesa Urbanized Area level.
9. ADOT should consider using additional project delivery metrics including "project administrative costs as a percent of budget."
10. With many innovative project management practices employed on the South Mountain Freeway project, ADOT should consider applying techniques and tools from this project to other ADOT freeway projects, as appropriate.
11. MAG should work with the local jurisdictions to gather and make available local performance indicators related to pavement and bridge deck condition at the Maricopa County or Phoenix-Mesa Urbanized Area level on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.
12. ADOT should continue its efforts currently underway to scientifically explore, evaluate, and implement active traffic management techniques where practical or feasible, including continued efforts to work with RTP partners on considering and prioritizing the maintenance of the communication infrastructure to remain functional and current.

Introduction and Background

In November 2004, Maricopa County voters extended an existing one-half-cent sales tax that was initially set to expire in 2005, for another 20 years with the passage of Proposition 400 (Prop 400). While the previous proposition mainly concentrated on the spending of incremental tax funding on freeway projects, Prop 400 added a significant investment in rail projects, new and improved freeways, arterial street improvement programs, and bus transit features. These projects were specified and incorporated into Maricopa County's 2025 long-range Regional Transportation Plan (RTP) compiled in 2003.

Developed by the Maricopa Association of Governments (MAG), the RTP includes goals and objectives for increasing mobility and reducing congestion through a mix of specific freeway, high-capacity arterial road and street, and transit improvement projects. Together with other RTP components, the freeway, arterial streets, and transit elements are known as the MAG Region's "regional transportation system." Since the ultimate blend of projects and activities considered necessary to meet transportation needs for the MAG Region including Maricopa County is a regional decision, MAG developed the RTP through a cooperative effort with government, business, and local public interest representatives. Every three to five years, MAG is required to update its long-range RTP to cover a rolling 20-year time period or longer. The most recent plan is the 2035 RTP updated in January 2014 that covers the remaining Prop 400 projects as well as other regional projects.

Maricopa County and the Urbanized Phoenix Area

With nearly 60 percent of the population, Maricopa County is the largest of Arizona's 15 counties and the fourth largest county in the nation.[6] When compared to other U.S. areas with populations greater than three million, the Phoenix-Mesa Urbanized Area was ranked third for lowest congestion hours of delay per commuter in calendar year 2014.[7] However, in another national comparison, Phoenix trends are worsening indicating that congestion may be a significant challenge for the region moving forward.[8] Currently, nearly 1,800 miles of freeway and 4,000 miles of arterial streets as well as 42 bus routes and 26 miles of light rail transport residents across and throughout the 30 cities and communities in the Maricopa County region.

Projects Proposed by Prop 400

When voters agreed to extend Maricopa County's half-cent sales tax increment to pay for transportation improvements, Prop 400's revenue stream was dedicated to projects approved and proposed as part of the original 2003 RTP for the following:

- 344 total miles of new or improved freeways and highways

[6] According to the Maricopa County website at www.maricopa.gov/bos/cities.aspx.
[7] According to the Texas A&M Transportation Institute 2015 Urban Mobility Scorecard. Congestion hours of delay is one of multiple metrics to measure congestion.
[8] According to the 2015 United States Department of Transportation Federal Highway Administration Urban Congestion Report, comparing calendar year 2014 to calendar year 2015 as measured for the three-month period from April to June each year. This report's measures are partially based on observed data, but also included volumes that are interpolated, factored, or imputed.

- 275 miles of new or improved streets
- 34 major intersections
- 27.7 new miles of light rail
- 40 enhanced or new bus routes

Projects were scheduled according to four distinct phases as follows:

- Phase I: Fiscal years 2005-2006 through 2009-2010,
  As well as January 1, 2005 through June 30, 2005
- Phase II: Fiscal years 2010-2011 through 2014-2015
- Phase III: Fiscal years 2015-2016 through 2019-2020
- Phase IV: Fiscal years 2020-2021 through 2024-2025,
  As well as July 1, 2025 through December 31, 2025

After the 2007 through 2009 recession and significantly reduced Prop 400 revenues, the RTP partners[9] developed program rebalancing scenarios applied to the portfolio of projects initially envisioned that could be completed with Prop 400 funding. The rebalancing done in 2012 shifted projects between the four phases, deleted certain projects from the plan, and extended other projects outside the 20-year tax window ending on December 31, 2025.

Prop 400 Funding

The RTP, which was created in 2003, served as the blueprint for projects to be funded through Prop 400. Although the MAG Region's RTP relies on other funding sources as well, the Prop 400 sales tax revenue was expected to provide nearly half of the funds for projects envisioned in the RTP. Under Arizona Revised Statutes §42-6105, funds generated under Prop 400 must be allocated as follows:

- **Freeway**:
  56.2 percent for freeways including capital expense and maintenance.
- **Arterial**:
  10.5 percent for major arterial street and intersection improvements.
- **Transit**:
  33.3 percent for capital construction, maintenance, and operation of public transportation as well as for capital construction costs associated with a light rail system.

Moreover, the enacted legislation prohibits the transfer of sales tax fund revenues distributed in accordance with these percentages from one transportation mode to another—for instance, freeway money cannot be transferred to transit projects, nor can transit funds be spent on

[9] RTP partners refers to MAG, Arizona Department of Transportation, Valley Metro, and local jurisdictions in Maricopa County.

arterial street projects. Other funds supplementing the Prop 400 funds include a variety of federal highway, federal transit, state highway, and local matching funds.

In November 2004 after Prop 400 passed, sales tax projections available to complete Prop 400 projects were estimated at $14.3 billion[10] for fiscal years 2005-2006 through 2025-2026. Yet, the effects of the economic recession between 2007 and 2009 reduced sales tax revenues during the first 10 years of the program and lowered total expected sales tax projections to $8.6 billion. Although sales tax receipts were only $3.3 billion through fiscal year 2014-2015, Maricopa County has experienced a resurgence in the past five years where revenues are starting to show slow growth and $5.3 billion in receipts are expected for fiscal years 2015-2016 through 2025-2026. The revised projections of $8.6 billion over the entire 20-year period is approximately 40 percent less than the $14.3 billion estimated at the time Prop 400 passed.

RTP Partner Entities Involved with Prop 400

While MAG is the primary entity responsible for developing the RTP and programming funding for the RTP projects, several other entities partner together in the MAG region to share responsibilities for planning, implementation, operation, and monitoring of projects and programs funded through Prop 400 as shown in Figure 1.

[10] According to the 2005 Prop 400 Annual Report.

Figure 1: Responsibilities of Entities Involved with Prop 400 and Related RTP

Citizens Transportation Oversight Committee (CTOC)

- Committee established with oversight responsibilities of the RTP, including reviewing and advising entities such as MAG, ADOT, and Valley Metro on matters and projects relating to RTP.

Maricopa Association of Governments (MAG)

- Federally designated metropolitan planning organization for Maricopa County
- Overseen by a 34-member agencies Regional Council
- Members include region's 27 incorporated cities and towns, Maricopa and Pinal Counties, three Indian Communities, CTOC, and ADOT
- Responsible for llong-term planning, developing the RTP, program funding for RTP projects, balancing RTP project costs with revenue, and managing the Arterial Life Cycle Program

Arizona Department of Transportation (ADOT)

- Statewide entity with primary role of implementing and maintaining state highway system
- Overseen by the State Transportation Board
- Responsible for the design, engineering, acquisition, construction, and maintenance of freeways
- Develops strategies for optimizing investment in preservation and expansion of transportation infrastructure
- Assists State Transportation Board with program policies and funding, such as grants and revenue bonds

Valley Metro Regional Public Transportation Authority (RPTA)

- RPTA is a political subdivision of the State of Arizona
- Overseen by a Board of Directors comprised of elected officials from the 16 member jurisdictions--Avondale, Buckeye, Chandler, El Mirage, Gilbert, Glendale, Goodyear, Maricopa County, Mesa, Peoria, Phoenix, Scottsdale, Surprise, Tempe, Tolleson and Wickenburg
- Responsible for short-term planning and the operation of the regional bus transit system in Maricopa County
- Administratively combined with Valley Metro Rail, Inc. under one Chief Excecutive Officer and together known as Valley Metro

Local Jurisdictions

- Cities, towns, and communities oversee local roads and transit services
- Overseen by individual city, town, or community councils
- Responsible for managing and delivering transportation improvement projects to residents
- 16 Cities include--Apache Junction, Avondale, Buckeye, Chandler, El Mirage, Glendale, Goodyear, Litchfield Park, Maricopa, Mesa, Peoria, Phoenix, Scottsdale, Surprise, Tempe, Tolleson
- 11 Towns include--Carefree, Cave Creek, Florence, Fountain Hills, Gila Bend, Gilbert, Guadalupe, Paradise Valley, Queen Creek, Wickenburg, Youngtown
- 3 Communities include--Fort McDowell Yavapi Nation, Gila River Indian Community, Salt River Pima-Maricopa Indian Community

Maricopa County

- Governed by a Board of Supervisors
- Responsible for transportation infrastructure construction and maintenance within the county, including implementation of arterial capital construction projects

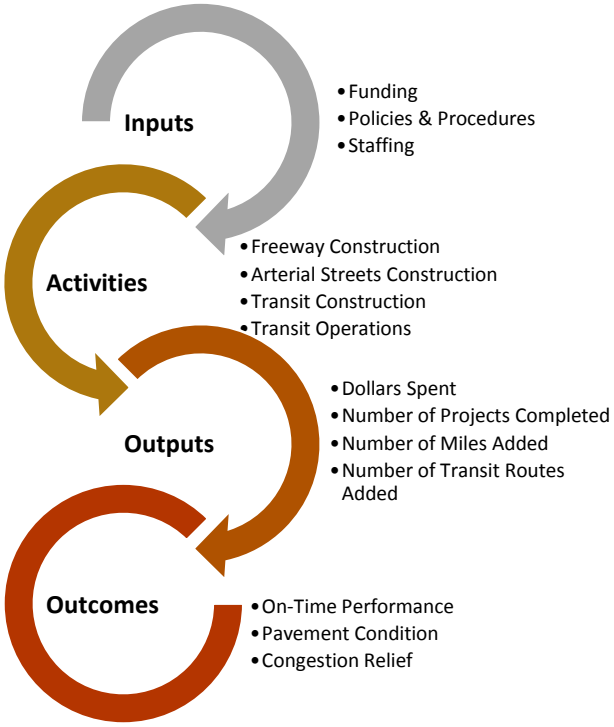
Valley Metro Rail, Inc.

- A non-profit, public corporation, formed by the cities of Glendale, Mesa, Phoenix, Tempe, and Chandler
- Overseen by a Board of Directors generally comprised of designated elected officials of the participating cities of Chandler, Glendale, Mesa, Phoenix, and Tempe
- Responsible for design, construction, and operation of the light rail system in Maricopa County
- Administratively combined with Valley Metro Regional Public Transportation Authority under one Chief Executive Officer and together known as Valley Metro

Measuring Effectiveness of Prop 400

Typical models for determining the effectiveness of a government program—such as Prop 400—center on inputs, activities, outputs, and outcomes. As presented in Figure 2, program inputs include the funding, staffing and expertise, and policies and procedures available for a program. For the Prop 400 program, inputs are the sales tax revenues and planning conducted by MAG and the RTP partners. These inputs are funneled into freeway, arterial streets, and transit projects and the day-to-day professional practices and activities employed by the RTP partners in completing and operating the RTP projects. Results of activities are outputs, or what is delivered by the program, as well as outcomes, or the ultimate impact of the program in reaching established goals.

Figure 2: Logic Model for Determining Effectiveness of Government Programs



Source: San Jose State University, Program Evaluation and Logic Models

This audit focused on evaluating the activities, outputs, and outcomes that resulted from the Prop 400 sales tax investment. Specifically, we reviewed the project management activities exercised by the RTP partners in constructing freeway, arterial streets, and transit capital projects, as well as reviewed the operational activities performed by Valley Metro over transit operations. Further, auditors assessed Prop 400 outputs for each of the transportation modes in terms of number of projects delivered and whether those projects were within budget and on schedule. Auditors also analyzed performance data reported on Prop 400 outcomes related to speed, congestion, travel delay, crashes, mobility, and pavement and bridge condition. Related regional efforts are presented in Chapter 1 of this report, and the performance assessment for individual modes are discretely presented in separate chapters that follow.

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Scope and Methodology

In accordance with Arizona Revised Statutes §28-6313, the Arizona Office of the Auditor General (Auditor General) has the responsibility for contracting with an independent auditor to conduct a performance audit of the Regional Transportation Plan (RTP). In April 2016, the Auditor General hired Sjoberg Evashenk Consulting, to conduct the second performance audit of the RTP for the five-year period covering fiscal years 2010-2011 through 2014-2015 as well as projects scheduled in fiscal years 2015-2016 through 2019-2020. The purpose of the audit is to assess the efficiency, effectiveness, and performance of MAG's RTP for Maricopa County and address the following seven objectives identified by the Auditor General:

1. Examine past expenditures of RTP projects previously funded between fiscal years 2010-2011 through 2014-2015 to determine project impacts on relieving congestion and improving mobility as well as performance of the system.
2. Review future RTP projects scheduled for funding during fiscal years 2015-2016 through 2019-2020 based on the performance factors in statute, the RTP, the federal New and Small Starts Criteria, and in context of the transportation system.
3. Confirm whether light rail systems met prescribed federal funding criteria.
4. Assess whether light rail systems have met standards and performance measures related to service levels, capital costs, operation and maintenance costs, transit ridership, and farebox revenues in addition to how performance compares to peer agencies.
5. Identify the extent to which active traffic management technology has been, and is being, effectively used to manage congestion and optimize existing freeway, road, and transit capacity as well as its impact on previously funded projects and future projects scheduled for funding.
6. Evaluate changes to federal or state laws that may have a significant impact on the RTP.
7. Make recommendations on whether further implementation of a project or a transportation system is warranted, warranted with modifications, or not warranted.

Audit Methodology

To fulfill these objectives, we conducted a series of in-depth audit tasks involving data mining and analysis, documentary examinations, peer comparisons, source data verification, and one-way interviews. Appendix A provides the detailed methodology employed on this audit.

We conducted this audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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Chapter 1: Regional Efforts and Progress Since 2011 RTP Performance Audit

CHAPTER SUMMARY

Funded in large part by Proposition 400 (Prop 400) revenues, the Regional Transportation Plan (RTP) is a comprehensive, multimodal plan including projects for freeways, arterial streets, and public transit in addition to other modes, safety, and intelligent transportation system technology.

Prop 400 Expectations

Ballot language for Prop 400 outlined general regional goals related to congestion relief and improved mobility through the implementation of transportation and transit improvement projects on freeways, arterial streets, light rail, and bus transit.

Implementing these projects relies on a number of different entities with shared responsibility at the state, regional, and local levels.

Regional Efforts

- ✓ Over the past five years, RTP partners [11] have implemented many of the 2011 RTP Performance audit recommendations and made extensive changes to performance measurement systems, project cards, external Prop 400 reporting, and administrative efficiencies at the transit operator level.
- ✓ Region is still in the process of developing performance targets.

Audit Results Highlights

- Many improvements have been made since the 2011 RTP Performance Audit to enhance the program; in particular, the Maricopa Association of Governments (MAG) performance measurement system now has interactive dashboard features that displays observed freeway and arterial street performance.
- Further, the RTP partners developed project cards and project scorecards to share project information and status with the public on agency websites. Minor improvements could be made to include budget to actual performance and make local jurisdictional data more centrally available.
- Targets are still not in place although best practices suggest that targets are a key component of a functioning performance monitoring system.
  - While RTP partners have established methodologies to set targets and have proposed some possible targets, RTP partners are waiting on pending federal guidance before officially setting specific targets as part of emerging federal requirements on transportation planning.
  - Yet, aligned with best practices, several transportation entities in the country already use targets to measure performance related to crash, speed, ride quality, and congestion goals.
  - Without targets, the RTP partners cannot assess how actual performance compares with goals and expectations on how the system should function.
- Citizens Transportation Oversight Committee (CTOC) is inactive and does not function as effectively as its peers.
  - Committee has not met since May 2014, or issued its required compliance audit since 2010.
  - Vacancies exist and impact the ability to establish a quorum of members.
  - CTOC is still not being utilized as effectively as it could or as compared to other similar committees in the country.

[11] RTP partners refers to MAG, Arizona Department of Transportation, Valley Metro, and local jurisdictions in Maricopa County.

Recommendations

- MAG should work with ADOT and the local jurisdictions to enhance freeway and arterial project cards by including cost budgets and baseline schedules to allow comparisons against actual.
- Valley Metro should strengthen current capital construction project scorecards by including the initial baseline budget for the project as well as develop consistent project scorecard formats for all transit capital construction projects, regardless of whether Valley Metro oversees the project or a local jurisdiction is managing the project.
- Valley Metro and MAG should work together to make available transit project scorecards on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.
- RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance.
- ADOT should work with the Citizens Transportation Oversight Committee to ensure responsibilities, such as annual reporting, are fulfilled and methods of committee operations are changed to be more effective in meeting statutory requirements.
- ADOT, as the Citizens Transportation Oversight Committee's administrative support, should encourage the County Board of Supervisors and the Governor's Office to fill vacancies on the Citizens Transportation Oversight Committee and encourage the committee to meet on a regular basis as statutorily required.

Many Improvements Have Been Made Since 2011 RTP Performance Audit

In 2011, the first Prop 400 audit offered 27 recommendations to MAG, ADOT, Valley Metro Regional Public Transportation Authority (RPTA), and Valley Metro Rail[12] to improve practices. Following the issuance of that audit report, the RTP partners[13] began addressing audit recommendations and have adopted or implemented the recommendations in some manner. While we find that some efforts related to the recommendations are still in progress, many improvements have been made. The RTP partners have:

- ✓ Ensured data on Prop 400 reports and related public documents are more consistent;
- ✓ Enhanced communication of performance data and provided easy to use tools and links to related information;
- ✓ Coordinated individual RTP partner performance measurement activities into a central location on MAG's website with links to other data as needed;
- ✓ Provided more detailed communications to committee members;
- ✓ Strengthened written agreements and protocols between RTP partners; and
- ✓ Realized operational efficiencies and stronger practices from administrative consolidation of certain Valley Metro functions.

[12] RPTA and Valley Metro Rail, Inc. are administratively combined under one Chief Executive Officer and known as Valley Metro, except when discussing light rail only activities. For those areas pertaining solely to light rail, we use Valley Metro Rail, Inc.
[13] RTP partners refers to MAG, ADOT, Valley Metro, and local jurisdictions in Maricopa County.

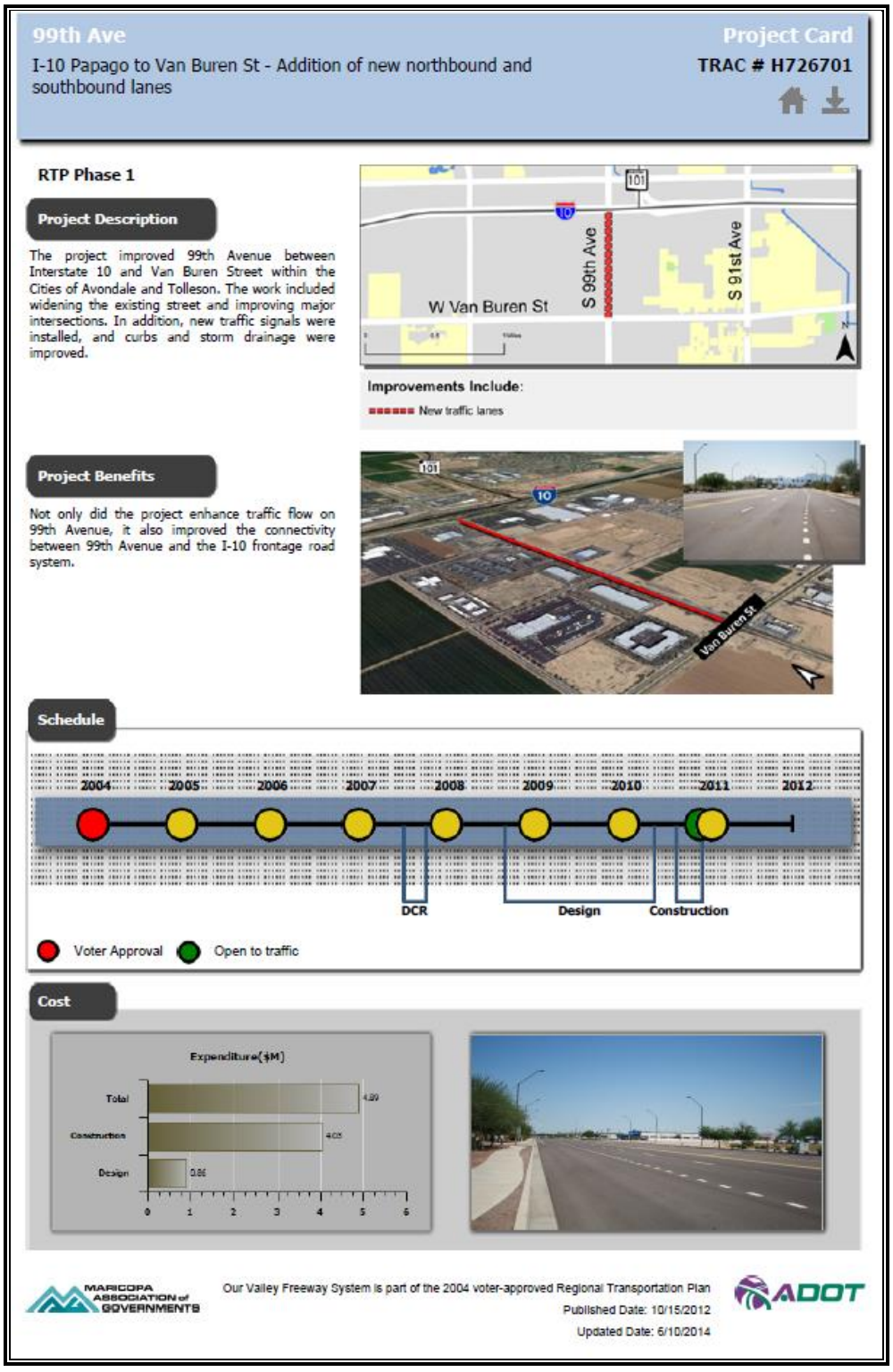
As recommended by the 2011 RTP Performance Audit, one improvement implemented relates to the creation of project cards to enhance transparency and report on project progress toward meeting budget, schedule, and outcome goals. Specifically, as shown in Figure 3, MAG and ADOT created project cards for freeway and arterial street projects to provide a quick description of a project, its benefits, current project schedule, and actual expenditures—although there is no budget or baseline information provided for comparison purposes.

Similarly, Valley Metro created monthly project "scorecards"[14] for light rail and transit projects that provide an overview of a project, schedule (baseline to current), actual and forecasted costs, and key project milestones including status of construction. Not only do the Valley Metro project scorecards provide additional levels of accountability to the public on how well projects are delivered, but also there are links to Valley Metro's project scorecards on MAG's performance dashboard that provide a centralized and transparent location to view performance related to Prop 400 projects.

Unlike light rail projects, most transit bus capital construction projects are managed by local jurisdictions and no project scorecards are easily available for these locally managed projects. We found two jurisdictions that had some similar information available on their website, but it was often limited to items such as capital improvement project maps, assigned project managers, prime contractors, bid and approval dates, and construction start and end dates. Thus, Valley Metro should work with the local jurisdictions to enhance the type of information available on these scorecards and establish formats with uniform elements to be reported such as baseline budget, revised budget, actual expenditures to-date, baseline schedule and revised schedule, and information on other key project milestones and updates. Additionally, MAG could include the scorecards on the performance dashboard or provide links to the local websites where scorecards are located.

[14] MAG refers to its project status documents as "project cards," while Valley Metro refers to its project status documents as "project scorecards." Both have similar content and serve a similar purpose.

Figure 3: Project Card Example for Completed Freeway Project

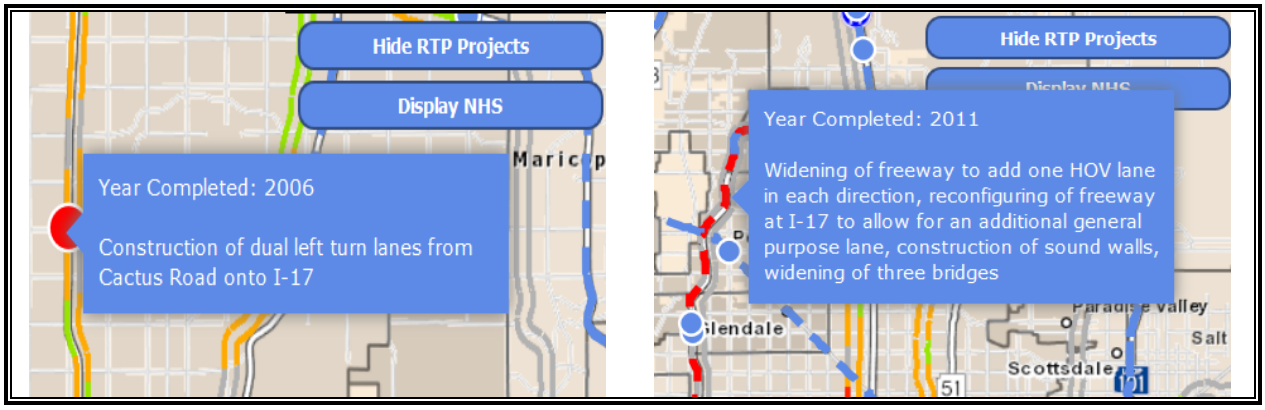


Source: MAG Performance Measurement website; http://projectcards.azmag.gov/

Robust Freeway and Arterial Performance Measurement System is in Place

Since the 2011 RTP Performance Audit's recommendations calling for enhancements to MAG's performance system, significant efforts and great diligence have been put into performance measurement with many strong practices being employed by MAG. For instance, to complement its existing performance data on freeways, MAG also uses private sector[15] data to analyze travel time, planning time, and congestion. This private sector data provides better information for arterial streets based on global positioning system data, rather than using less reliable counting station data previously available. Moreover, MAG conducts several activities to analyze the performance data captured before reporting this information on its website. Another enhancement to MAG's performance system is its MAGnitude Dashboard with interactive maps—as shown in Figure 4—with toggle buttons to show or hide certain map layers showing where RTP projects were completed or are still in progress. Hovering the pointer over a project area would "pop-up" information including the year completed and a short description of the project.

Figure 4: MAGnitude Dashboard's RTP Project Pop-Up Information Available



Source: MAG Performance Measurement website, http://performance.azmag.gov

Many of MAG's efforts were in response to emerging federal requirements from the Moving Ahead for Progress in the 21st Century (MAP-21) Act implemented in 2012 and the Fixing America's Surface Transportation (FAST) Act in December 2015.[16] While performance measures have been encouraged and discussed for at least 30 years, the federal government is now mandating performance-based planning and development of certain performance indicators. These performance requirements are aimed at increasing accountability and transparency and improving project decision-making through performance-based planning and programming.

Systemwide performance data is also captured and reported by MAG—mainly focused on freeways and arterial streets. Transit performance is not specifically detailed in the MAGnitude Dashboard, but based on the 2011 RTP Performance Audit recommendations, MAG's website has

[15] Two private data providers were under contract with MAG, including NAVTEQ a provider of base electronic navigable maps.
[16] The main purpose of MAP-21 was to provide long-term federal funding for surface transportation, but the law also established national performance goal areas codified in 23 U.S.C. 150. The FAST Act modified and continued the long-term funding in addition to strengthening the performance goal areas by requiring target setting to be incorporated into performance based planning.

links to Valley Metro's website for transit performance data. In addition, ADOT tracks performance indicators including bridge and pavement conditions and fatal and serious injury crashes. However, this data is reported at the statewide level and is not specific to the Maricopa County region.

Performance Targets for Freeways and Arterial Streets have not yet Been Established

For decades, best practices have recommended using targets or standards as part of any entity's performance plan. In the 1990s, the federal government enacted the Government Performance and Results Act[17] to improve public accountability by encouraging governmental entities to report on whether they were meeting annual performance goals and what actions were needed to achieve or modify goals not met.[18] Further, the U.S. General Accounting Office offered additional direction that entities should use a particular target level or baseline to assess their progress towards goals. More recent guidance from the Transportation Research Board also cites realistic targets as one of the characteristics of an effective performance-measurement system allowing program staff to monitor progress towards program objectives and goals and to enhance public transparency and accountability. However, ADOT and MAG have not yet set formal or official targets for the freeway or arterial network.

According to MAG, they are in the process of establishing targets that will likely be introduced with the next iteration of the RTP—which may occur in fiscal year 2017-2018. Specifically, MAG has developed a detailed methodology to set targets and proposed preliminary targets in certain areas. Additionally, ADOT has begun discussions with MAG and other metropolitan planning organizations across the State to develop performance targets and measures in accordance with federal provisions encouraging coordination between state departments of transportation and metropolitan planning organizations. In part, MAG and ADOT are waiting for final federal rulings on FAST Act performance measures—a draft ruling was open for comment until August 20, 2016, but a final rule date has not yet been set. Because it is challenging for entities to address the evolving changes regarding performance data as required by FAST Act and how those requirements will reshape future efforts, it is understandable that MAG has adopted a "wait and see" approach before devoting significant resources in developing policies and practices to comply with still-evolving federal rules.

Nonetheless, some level of performance targets are still needed—not just for the sake of compliance with federal guidance, but simply for evaluating system performance against expected outcomes and demonstrating accountability to the Maricopa County taxpayers that supported the 2004 tax initiative. However, MAG believes that setting and reporting on targets prematurely leads to consecutive shifting and moving targets that results in counterproductive and conflicting information to various audiences.

[17] The Government Performance and Results Act of 1993 set forth provisions to improve government performance management by setting goals and reporting progress.
[18] U.S. General Accounting Office Publication GAO/GGD-10.1.20 An Evaluator's Guide to Assessing Agency Annual Performance Plans, April 1998.

Other Transportation Peers Regularly use Performance Targets

We found examples in the nation where other transportation entities regularly reported performance targets as shown in the sections that follow.

San Francisco Bay Area, California

The Metropolitan Transportation Commission for the San Francisco Bay Area and its sister agency, the Association of Bay Area Governments, use performance targets to measure and report on its transportation network conditions including:

- Reduce the number of injuries and fatalities from all collisions by 50 percent.
- Increase non-auto mode share by 10 percent and decrease automobile vehicle miles traveled per capita by 10 percent.

Champaign-Urbana Urbanized Area, Illinois

In its long-range transportation plan titled *Choices 2035*, the metropolitan planning organization for the Champaign-Urbana region in central eastern Illinois established objectives and performance measures with specific targets such as:

- Increase the miles dedicated to bicycle facilities and bike routes by 15 percent by 2014.
- Reduce the total number of crashes in the region by 5 percent by 2014.
- Improve average vehicular travel by at least 1.5 minutes during peak hours on major corridors by 2035.

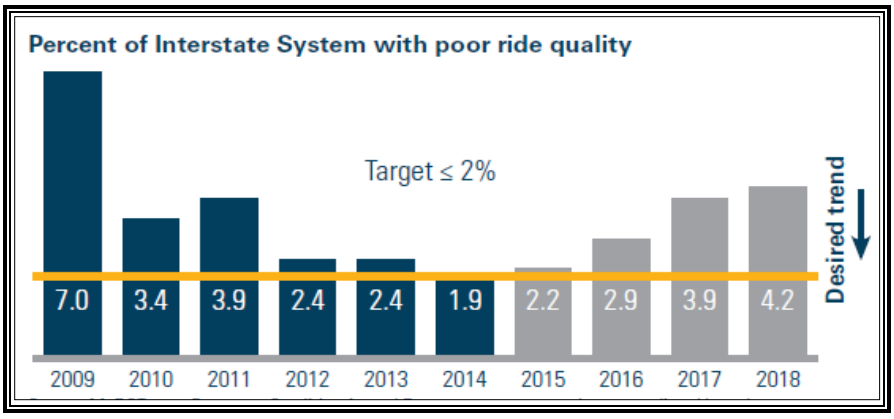
Minnesota Department of Transportation

To determine investment levels and guide decision-making, the Minnesota Department of Transportation uses performance targets such as the following:

- Have less than or equal to 2 percent of Interstate System with poor ride quality.
- Realize less than or equal to 5 percent of system miles operating at more than two miles per hour below corridor level speed target.

For each measure the Minnesota Department of Transportation presented data showing trends, projected future performance, targets, and desired trends. For example, as shown in Figure 5, the Minnesota Department of Transportation tracks performance against its target to keep the percentage of its interstate roadway system in “poor ride” quality at less than 2 percent. Further, the department prepares annual performance reports that also provided narrative on how the data was used to affect transportation improvement decision-making.

Figure 5: Example of Minnesota Department of Transportation Performance Measure Reporting Against Established Targets

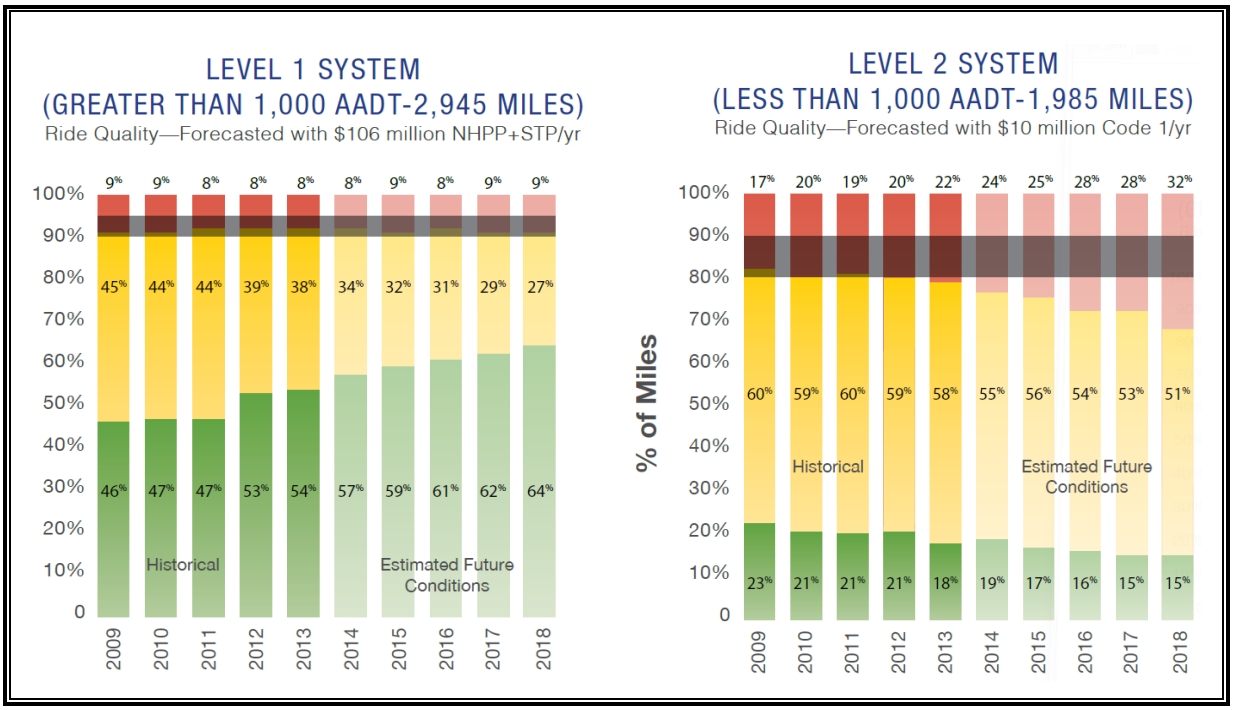


Source: Minnesota Department Transportation, 2014 Transportation Performance Report based on investments in the 2015-2018 State Transportation Improvement Program

Utah Department of Transportation

In Utah, performance targets are used to prioritize where funds should be directed by creating a tiered classification system. Specifically, the Utah Department of Transportation created two levels of system targets with the Level 1 system designated as roads with average annual daily traffic (AADT) greater than 1,000 vehicles. As shown in Figure 6, the Level 1 system's target, indicated by a shaded band, is to have less than 10 percent of road miles in poor condition as shown in red on the graph. Green reflects miles in good condition and yellow shows miles in fair condition. For example, in 2013, Level 1 system road quality was 54 percent in the green, or good condition, and 38 percent in fair condition—leaving only 8 percent of the roads registering in poor condition indicating the target was met. The Level 2 system, consisting of roads with less traffic, has a goal of less than 20 percent of miles in poor condition.

Figure 6: Example of Tiered Targets Used by Utah Department of Transportation[19]



Source: Utah Department of Transportation Strategic Direction and Performance Measures, 2014

Performance can be Reported through Trend Analysis

Even without targets, MAG and ADOT could report useful information on whether freeways and arterial street performance trends are favorable or unfavorable. This trend information is important when presenting performance data because a measure with a numerical decrease could indicate a favorable or unfavorable direction. For some measures the direction is obvious, such as for safety related measures for which a downward trend (towards zero crashes) is favorable. However, for other measures, the goals of the region can affect whether a specific measure going down is favorable or not. For example, a region may have a target to increase vehicle miles traveled as part of its goal of a stronger economy, while another region may have a target to decrease vehicle miles traveled as part of its goal to promote alternative forms of transportation. Because an unfavorable trend might still be aligned with regional goals, such as keeping congestion below certain thresholds where projections indicate congestion will rise with regional population growth, it is important to include narrative explaining trend results.

One partnership in Arizona—AZTech—has issued public reports that discuss freeway performance trends. AZTech was launched in 1996 as a regional coalition led by ADOT and the Maricopa County Department of Transportation that includes more than 17 contributing agencies, including the towns and cities in the region, MAG, Valley Metro, the Federal Highway Administration (FHWA), and the Arizona Department of Public Safety. Although it is not a

[19] Red indicates "poor" condition, yellow indicates "fair" condition, and green indicates "good" condition. These ratings are based on the International Roughness Index ratings and accepted by the FHWA as the standard reference widely-used freeway pavement condition indicator that captures ratings of smoothness of freeway pavement.

regulatory or governing body, AZTech has a stated goal of improving mobility, reducing congestion, and increasing safety for travelers throughout the region as well as guiding the application of intelligent transportation system technologies for managing regional traffic. AZTech has evaluated performance trends and reported on whether changes were favorable or unfavorable as shown in Figure 7.

Figure 7: Example of AZTech Performance Data Reported in 2015

Performance trending in favorable direction. *Performance is trending in an unfavorable direction.*

Policy Goal/ Performance Measure	CY 2012-2013 Period	CY 2014-2015 Period	Description
Freeways			
Percent of Miles Congested (Out of Total of 240 Miles Measured)	31.6%	36.7%	Overall freeways are experiencing more congestion where average vehicle speeds drop below 50 mph
Percent of Time Congested Per Mile (Out of Total of 240 Miles Measured)	25.2%	32.1%	Overall freeways are experiencing more congested time where average vehicle speeds drop below 50 mph

Source: AZTech Traffic Management and Operations Performance Indicators Book, 2015

In Maricopa County, MAG and ADOT should work together to establish freeway and arterial targets for the region given that performance data is available. If sufficient levels of baseline data are not available[20], the entities could, at a minimum, set directional or aspirational targets to capture general performance expectations, recognizing that there are many factors that affect the ability to meet these targets. As more historical data becomes available, more realistic targets can be developed at that point since targets are meant to be constantly monitored and refined. These types of targets could be established while MAG and ADOT continue to monitor and comply with emerging federal performance measure rules and regulations. Some preliminary trend analysis was presented to a regional performance measures and targets working group in July 2016, but those targets presented have not been officially adopted according to MAG.

Transit Employs a Strong Performance Measurement and Monitoring System

As part of a performance framework built on industry-standard metrics and best practices, Valley Metro collects a broad range of performance data both for transit systemwide and by category of rail, fixed route, vanpool, and paratransit (dial-a-ride) service[21] related to cost efficiency (such as operating cost per boarding), service effectiveness (such as safety incidents per 100,000 boardings), on-time performance, and total mechanical failures. Moreover, Valley Metro collects and reports performance through a variety of avenues including transit performance reports, ridership reports, rider satisfaction surveys, transportation demand management reports, and on-board surveys as summarized in the bullets that follow:

[20] According to MAG, at least three years of traffic data is needed to determine baseline levels for trend analysis. National discussions support this premise calling for a similar number of years-worth of data before setting baseline targets.
[21] Transit services include rail (a light rail electric railway with a light passenger volume capacity), fixed route bus services (with regular schedules and dedicated stops), vanpool (seating capacity for at least six people), and paratransit (dial-a-ride) services.

- **Transit Performance Report:** This report captures performance measurement data for regional and local bus services, including fixed route, paratransit (dial-a-ride), vanpool, and light rail services regardless of whether the service is funded by Proposition 400 or by a local city operator. Valley Metro tracks its performance compared to peers for a variety of industry-standard metrics related to on-time performance, cost recovery, and ridership, and this report includes dashboard indicators showing whether trends are positive, neutral, or negative through green, yellow, and red signals.
- **Rider Satisfaction Survey:** Valley Metro's Annual Rider Satisfaction Survey is designed to capture demographic characteristics, ridership patterns, and level of satisfaction of people who use Valley Metro's bus, light rail, and paratransit services.
- **Transportation Demand Management:** Valley Metro conducts annual phone surveys to understand the travel behavior of Maricopa County residents, including both riders and non-riders, as well as asks respondents about their familiarity with Valley Metro services and opinions on the most important transit-related issues facing Maricopa County. The survey provides some insight into the demand for and public perception of transit services that assist Valley Metro with transit planning.
- **Ridership Report:** This annual ridership report contains a detailed breakdown of ridership for each mode and route by fare type (such as full fare, reduced fare, or monthly passes) and weekday versus weekend service.
- **On-Board Survey**: Over the last five years, Valley Metro completed two on-board surveys to capture ridership behavior, trip origin and destination, and general demographic data for use on transit capital construction project studies. Additionally, Valley Metro surveys riders to identify transit customers and system usage, issues with individual routes, and opportunities to improve connectivity within the transit system. For instance, the most recent report revealed that approximately 66 percent of riders only use one route to complete their one-way trip—thus, most riders do not need multiple connections to reach their end destination.

In addition to these performance tracking tools, Valley Metro has focused on tracking and improving connectivity between bus stops and routes, light rail stations and routes, and park-and-ride centers during fiscal year 2015-2016.[22] Specifically, Valley Metro completed a recent study in fiscal year 2015-2016 that made several recommendations to increase service frequency, optimize and streamline routes, eliminate service, add service, and better integrate local bus with rail service.

These efforts are aligned with others across the U.S. where measuring transit performance related to connectivity is picking up momentum. Specifically, with more federal focus on performance measurement including connectivity since 2011,[23] other transit entities are beginning to develop and use connectivity measures.[24] For instance, the City of Colorado Springs

[22] Connectivity refers to the ease of transfer from one system to another such as bus to bus, bus to light rail, or vehicle to light rail.
[23] More federal focus on connectivity is seen as part of the MAP-21 and FAST Acts.
[24] According to a January 5, 2015 USDOT Transportation Connectivity Whitepaper.

tracks the number of system connectivity components, such as transit transfer locations and park-and-ride lots. In Washington D.C., one measure used for connectivity is how many high-capacity transit stations are within a 7.5-minute walk. Like these other entities, Valley Metro indicated that it implemented a practice in calendar year 2016 to assess system connectivity as part of its route evaluation process. Prior to any service change or new service implementation, Valley Metro now conducts a route analysis to identify and measure the number of direct transit route connections to assess regional connectivity. However, this practice was not in place during our audit fieldwork; thus, we could not review Valley Metro's efforts in this area.

Transit Performance Targets would Help Manage the Progress toward System Goals

In fiscal year 2010-2011, Valley Metro stopped including performance targets in its annual transit performance reports although targets are a key component of a comprehensive performance measurement system. Rather, Valley Metro uses performance thresholds to measure individual route performance against other similar routes. However, without targets, Valley Metro cannot assess its progress towards meeting performance goals. At a minimum, some level of narrative describing what the performance and trend data indicates is needed to assist taxpayers in understanding whether transit is achieving its stated goals for the region.

Other entities, such as Seattle Sound Transit, provide monthly actual, and year-to-date performance against targets for a variety of measures such as on-time performance, percentage of scheduled trips operated, and farebox recovery. This entity also provides a brief narrative of the historical performance and expectations for future trends. While we noted that Valley Metro discussed performance trends in detail during board presentations, this discussion was not included in the annual Transit Performance Report itself making it difficult for taxpayers reviewing the data to discern whether or not performance trends were favorable or unfavorable.

In a 2014 report on best practices in transit performance, the Florida Department of Transportation cites a variety of authoritative documents and case studies of performance practices and setting targets. Valley Metro employs many of these best practices and benchmarks its performance against peer transit providers in the country. Yet, without some type of target or standard such as "increasing ridership by 10 percent every five years" or "realizing on-time performance at least 90 percent of the time on an annual basis," Valley Metro cannot assess whether it is meeting its performance expectations and goals.

Transit uses Performance Categories for Decision-Making

In an effort to use performance data to develop a performance-based public transportation system consistent with federal and state requirements and as recommended in the 2011 RTP Performance Audit, Valley Metro began a Regional Transit Standards and Performance Measures study in 2013. The study, meant to establish a set of service standards and performance measures to guide the development of current and future transit services, was conducted in three phases with final completion in June 2016.

Study phases included:

1. **Phase I:** Completed in November 2013, this phase focused on development of service goals, standards for transit service, and measures for assessing the performance of transit services. Many stakeholders—including MAG, ADOT, local jurisdictions, and regional peer agencies—were involved with identifying challenges and opportunities as well as establishing the final eleven performance measures to evaluate transit performance.
2. **Phase II:** This phase, completed in December 2014, focused on developing measurement tools, service thresholds, and standards for assessing the need for new services. In order to compare the relative performance of specific routes or services areas, Valley Metro developed a transit service threshold tool.
3. **Phase III:** Recently completed in June 2016, this phase established standards for service design—including route duplication and end-of-line vehicle turnaround standards—as well as created a fleet prioritization process to meet current and future fleet needs.

In accordance with its Regional Transit Standards and Performance Measures study, individual routes are ranked based on five industry-standard and appropriate performance metrics:

1. On-time Performance
2. Weekday Boardings per Revenue Hour
3. Weekday Boardings per Revenue Mile
4. Weekday Farebox Recovery Rate
5. Weekday Boardings per Trip

Routes falling within the bottom 25 percent or rising to the top 25 percent in two of the five metric areas are evaluated annually to determine if system or route specific adjustments are warranted including route revisions, increased or decreased service levels, or expanded or eliminated services.

Our review of individual route performance found that Valley Metro actively monitored and made adjustments following this performance-based methodology using actual performance data. Specifically, we selected five routes funded with Prop 400 funds for further analysis as shown in Table 1, including a variety of fixed route service, rural service, and link service. We found that when route performance declined over the audit period, Valley Metro made route adjustments or eliminated the underperforming routes. For instance, performance data revealed Route 511 had low ridership and a high subsidy per boarding; specifically, the farebox recovery ratio was only 2.2 percent and the subsidy per boarding was $62.25 in fiscal year 2010-2011. Initially, Valley Metro reduced service on this route in 2012 and saw increases in the amount of "per boarding subsidies" between fiscal years 2011-2012 and 2012-2013. Yet, when those subsidies sky-rocketed to $140.56 in fiscal year 2014-2015, Valley Metro ultimately eliminated the route.

Table 1: Prop 400 Funded Route Performance, Fiscal Years 2010-2011 to 2014-2015

Performance Measure:	Route 40 [A]	Route 112 [B]	Link-Arizona Avenue [C]	Route 511 [D]	Wickenburg Connector [E]
Farebox Recovery [F]					
FY 2010-11	22.9%	33.5%	13.8%	2.2%	Not Available
FY 2011-12	21.8%	26.9%	15.5%	1.5%	3.6%
FY 2012-13	27.6%	34.2%	22.0%	1.5%	Not Available
FY 2013-14	25.1%	34.8%	23.2%	1.7%	Not Available
FY 2014-15	22.1%	29.5%	20.9%	1.3%	Not Available
Subsidy per Boarding					
FY 2010-11	$2.93	$1.69	$5.27	$62.25	Not Available
FY 2011-12	$2.95	$2.29	$4.63	$89.28	$76.84
FY 2012-13	$2.57	$1.86	$3.53	$88.78	Not Available
FY 2013-14	$2.59	$1.65	$2.84	$95.15	Not Available
FY 2014-15	$2.89	$1.97	$3.04	$140.56	Not Available
Boardings per Revenue Mile					
FY 2010-11	1.55	2.21	0.97	2.35	Not Available
FY 2011-12	1.86	2.24	1.28	1.62	0.07
FY 2012-13	2.06	2.59	1.62	1.57	Not Available
FY 2013-14	1.87	2.55	1.75	1.42	Not Available
FY 2014-15	1.82	2.42	1.76	1.00	Not Available
Net Operating Cost per Mile					
FY 2010-11	$4.56	$3.74	$5.09	Not Available	Not Available
FY 2011-12	$5.49	$5.13	$5.93	$7.21	$5.13
FY 2012-13	$5.30	$4.82	$5.71	$6.91	Not Available
FY 2013-14	$4.84	$4.21	$4.97	$6.54	Not Available
FY 2014-15	$5.28	$4.77	$5.35	$7.04	Not Available

Source: Valley Metro Transit Performance Reports

Note: [A] Route 40 provides local service within Mesa, and was reduced in fiscal year 2011-2012; [B] Regional Funding for Route 112, which runs from Chandler to Mesa increased in fiscal year 2011-2012; [C] Arizona Avenue-Link service runs from Chandler to Main Street in Mesa. [D] Route 511 service ran from the Scottsdale Airpark to the Chandler Park and Ride. [E] Wickenburg Rural Service Connector began in 2006 and was eliminated in 2011; [F] Farebox Recovery is rounded to the nearest tenth of a percent for fiscal years 2011-2012 through 2014-2015.

Statutorily Established Citizens Transportation Oversight Committee is not Functioning as well as other Peers

In 1994, Arizona statutes created the Citizens Transportation Oversight Committee (CTOC) as part of Maricopa County's Proposition 300 sales tax initiative which was primarily related to freeway transportation projects. With the passage of Proposition 400 (Prop 400) in 2004, CTOC was tasked with facilitating citizen involvement in the decision-making process for planning and construction of freeways as well as those activities related to arterial streets and transit improvements funded by the one-half cent sales tax. Composed of public members, CTOC is an independent body with authority and responsibility separate from the RTP partners illustrated and discussed in Figure 1 in the Introduction and Background section of this report.

The 2004 publicity pamphlet for Prop 400 describes CTOC as having responsibility for monitoring the RTP. However, CTOC is not functioning as intended. For example, CTOC has not contracted for a statutorily required financial compliance audit of all expenditures from the regional area road fund and the public transportation fund since fiscal year 2013. In addition, CTOC has not met since May 2014. Two factors may explain CTOC's failure to meet as required by statute. First, Arizona legislative House Bill 2600 was proposed in 2016 to eliminate CTOC—efforts that were not successful, but may have dissuaded the committee from fulfilling its responsibilities. Second, as of August 31, 2016, there were several vacancies on CTOC.

Even when CTOC was meeting, its role was limited. Based on our review of minutes for the 19 CTOC meetings held during our five-year audit period, the RTP partner agencies did not ask the committee for input or recommendations on proposed changes to the RTP. Further, CTOC seldom voted or made recommendations during any of its meetings other than on CTOC internal activities such as meeting schedules and required annual CTOC reports.

Arizona Revised Statute 28-6356 provides CTOC broad authority and allows it to advise and make recommendations on matters in the regional transportation plan. Specifically, CTOC is statutorily tasked with key responsibilities as follows.

- Review and advise the Governor, Legislature, State Transportation Board, Director of ADOT, MAG Regional Council, and the Board of Directors of the Regional Public Transportation Authority on matters related to projects funded by Proposition 400 and in the RTP;
- Review and make recommendations regarding any proposed major amendment of the RTP by the MAG Regional Council;
- Annually review and comment on the criteria developed by MAG to establish the priority of corridors, corridor segments, and other transportation projects.
- Annually contract with an independent auditor who is a certified public accountant to conduct a financial compliance audit of all expenditures from the regional area road fund and the public transportation fund and receive the auditor's report.

The CTOC may also make recommendations to MAG, RPTA, and the State Transportation Board regarding transportation projects and public transportation systems funded in the RTP, the Transportation Improvement Program, the ADOT Five-Year Construction Program and the Life Cycle Management Programs. Although other avenues are available for citizens to provide a great deal of input through the various RTP partners' committee processes, this input is typically provided during a short public-comment window at a committee meeting. Through a mechanism like CTOC, citizens serving on the committee have an opportunity to inquire, deliberate, and request additional information from the RTP partners on proposed RTP actions.

Unlike CTOC, other peer agencies have developed formal protocols to guide committee functions and operate as a more critical step in the regional transportation process. In particular San Diego's "Statement of Understanding Regarding the Implementation of the Independent Taxpayer Oversight Committee for the *TransNet* Program" describes not only practices guiding how the committee fulfills its duties, but also its functional role as a partner to the regional planning agency. The established protocols delineate a number of responsibilities and duties such as to review the major congestion relief projects for performance in terms of cost control and schedule adherence on a quarterly basis. Another citizens' sales tax oversight committee from the City of Springfield, Missouri spent time developing specific functions to fulfill its mandate, identifying information to request, defining how to interpret and evaluate data, and contemplating mechanisms for obtaining citizen input.

Further, other similar oversight committees are provided substantive data related to projects and rationale behind ultimate actions and decisions made as part of the same presentation packets that are provided to official decision-making bodies. With this type of data, CTOC members can vote their formal approval or disapproval of project activities and that vote can be carried forward with the CTOC chair as a voting member of the MAG Transportation Policy Committee. Moreover, if CTOC incorporated some of these peer techniques, CTOC could better employ its duties transferring knowledge between members rotating on or off the committee, establishing expectations for information and data needs from the RTP partners, and demonstrating accountability to the public.

With half of the Prop 400 term still remaining, ADOT should work together with existing CTOC members to transition the current inactive state of CTOC into a more robust oversight committee that better serves the public and contributes to the transportation and transit processes. As such, we believe that ADOT, as the administrative support for CTOC, should work cooperatively with the remaining CTOC members, County Board of Supervisors, and the Governor's Office to fill CTOC vacancies and revamp committee practices. Consideration should be given to ensure CTOC members possess a broad complement of skills and expertise related to freeway, arterial streets, bus transit, and rail. Moreover, ADOT should encourage all the RTP partners to use the committee as an important step in the RTP planning and project implementation process to seek perspective and input on the broad spectrum of project and program issues, whether it is related to funding or project design and scoping issues. They should strive to facilitate citizen input and best protect the public's interest. In addition, ADOT should ensure that CTOC contracts with an independent auditor to conduct the annual financial compliance audit.

Chapter 2: Freeway Performance

CHAPTER SUMMARY

With 56.2 percent of funding earmarked for improvements on the freeway network in the Maricopa County region, Proposition 400 (Prop 400) placed significant emphasis on the construction of new freeway corridors and expanding capacity on existing freeways to help relieve congestion.

Prop 400/RTP Improvements Proposed

Of the $14.3 billion of Prop 400 funding expected in 2005, $8 billion in sales tax revenues was allocated towards freeway and highway projects intended to build nearly 770 miles of new and improved freeways through new corridors, added lanes, high occupancy vehicle lanes, and freeway-to-freeway interchanges, landscaping, and maintenance.

Funding deficits during the recession required rebalancing efforts to cut the freeway program down to $6.6 billion in fiscal year 2011-2012 which was mainly achieved through value engineering decisions that cut costs and the deferral of projects beyond the 2003 Regional Transportation Plan (RTP) horizon of fiscal year 2025-2026.

Status of Projects and Activities

As of June 2015, 67 freeway projects have opened to traffic adding approximately 240 miles of new and improved lanes to the freeway network—for a total of nearly 1,800 freeway miles in Maricopa County.

Performance

- ✓ There were over 30 million vehicle miles of travel on freeways in calendar year 2014 which was about four percent greater than in calendar year 2011.
- ✓ Average travel time index during the afternoon peak travel hours increased resulting in longer travel times across the regional freeway system from calendar years 2010 to 2014.
- ✓ Morning average travel time index remained relatively flat and midday travel time decreased.
- ✓ 37 projects opened to traffic between fiscal years 2010-2011 and 2014-2015 adding or improving 153 freeway miles and 10 traffic interchanges.

Audit Results Highlights

- Between fiscal years 2010-2011 and 2014-2015, freeway performance trends related to the expenditure of Prop 400 and RTP funding show congestion and travel time have increased in the afternoon and decreased during midday.
- While performance indicators generally reveal higher levels of congestion with longer travel times in the afternoon, we cannot evaluate this performance in terms of expectations because no official or formal targets have been established or adopted.
- Congestion growth trends in Maricopa County are aligned with performance nationwide—although the Phoenix-Mesa Urbanized Area is less congested than several other peers in the nation.
- Completed portions of the Red Mountain/Loop 101 Pima to Broadway design-build project were delivered below budget and schedule delays were reasonable and documented.
- Arizona Department of Transportation (ADOT) uses many widely-accepted project management best practices and also tracks internal project delivery efficiency and performance.
- Major progress has been made on the South Mountain/Loop 202 freeway with many leading and innovative practices being employed.

Recommendations

- ADOT should report freeway bridge and pavement condition data at the Maricopa County or Phoenix-Mesa Urbanized Area level, in addition to current statewide data already available.
- ADOT should track and report internal project delivery performance metrics at the Maricopa County or Phoenix-Mesa Urbanized Area level.
- ADOT should consider using additional project delivery metrics including "project administrative costs as a percent of budget."
- With many innovative project management practices employed on the South Mountain Freeway project, ADOT should consider applying techniques and tools from this project to other ADOT freeway projects, as appropriate.

Performance Results Show that the Freeway Systemwide is More Congested during the Evening Commute, but Less Congested during Midday and Morning Commuting Hours

With a majority of Prop 400 funds and other state and local funds allocated to the freeway system, the RTP freeway projects are important to the successful operation of the MAG regional network as freeways comprise the vast majority of the entire multimodal network. Thus, freeway performance in terms of congestion and speed is critical to mobility in the region.

The Maricopa Association of Governments (MAG) is currently tracking performance on 10 freeway corridors, which represent the key travelled corridors and cover the majority of the region's freeway network. Performance is not tracked on all corridors because some freeways are not yet complete (e.g. South Mountain) or data is limited or not available for others.[25] As of June 30, 2015, more than $2.4 billion has been spent on these 10 corridors as part of the RTP and Prop 400 projects started in 2005 as shown in Table 2.

To understand potential impacts resulting from expenditures on these freeway projects over fiscal years 2010-2011 through 2014-2015, we reviewed changes in system performance using MAG's new dashboard feature—MAGnitude—which offers a multitude of valuable performance information related to freeway activity. While we were asked to examine performance of the system, MAG also has voluminous data available to examine the 10 freeway corridors separately by time of day and in various directions (northbound, southbound, westbound, and eastbound).

Specifically, we assessed regional freeway performance using calendar year data available based on four industry standard performance indicators—vehicle miles of travel, speed, travel time, and planning time.[26]

[25] Given the expense, significant effort, and cost-benefit involved with capturing performance data, others in the U.S. are similar to Maricopa County where performance data is not captured or available for every segment or mile of freeway.
[26] Only calendar year data was available so performance assessments do not exactly align with the fiscal years under audit.

Table 2: Regional Freeway System Performance Corridors and Costs in Maricopa County, July 1, 2005 through June 30, 2015 (dollars in millions)

	Corridor	Design	Right-of-Way	Construction	Total
1	**I-10 Papago & Maricopa**	$ 24.0	$ 204.6	$ 214.4	$ 443.0
2	**I-17 Black Canyon**	$ 14.6	$ 94.5	$ 317.2	$ 426.3
3	**SR 51 Piestewa**	$ 3.7	$ 0.1	$ 49.9	$ 53.7
4	**US 60 Superstition**	$ 3.2	$ 2.3	$ 128.9	$ 134.4
5	**SR 101 Agua Fria**	$ 2.4	$ 1.2	$ 185.0	$ 191.4
6	**SR 101 Pima**	$ 15.0	$ 4.0	$ 202.1	$ 217.1
7	**SR 101 Price**	$ 5.0	$ -	$ 43.9	$ 49.2
8	**SR 143 Hohokam**	$ 3.6	$ 0.3	$ 20.7	$ 24.3
9	**SR 202 Red Mountain**	$ 4.3	$ 5.0	$ 394.2	$ 398.5
10	**SR 202 Santan**	$ 1.8	$ -	$ 114.0	$ 500.2
	Total Freeways:	**$ 77.6**	**$ 312.0**	**$ 1,670.3**	**$ 2,438.1**

Source: ADOT Freeway Life Cycle Program Certification, July 2015

I = Interstate; SR = State Route

Some data is available for the Maricopa County region, while other data is only available for the Phoenix-Mesa Urbanized Area as defined by the U.S. Census.[27] Because the Phoenix-Mesa Urbanized Area accounts for the vast majority of the population in Maricopa County, it is a useful indicator of regional performance. Specific results are discussed in the sections that follow; however, performance of the freeways systemwide in terms of congestion is mixed depending on specific corridor traveled and time of day. While performance is measured, an evaluation of whether expectations were met cannot be determined with certainty until ADOT and MAG officially set formal performance targets.

Vehicle Miles of Travel on Freeways Has Mostly Increased

Vehicle miles of travel (VMT) is a measure of the volume of traffic for a roadway system. [28] The vehicle miles of travel for the Phoenix-Mesa Urbanized Area is captured by ADOT's freeway management system that counts and measures traffic volume through a network of cameras, ramp meters, and traffic detectors connected by miles of fiber optic networks. Loop detectors embedded in asphalt assist in determining the speed of vehicles that pass over them, while MAG analyzes and reports on the freeway performance information gathered for the MAG region.

Based on this data, the annual average of daily vehicle miles of travel for the Phoenix-Mesa Urbanized Area increased approximately four percent between calendar years 2011 and 2014

[27] U.S. Census urbanized areas are areas consisting of a central core and adjacent densely settled territory with 50,000 residents or more.

[28] Vehicle miles of travel (VMT) is a measure of the number of miles traveled by vehicles in a region over a period of time. VMT is determined by either actual odometer readings or by estimated modeling calculations.

rising from 29.5 million miles in calendar year 2011 to 30.8 million miles in calendar year 2014. According to MAG's 2014 RTP Update Report, the increase in vehicle miles of travel is linked to the upward trend in the national and regional economy where more people are employed and are using their vehicles to drive to jobs.

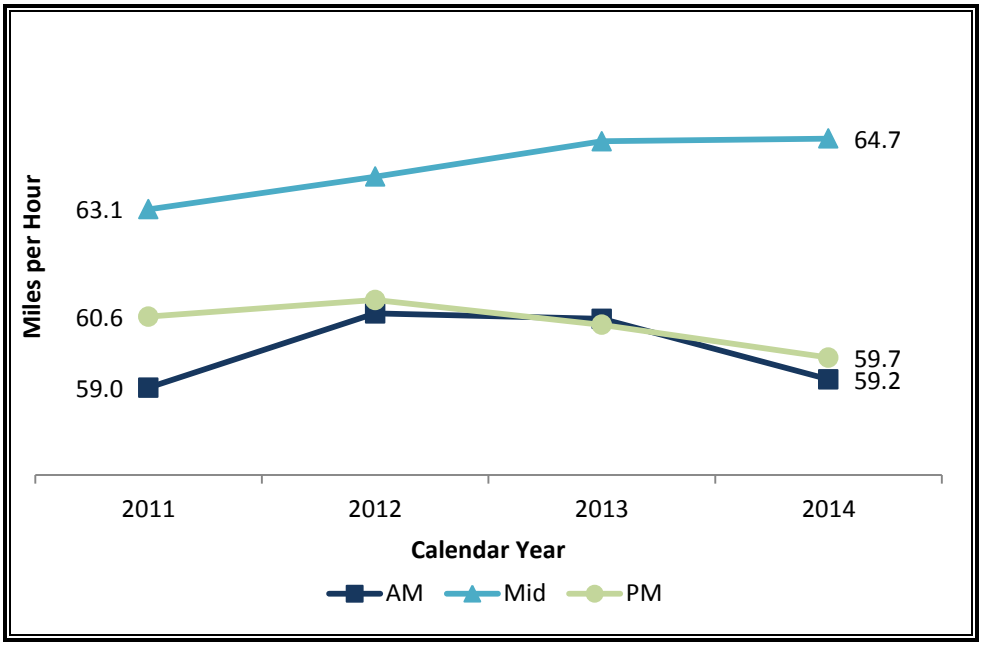
Speed Levels have Slightly Increased Midday, but Slightly Decreased in the Afternoon on Maricopa County Freeway System

Speed is an important measure for the general taxpaying public as most individuals want to drive on the freeways at maximum posted speed limits. Like others in the industry, MAG purchases performance data from third party private sector vendors[29] to capture information on the entire freeway system and not just the miles covered by ADOT detection methods. MAG uses geographic information system software to visually display the data on the MAGs performance measurement website. The result is an interactive map with color-coded streets and freeways that show the speed and congestion. MAG also uses the data to calculate traffic statistics, averaged over three periods of the day.[30]

For the Maricopa County freeway system, we found varying speed results for different times of day, as shown in Chart 1. Specifically, morning and midday speeds favorably increased between calendar years 2011 and 2014—although by small increases of 0.3 percent and 2.5 percent, respectively.[31] Conversely, afternoon speeds have decreased slightly by 1.5 percent from 60.6 miles per hour to 59.7 miles over the same period.

[29] Two private data providers were under contract with MAG, including NAVTEQ a provider of base electronic navigable maps.
[30] The three periods of the day used for reporting are morning (6:00 a.m. to 9:00 a.m.), midday (9:00 a.m. to 3:00 p.m.), and afternoon (3:00 p.m. to 6:00 p.m.).
[31] Percent change in speed was calculated based on the speeds rounded to the nearest tenths decimal place.

Chart 1: Average Speeds on Freeway System
Calendar Years 2011 through 2014



Source: Private sector data provided from MAGnitude Dashboard at http://performance.azmag.gov/

A.M. refers to morning data (6 a.m. to 9 a.m.); Mid refers to midday data (9 a.m. to 3 p.m.); P.M. refers to afternoon data (3 p.m. to 6 p.m.)

The change observed when summarizing speed across the entire freeway system may at first seem small in magnitude. However, the summary includes both directions of each section of freeway, so variances in speed due to high commute traffic will be minimized. For example, on Interstate-10 Papago,[32] the average westbound afternoon speed was about 53 miles per hour in 2014, whereas the average eastbound speed was about 64 miles per hour. Further, some corridors of the freeway system, such as the Agua Fria Freeway/Loop 101, showed an increasing trend in afternoon speeds for both directions of travel.[33]

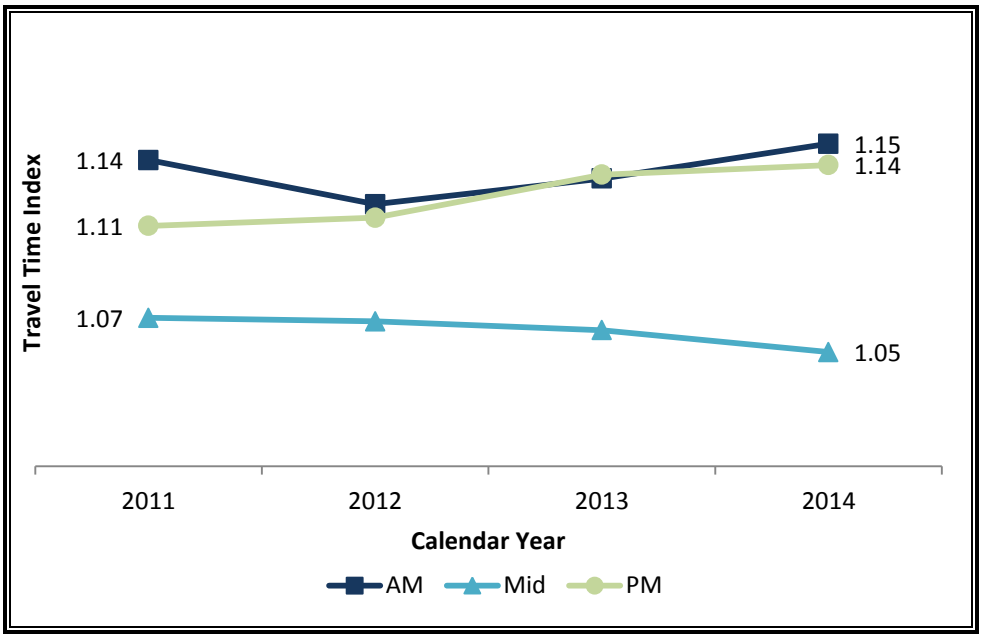
Travel Time Reliability on Maricopa County Freeways has Mostly Shown Slight Increases

Another important measure of freeway performance is the reliability of the network for drivers to reach their destinations within expected timeframes. One metric, the travel time index, conveys the estimated time needed to travel a segment of freeway compared to "free flow" or normal conditions.[34] The higher the travel time index, the longer a driver's travel time will be. For instance, a travel time index of 1.14 means that a 30-minute commute at normal free-flow conditions would take approximately 34.2 minutes in reality.[35]

[32] The segment known as I-10 Papago is located west of Phoenix and was analyzed for portion of road between Agua Fria Freeway/Loop 101 and State Route 51.
[33] Average afternoon speed for the Agua Fria Freeway/Loop 101 corridor in 2014 was 65.1 miles per hour in the north-east bound direction and 62.7 miles per hour in the south-west bound direction.
[34] The free flow speed is calculated based on the 85th-percentile of observed speeds on a specific segment (across all time periods), which establishes an estimation of the speed of traffic at "free-flow" for that segment.
[35] 30 minutes multiplied by 1.14 travel time index equates to 34.2 minutes of driving time.

As indicated in Chart 2, the average travel time index across the freeway system in Maricopa County increased only slightly between calendar years 2011 and 2014 during the morning and afternoon peak travel hours—while midday average travel time index slightly decreased.[36] The largest change in the average freeway travel time index was shown in the afternoon peak hours. In 2011, the average travel time index for the freeway system was 1.11 and in 2014 was 1.14—an approximate 2.7 percent increase.[37] This means that a commute that took 33.3 minutes in calendar year 2011 took slightly more time at 34.2 minutes in calendar year 2014—a mostly insignificant increase.

Chart 2: Average Travel Time Index on Freeway System Calendar Years 2011 through 2014



Source: Private sector data provided from MAG Performance Measurement website http://performance.azmag.gov/
A.M. refers to morning data (6 a.m. to 9 a.m.); Mid refers to midday data (9.a.m. to 3.p.m.); P.M. refers to afternoon data (3 p.m. to 6 p.m.)

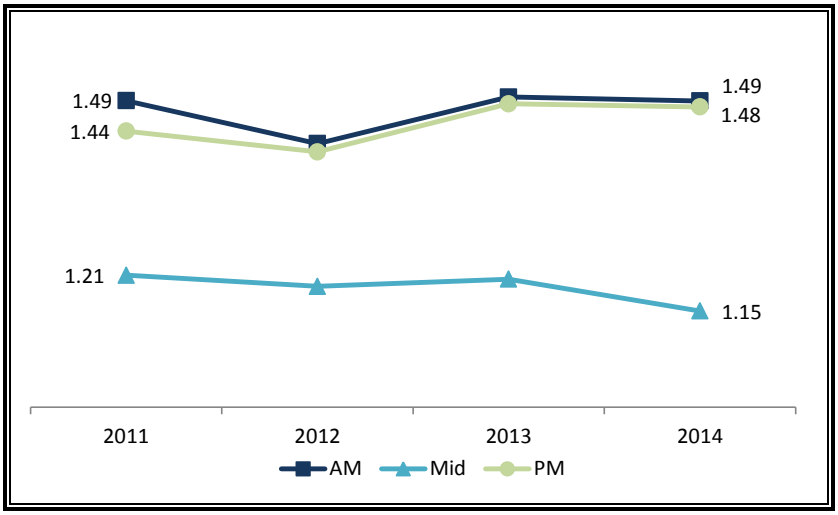
Planning Time Reliability on Maricopa County Freeway System also had Varied Results

For drivers, a planning time index can often be more useful for determining how long a freeway trip will take to arrive at a destination on-time 95 percent of the time.[38] In Maricopa County, between calendar years 2011 and 2014, the planning time index was flat during the morning commute, decreased during the midday commute indicating shorter than expected time spent on the freeway system, and increased on the afternoon commute resulting in longer than expected time spent on the freeway system as shown in Chart 3.[39] For an example of how the planning

[36] Travel time index data was summarized on the MAGnitude Dashboard by three periods—morning (6:00 a.m.to 9:00 a.m.), midday (9:00 a.m.to 3:00 p.m.), and afternoon (3:00 p.m.to 6:00 p.m.).
[37] Percent change in travel time index was calculated based on the travel time index rounded to the nearest hundredths decimal place.
[38] The planning time index is a multiplier of "free flow" or normal conditions time just like travel time index.
[39] Planning Time Index data was summarized on the MAGnitude Dashboard by three periods—morning (6:00 a.m.to 9:00 a.m.), midday (9:00 a.m. to 3:00 p.m.), and afternoon (3:00 p.m.to 6:00 p.m.).

time index works, imagine a driver that wants to be certain (at a 95 percent confidence level) to arrive at the airport on time for a 5 p.m. flight. If the trip normally took 30 minutes in free flow conditions, that driver would need to plan for 43.2 minutes of travel time in 2011. By 2014, that planning time grew slightly to 44.4 minutes in 2014.[40]

Chart 3: Average Planning Time Index on Freeway System
Calendar Years 2011 through 2014



Source: Private sector data provided on MAG Performance Measurement website http://performance.azmag.gov/
A.M. refers to morning data (6 a.m. to 9 a.m.); Mid refers to midday data (9 a.m. to 3 p.m.);
P.M. refers to afternoon data (3 p.m. to 6 p.m.)

Yet, there were also variances in planning time index results across specific freeway corridors. For example, one of the highest planning time indices calculated was for the I-10 Papago[41] freeway, eastbound traffic for the morning period. In 2014, the planning time index was 2.12, meaning that a driver should more than double the normal trip time to ensure an on-time arrival. Specifically, a 30-minute commute in free flow conditions should be planned to take over 63 minutes. In another corridor, the Agua Fria Freeway/Loop 101, auditors calculated that the planning time index increased moderately for some parts of the day depending on direction of travel and remained flat during the other times. Even with these increases, the Agua Fria Freeway/Loop 101 planning time indices were in the 1.1 to 1.4 range in 2014—well below the levels registered on the I-10.

Freeway Performance Trends in the Phoenix-Mesa Area are Better than Others Across the Nation

While there are several entities that track freeway performance throughout the country, one of the most widely-accepted reports on congestion is the Urban Mobility Report issued by the Texas Transportation Institute. The report has its critics, but the data provided is the most readily available and widely used by government agencies and the general public. According to this

[40] 2011 planning time of 43.2 minutes calculation of 30 minutes x 1.44; 2014 planning time of 44.4 minutes calculation of 30 minutes x 1.48.
[41] The free segment known as I-10 Papago is located west of Phoenix and was analyzed for portion of road between Agua Fria Freeway/Loop 101 and State Route 51.

report, the Phoenix-Mesa Urbanized Area trends showing reduced speeds in the afternoon on freeways and increased travel time indexes are aligned with national observations that congestion was worse during afternoon commutes than at other times of day.[42] The Texas Transportation Institute also pointed to the recovering economy—with increases in population and employment—as an integral driver behind those congestion level increases.

Yet, even with the Phoenix-Mesa Urbanized Area's worsening trends, congestion levels were better than most other comparable large urban areas. Specifically, when compared to 15 other urban areas with populations greater than 3 million, the Phoenix-Mesa Urbanized Area experienced the second lowest travel time index—meaning that travelers in the area experienced faster trips than travelers in all but one of the other peer areas.[43]

Fatal and Serious Injury Crash Rates Decreased Statewide and in Maricopa County, but Total Crashes Increased

Total crashes on Maricopa County freeways were greater by more than 21,000 in calendar year 2014 than in calendar year 2011 when approximately 18,000 crashes were reported.[44] Although vehicle miles of travel was also greater, the growth was smaller than the increase in crashes. In other words, the rate of crashes per thousand vehicle miles of travel was 11.5 percent greater in calendar year 2014 than compared to calendar year 2011 as shown in Table 3.

Table 3: Rate of Total Crashes per Thousand Vehicle Miles of Travel on Freeways, Calendar Years 2011 to 2014

	2011	2012	2013	2014	Percent Change from 2011 to 2014
Total Freeway VMT	29,495,000	29,073,330	29,400,899	30,802,738	4.4%
Freeway Crashes	18,083	18,139	20,073	21,064	16.5%
Crashes per Thousand VMT	0.613	0.624	0.683	0.684	11.5%

Source: MAG Performance Measurement website http://performance.azmag.gov/ and crash data provided by MAG
Note: VMT = vehicle miles of travel

ADOT reports that the trend in "fatal and serious injury" only crashes on freeways was down 8 percent statewide between calendar years 2011 and 2014. When compared to overall national trends, the Maricopa County freeway system had a lower level of fatal crashes as a rate of vehicle miles of travel.[45] Further, the rate of fatal crashes per vehicle miles of travel for the Phoenix-Mesa Urbanized Area freeway system was slightly lower in calendar year 2014 when compared to calendar year 2011—a trend that is similar to national results where fatalities also slightly decreased during that same time frame.

[42] Texas A&M Transportation Institute's 2015 Urban Mobility Scorecard.
[43] Texas A&M Transportation Institute's 2015 Urban Congestion Report. The urban area with the lowest reported congestion was the Philadelphia area; highest was the Los Angeles-Long Beach-Anaheim area.
[44] While MAG has assumed the lead role in reporting performance data for the freeway system in Maricopa County, ADOT also collects and reports on certain other performance elements including safety related measures of fatal and serious injury crash rates.
[45] Federally reported data did not distinguish between freeway and arterial roadways.

Statewide Data Suggests Freeway Pavement and Bridges are in Fair or Good Condition

Another measure of how well a freeway system performs relates to the condition of its pavement and bridges that can affect the quality and speed of the ride as well as the safety on those roadways. In Maricopa County, ADOT tracks pavement and bridge conditions—yet this data is only reported at the statewide level and not easily reportable discretely by county. That said, ADOT reports that freeway pavement and freeway bridges in the state are in good condition with the most recent performance data from calendar year 2014 suggesting a solid foundation is in place. Specifically, 2014 calendar year statewide data demonstrates the following:

- 94 percent of miles of pavement are in good or fair condition[46]
- 98 percent of freeway bridges are in good (65 percent) or fair condition (33 percent)[47]

As ranked by the Federal Highway Administration, only Florida, Texas, and Nevada have more bridges in good condition than Arizona nationwide.[48] However, there has been a slight decline in freeway bridge condition dropping from 73 percent of bridges in good condition in calendar year 2011 to 65 percent in good condition in calendar year 2014. Even so, Arizona compares favorably to other states. To enable Prop 400 voters to weigh performance against their sales tax investments, ADOT should report pavement and bridge condition data at the Maricopa County or the Phoenix-Mesa Urbanized Area level.

Impact of Individual RTP Projects on Travel Time is Difficult to Evaluate

In addition to analyzing performance trends over freeways systemwide, we attempted to assess how certain RTP project improvements along a specific corridor affected performance in that particular area. Yet, it should be noted that the performance of a specific project is influenced by many factors mostly outside the RTP partners' control such as population changes, volume of traffic incidents, and economic vitality. Additionally, measuring performance of a single project may over or under estimated that project's impact on overall system performance—especially if the project is part of a series of project improvements along a corridor or freeway segment. Nonetheless, project level analysis provides some indication of performance that can be analyzed and used as part of monitoring efforts.

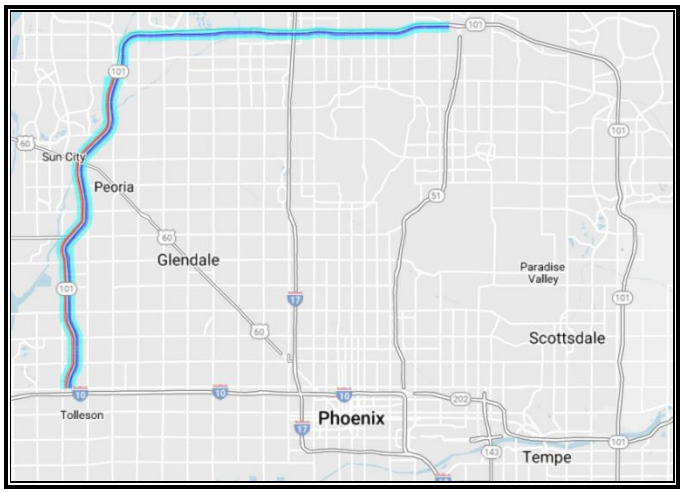
As such, we reviewed the performance of the Agua Fria Freeway/Loop 101 from Interstate-10 Papago to Tatum Boulevard as highlighted in Figure 8. This project opened to traffic in October 2011 and added 30 miles of new northbound and southbound high occupancy vehicle lanes.

Based on data from the MAGnitude Dashboard, reliability decreased after the RTP project was completed. Data revealed that the planning time index was higher—indicating longer travel times in calendar year 2012 after the RTP project was completed, than when compared against

[46] As categorized against the International Roughness Index—an-FHWA accepted standard reference and widely-used and freeway pavement condition indicator that captures the smoothness of freeway pavement.
[47] Using the National Bridge Inventory Condition Rating that ranks bridge deck conditions on a scale from 0 to 9, where a rating of 0 to 4 is considered poor, 5 to 6 is fair, and 7 to 9 is good.
[48] According to FHWA's National Bridge Inventory 2015 data, Arizona ranks 4th of 51 States with reported data.

travel times in calendar year 2010 before the project was completed. In particular, the morning planning time index was greater by about 2.2 percent in the north/east direction and greater by about 2.6 percent in the south/west direction. In practical terms, these results indicate that a driver with a 20-minute commute in normal, free flow conditions, south-west bound in the morning would have planned for an average of 22.6 minutes to travel in 2010 and increased planning time to 23.2 minutes in 2012.

Figure 8: Map of SR101, I-10 Papago to Tatum Boulevard Improvements



Source: Map data ©2016 Google, INEGI displayed on MAG MS2 website
http://mag.ms2cloud.com/tdms.ui/ttds/dashboard?loc=Mag

While an increase in travel time may not be favorable, it could be a result of a growing population or strengthened economy. As population increases, it seems logical to assume that congestion and travel times might also increase. Yet, it is difficult to determine whether these increases in travel time noted on the Agua Fria Freeway/Loop 101 project were expected by MAG and ADOT without being able to measure against some level of targets or whether this increase in travel time was within acceptable limits for the region. As recommended in Chapter 1, establishing targets would enable the quantifiable evaluation of implemented projects against performance expectations and strategies in achieving regional goals. For example, an entity may expect travel time to increase even after a project was completed given possible projections of a growing population and increased demand on a roadway. Yet, those expectations could also estimate that travel time would increase by a smaller percentage than it would have if a project was not completed at all.

MAG has indicated that it is ready to set targets, but it is waiting to collaborate with ADOT's in-progress target setting efforts as well as receive final rule guidance from the federal government on implementing targets as part of the FAST Act.

ADOT is Completing Many Projects as Promised under Prop 400, Although Some Future Projects have been Delayed or Replaced with Other Projects

Performance can also be measured in terms of output and completed projects. In Maricopa County, many of the promised freeway projects have been completed. Specifically, in the 2003 RTP, 96 freeway projects were planned for completion by fiscal year 2025-2026 at an estimated cost of $8 billion.[49] Since that time, those original projects have evolved into a myriad of project segments where project scope, limits, and budgets have changed over time with projects added, merged, delayed or even removed outside the original 2003 RTP plan timeline past fiscal year 2025-2026. These changes were discussed and deliberated through the MAG committee process in response to changing conditions similar to transportation planning processes that occur in other regions throughout the nation. For example, the new State Route 303 freeway originally consisted of two projects, but has since grown to include seven individual projects.

ADOT has completed many projects promised under Prop 400. Specifically, as of June 30, 2015, ADOT has completed 67 freeway projects including capacity improvements through new general purpose and high occupancy vehicle lanes, new ramps, bridges, and traffic interchange improvements at a total cost of $3.7 billion. Of those 67 projects, 37 projects totaling $2 billion opened to traffic between July 1, 2010 and June 30, 2015 as shown in Table 4. The other 30 projects opened to traffic prior to July 1, 2010 as discussed in the 2011 RTP Performance Audit.

Table 4: Number of Freeway Projects Completed and Opened to Traffic, July 1, 2010 through June 30, 2015

	Corridor	Segment	Project Type	Date Open to Traffic	Expenses as of 6/30/2015 (in millions)
1	**I-10** SR-85 to SR-303	Verrado Way - Sarival Road	GPL	Aug-11	$30
2		Perryville Road	TI	Oct-14	$29.5
3	**I-10** SR-303 to SR-101	Sarival Ave - Dysart Road	GPL	Jan-11	$38.7
4		Sarival Rd – 101 Loop Agua Fria	GPL, HOVL	Jul-10	$93
5		Avondale Blvd @ I-10	TI	FY2010/11	$2.8
6	**SR-24** 202L Santan to Meridian Road	Jomax Road - SR74 Carefree Highway	GPL, HOVL	Jul-10	$97.6
7		202 Loop Santan - Ellsworth Road, Phase 1	4 GPLs	May-14	$119.73
8	**US-60 Grand Ave** SR-303 to SR-101	303 Loop Bob Stump - 99th Avenue, Phase 1	GPL	Jun-11	$33.18
9		99th Ave - 83rd Avenue, and new river bridge	GPL, Bridge	Apr-11	$12.01
10	**US-60 Grand Ave** SR-101 to Van Buren	101 Loop Agua Fria - 71st Avenue	Widening	Aug-13	$6.41
11		71st Avenue - McDowell Rd (101 Loop - McDowell Road)	Widening	Jul-14	$31.72
12	**SR-74** US-60 to SR-303	US 60 Grand – 303 Loop Bob Stump MP 13-15	Pass Lane	Apr-11	$4.11
13		US60 Grand – 303 Loop Bob Stump MP 20-22	Pass Lane	Oct-10	$4.3

[49] Amount estimated in 2002 dollars.

	Corridor	Segment	Project Type	Date Open to Traffic	Expenses as of 6/30/2015 (in millions)
14	**SR-85** I-8 to MC-85	SR 85 at Gila Bend, Phase 1	GPL	Jan-13	$24.88
15	**SR-85** MC-85 to I-10	Southern Avenue - I-10 Papago	GPL	Jul-11	$12.61
16	**SR-87** Forest Boundary to Mile Post 213	New Four Peaks Road - Dos S Ranch	Turn	May-11	$16.51
17		MP 211.8 - MP 213	Drainage	May-11	$1.39
18	**SR-8** Fish Creek Hill	Fish Creek Hill	Retaining Walls	FY2012	$0.59
19	**SR-101** I-10 to US-60	I-10 Papago - Tatum Boulevard	HOV	Oct-11	$109.33
20		I-10 Papago - Van Buren (99th Avenue)	GPL	Dec-10	$5.66
21		Maryland Avenue HOV Ramps	HOV Ramps	Mar-14	$14.31
22		Olive Avenue	TI	Jul-11	$3.86
23	**SR-101** US-60 to I-17	Beardsley Road/Union Hills Drive	TI	May-11	$20.06
24	**SR-101** Princess Dr to SR-202	Chaparral Road	TI Imp	Aug-11	$1.17
25	**SR-143** SR-143 at SR-202	SR143/SR 202 Loop	TI New	Jul-12	$27.52
26	**SR-202** I-10 to SR-101 Pima	I-10/SR 51 TI – 101 Loop Pima	GPL	Aug-10	$216.29
27	**SR-202** SR-101 Pima to Gilbert Rd	101 Loop Pima - Gilbert Road	HOV	Aug-10	$27.59
28	**SR-202** Val Vista Dr - Gilbert Rd to I-10 Maricopa	Gilbert Road - I-10 Maricopa	HOV & 2 HOV Ramps	Oct-11	$101.30
29	**SR-303** I-10 to US-60	I-10/303 Loop System TI, Phase 1, I-10 Realignment	New Fwy	Sep-14	$290.10
30		Thomas Road - Camelback Road	New Fwy	Nov-13	$41.80
31		Camelback Road - Glendale Avenue	New Fwy	May-14	$55.40
32		Glendale Avenue - Peoria Avenue	New Fwy	Sep-13	$93.50
33		Peoria Ave - Mountain View Road	New Fwy	Nov-13	$150.50
34		Cactus Road, Waddell Road & Bell Road	New Fwy	Mar-11	$37.40
35		Waddel Road - Mountain View Road	New Fwy	Nov-13	$11.50
36	**SR-303** US-60 to I-17	Happy Valley Road - Lake Pleasant Road	New Fwy	May-11	$128.54
37		Lake Pleasant Road - I-17 Black Canyon	New Fwy	May-11	$92.60
				Total:	**$2 Billion**

Source: 2015 Prop 400 Annual Report

Note: GPL = General Purpose Lane; HOVL = High Occupancy Vehicle Lane; TI = Traffic Interchange; SR = State Route; MP = Milepost

In addition to the $3.7 billion in freeway projects completed to date, the 2003 RTP programmed a total of eight projects to begin construction in Phase III of the RTP between July 1, 2015 and June 30, 2020. Of those eight projects, seven are capacity improvement projects adding a general purpose and/or high-occupancy vehicle lane while the remaining project will add a high occupancy vehicle ramp. Related costs for these eight projects were estimated to be $1.6 billion in 2003.

For these eight original Phase III planned projects, ADOT is experiencing some delays although one project was completed ahead of time. Table 5 details the status of the eight projects originally planned for Phase III. As of June 30, 2015, three projects are partially complete and the remaining four projects are currently in the design phase; however, for these remaining projects, construction is not scheduled to begin until Phase IV with some projects even pushed beyond the Prop 400 sunset date of December 2025. However, ADOT has also programmed 18 additional projects for Phase III that were not part of the original 2003 Phase III projects. For example, the new South Mountain freeway was originally planned for Phase I and II, but has been delayed to Phase III. Similarly, there are elements of completed projects that still need to be constructed such as interchanges on the new State Route-303 freeway, US-60, and Interstate-10 freeways. The majority of these projects are currently underway.[50]

While ADOT has moved construction start and anticipated completion dates for many of its Phase III projects, those changes and reasons behind the changes are reviewed and approved through the MAG committee process as discussed in the 2011 RTP Performance Audit.

Table 5: Status of Eight Planned Phase III Projects as of June 30, 2015

#	Corridor	Segment	Project Type	Length (Miles)	Programmed for Final Construction	Total Estimated Cost FY06-26 (in millions)	Current Status
1	I-17	Arizona Canal to McDowell Road	GPL	7	FY2021-26	$385.60	DCR ("Spine Study")
2	I-17	I-10 (West) to I-10 (East)	HOV	7	FY2021-26	$400.00	DCR ("Spine Study")
3	Loop 101	Agua Fria: I-10 to US 60/Grand Avenue	GPL/ HOV	10	FY 2027-35	$226.35	HOVL Opened 10/2011; GPL delayed to Phase V
4	Loop 202	Red Mountain: Gilbert Road to Higley Road	GPL/ HOV	5	FY2027-35	$51.90	HOVL Opened 12/2015; GPL delayed to Phase V
5	US 60	Superstition: Crismon Road to Meridian Road	GPL/ HOV	2	FY2016-20	$30.53	DCR
6	SR-24	Loop 202 to Ellsworth Road	GPL	2	FY2027-35	$188.53	Interim Lanes Opened 5/2014; Final Lanes delayed past the Prop 400 timeframe
7	SR-24	Ellsworth Road to Meridian Road	GPL	3	FY2027-35	$213.30	DCR
8	Loop 202	Santan & Loop 101/Price	n/a	n/a	Completed	$101.30	Opened October 2011
					Total:	**$1.6 Billion**	

Source: 2003 RTP; 2015 Prop 400 Annual Report

Note: GPL = General Purpose Lane; HOVL = High occupancy Vehicle Lane; TI = Traffic Interchange; DCR = Design Concept Report

[50] Per the 2015 Prop 400 Update Report.

ADOT Uses Metrics to Track Progress against Internal Performance Targets

In addition to measuring performance outcomes and outputs, ADOT also uses metrics to measure internal project performance and efficiency in delivering capital projects. This leading practice uses meaningful goals and tracks performance against those goals to help highlight potential areas in need of improvement, hold project owners accountable and efficient, and demonstrate performance to the public. ADOT practices align with other peers across the country that measure their own project performance with examples of these tools found in California, Florida, Missouri, Virginia, and Washington as well. Still other transportation entities across the country are just beginning to realize that efficiency performance measurement is a critical tool used at a project level allowing stakeholders to evaluate the benefits of transportation improvements. Since the beginning of calendar year 2016, ADOT has tracked several monthly project performance targets on a statewide level through an agency scorecard as shown in Table 6.

Table 6: ADOT Agency Scorecard Project Management Performance Metrics, Statewide Results

Metric	Target	Actual as of July 2016[A]	Target Met as of July 2016
Task Order Execution Time: Decrease time needed to execute a design consultant task order from 172 days to 50 days or less by the end of CY 2016	50 Days	64	No
On-Time Construction Delivery: Increase the percent of construction projects with on-time delivery from 50 percent to 55 percent by the end of CY 2016	55%	33%	No
On-Budget Construction Delivery: 100 percent of construction projects delivered within original program amount [B]	100%	100%	Yes

Source: ADOT Agency Scorecard, July 2016

Note: [A]ADOT tracks internal performance on a calendar year basis; in this table, actual is from January 2016 to July 2016;

[B] Calculated monthly using final construction cost vs. total construction delivery cost (=program amount) which includes contract award amount, construction administration, and other related costs. This is not the construction contract cost only.

While the scorecard's design is still in-flux and metrics are being fine-tuned, ADOT reported that 33 percent of construction projects statewide were delivered on-time—below its current target of 55 percent. Similarly, while ADOT has not yet met its target of 50 days to execute design consultant task orders, it has made progress towards that goal by decreasing the average time from 172 days on average to 64 days as of July 2016. ADOT also reported that 100 percent of its completed construction projects were delivered within the total project's budget. Yet, to allow Prop 400 voters to weigh RTP project performance against their sales tax investments, ADOT should report this internal performance data at the Maricopa County or Phoenix-Mesa Urbanized Area level.

Additional performance metric information also seems to indicate improvements in project delivery. For example, as shown in Table 7, internal metrics for projects completed in ADOT's Phoenix District show improvement over the last five years in many categories. Not only are construction contract costs staying within five percent more of the contracted amount

regularly—only exceeding 27 percent of the time in calendar year 2015 versus 34 percent of the time in calendar year 2010—but also the number of working days was 40 days shorter than the construction contract period in 2015. ADOT uses this information to assess how well construction projects are managed in terms of schedule and cost and, if necessary, to adjust its practices in delivering projects more efficiently.

Table 7: ADOT Phoenix District (District 1, Maricopa County) Project Delivery & Management Performance Metrics[51]

Metric	2010	2015
Number of Finalized Construction Projects where the Final Cost Exceeded the Bid Amount by 5 percent[A]	11 (34%)	8 (27%)
Number of construction working days allowed per contract versus actual days used	2680 days longer	40 days shorter
Comparisons of ADOT engineer's construction cost estimate versus contractor low bid received on average	Bids 4.19% lower	Bids 1.27% lower

Source: Auditor-calculated results using data from monthly ADOT State Engineer's Report to State Transportation Board.

Note: [A] This is tracking the construction contract bid or awarded amount against the total amount paid to the contractor at the end of the project.

Tracking internal project performance is a strong practice employed by ADOT and it should continue to monitor and refine its practices based on results. To improve its tracking, ADOT could also track percent of "project administrative costs as a percent of budget." Other state departments of transportation use this metric to create greater accountability and ultimately contain administrative and support costs incurred by state employees. Examples can be found at state departments of transportation in California, Florida, Missouri, Virginia, and Washington.

ADOT Employs Many Leading Project Management Practices

Overall, our audit revealed that ADOT has employed several strong practices to implement freeway capital projects. For example, ADOT uses typical project management practices such as cradle-to-grave project management with one project manager involved from the design stage through construction, regular project team meetings, and various project management plans.[52] In addition, in 2015, ADOT began using newer industry project management best practices such as cost risk assessments to help evaluate cost and schedule concerns, identify those areas that could adversely impact cost and schedule, and develop mitigation strategies. ADOT is also in the process of creating an alternative project delivery decision matrix for use in scoring factors related to various project delivery methods and assisting in determining the delivery approach to

[51] ADOT engineering and maintenance operations are divided into seven districts with District 1 (Phoenix District) covering most of Maricopa County and part of Pinal County.

[52] Best practices are drawn from a variety of industry sources including the Construction Management Association's Construction Management Standards of Practice, Federal Highway Administration guidance, and Project Management Body of Knowledge, among others. Auditors reviewed ADOT project files for availability and completeness of key documentations such as procurement records, design concept reports, project team meeting minutes, and change order discussions.

use on a particular project such as between traditional design-bid-build, design-build, or construction manager at-risk approaches.[53]

To gain a more detailed understanding of ADOT's project management practices and how they are used on freeway projects, we selected the Red Mountain/Loop 101 Pima to Broadway project for review. This capacity-increasing project involved a 6-mile stretch of freeway that added one high occupancy vehicle lane and one general purpose lane—the High Occupancy Vehicle lane opened to traffic in July 2010 and the general purpose lane opened in December 2015. As part of using a design-build project delivery method for this project, the design-builder team was appropriately tasked with finalizing designs while at the same time coordinating construction activities. The design and construction overlap envisioned by this delivery approach is geared to save project delivery time, but also requires close collaboration between the design-builder and the ADOT project-owner.

Our review of project files for the Red Mountain/Loop 101 Pima to Broadway project found that ADOT employed several best practices in project management as shown in Table 8.

Table 8: ADOT Employed Best Project Management Practices on Red Mountain/Loop 101 Project

General Best Practices Areas	Practices Employed by ADOT
Project Management Plans and Related Tools	✓ Design Quality Management Plan ✓ Construction Quality Management Plan ✓ Design Partnering Workshop ✓ Cost Risk Assessments
Inspections and Field Reports	✓ Daily Diary ✓ Material Quantity Sheets ✓ Force Account ✓ Bituminous Material Price Adjustments
Construction Progress Payments and Change Orders	✓ Progress Payments Reviews ✓ Change Order Negotiations
Schedule and Task Management	✓ Primavera for Scheduling ✓ Critical Path Method
Project Management Performance Measures	✓ Lessons Learned ✓ On-Time Delivery ✓ Change Order % against Contingency

Source: Red Mountain/Loop 101 project files. Auditors compared general best practices as indicated in Footnote 50 to demonstrate ADOT practices documented in project files.

[53] Design-bid-build is the typical project delivery method where the design and construction is sequenced with the project owner hiring a contractor after design is complete. Design-build allows for closer cooperation between the engineer/architect and construction contractor as those are normally joint venture partners for designing and building. Construction manager at-risk project delivery, also known as CMAR or construction manager/general contractor (CM/GC), is a project delivery method which entails a commitment by the Construction Manager to deliver the project within a Guaranteed Maximum Price with the Construction Manager generally provides input to the designer during the design phase.

Red Mountain/Loop 101 Pima to Broadway Project Schedule Delays Appear Reasonable, and Project will likely be Delivered On-Budget

To identify whether ADOT's project management practices provided needed controls over project schedule and budget, we reviewed milestones for the Red Mountain/Loop 101 Pima to Broadway Project. Our review revealed a 3-month delay for substantial completion.[54] However, the substantial completion date of February 2016 still fell within the 600-calendar day maximum set-forth by the contract as shown in Table 9; thus, there was no significant impact to the overall project schedule. According to the ADOT project manager, the main reasons for the delay related to two change orders that added 14 and 42 days respectively. These changes were to procure and install wrong way signs to comply with new ADOT guidelines issued in June 2015 after the contract was awarded and to fix pavement resulting from unforeseen conditions—all reasons that were documented and appeared reasonable.

Table 9: Planned-to-Actual Milestones for Red Mountain/Loop 101

Milestones Planned-to-Actual			
	Planned	**Actual**	**Deadline Met**
Design-Build Contract Award	09/2014	09/12/2014	Yes
Design & Construction Start/notice to proceed	10/27/2014	10/27/2014	Yes
Substantial Completion w/Completion Memo	11/15/2015	02/14/2016	No
Total Days between Contract Award and Substantial Completion	**429 Days**	**520 Days**	

Source: Red Mountain/Loop 101 project files.

Moreover, while two design concept reports estimated costs for the Red Mountain/Loop 101 project at $126 million, current project expenses only total $104 million as of April 2016. The project is still not fully complete as there is another related High Occupancy Vehicle segment—Higley Road to US 60 (now known as Broadway Road to US 60)—that is not scheduled to start design until fiscal year 2020-2021. Yet, even when combining this additional segment currently budgeted at $5.65 million with the actual $104 million spent to date, this project is still likely to be completed within the original cost estimate amounts.

In-Progress South Mountain Freeway Project uses Techniques that could be used on Other ADOT Projects

After deliberations spanning more than 30 years, construction on the South Mountain/Loop 202 Connection began in February 2016 when ADOT issued a notice to proceed for final design and construction. With the project currently in-progress, auditors reviewed the project management practices, file documentation, agreements, and plans developed to date. Similar to the Red Mountain/Loop 101 project, we found many standard project management practices in place as well as certain innovative practices.

[54] Substantial completion is an industry term used to describe the completion status of a construction project when it is ready for its intended use.

In particular, ADOT is using several practices on the South Mountain/Loop 202 freeway project that should be considered and implemented on other future projects—scaled to the specific size and complexity of other ADOT projects. ADOT should consider the following:

- ✓ Conducting risk modeling or a cost risk assessment process with technical experts discussing results from running Monte Carlo risk analysis using Microsoft Excel "At-Risk" iterative algorithm.
- ✓ Providing more detailed activities with shorter lengths of time for completion on the schedule of values.[55] By breaking the work into blocks that are completed within one billing cycle, payment negotiation may be easier because most tasks will be 100 percent complete and ready to bill or will be in progress for at most one billing cycle.
- ✓ Using monthly reports to assist in tracking the progress and measuring success of the project related to meeting or exceeding project goals with data such as cash flow, schedule variances, change orders, submittal status, and milestones.
- ✓ Enhancing document control with system tools, such as E-builder that uses a cloud-based application, or similar methods that maintain and track process workflows, received dates, action taken, approval, correspondence, payment requests, and changes to payment requests in addition to providing internal project management performance statistics.
- ✓ Tracking of internal project management performance statistics electronically, such as average number of days for document approval turnaround times, through data collected in E-builder or similar tools.
- ✓ Maintaining records supporting contractor payment approvals such as schedule of values reviews, deliberations, and negotiations.

[55] A schedule of values is a document based on the contractor's bid listing all elements of the services and goods to be provided under the contract including quantities and pricing. It is typically updated monthly and serves as the basis for progress payments.

Chapter 3: Arterial Street Performance

CHAPTER SUMMARY

Arterial street projects in the Regional Transportation Plan (RTP) are expected to help relieve congestion by adding new arterial linkages, widening existing streets, improving intersections, and implementing intelligent transportation system technology and plans.

Prop 400/RTP Improvements Proposed

Of the $14.3 billion of Proposition 400 (Prop 400) funding expected in 2005, $1.5 billion in sales tax revenues was dedicated towards arterial street projects.

Arterial streets primarily consist of roadways with four or more lanes on a mile grid and, in Maricopa County, carry over half of the total vehicles miles traveled.

The 2003 RTP outlined 95 arterial projects planned to provide approximately 200 individually defined projects adding capacity to 281 arterial miles and improving 32 intersections, as well as allocating funds for systemwide intelligent traffic system technology improvement projects.

Status of Projects and Activities

As of June 30, 2015, 54 of the 200 arterial projects have been completed, adding over 74 miles of new and improved roadways and 17 traffic interchanges.

Arterial Street Performance

- ✓ Several performance factors show increases in crashes and congestion on arterial streets.
  - Arterial crashes increased from 54,721 crashes in 2011 to 58,578 in 2014.
  - Congested arterial miles increased from 15 percent in 2011 to 35 percent in 2014.
- ✓ Pavement and bridge conditions were mostly reported in good condition and are regularly assessed.
  - Pavement conditions reported range from at-risk to good condition.
  - Over 88 percent of bridges were reported to be in good condition.
- ✓ 34 projects were completed during the five-year audit period between fiscal years 2010-2011 and 2014-2015.

Audit Results Highlights

- Congestion growth trends in Maricopa County are aligned with other entity performance nationwide.
- While performance indicators reveal higher levels of congestion and travel times at lower speeds, we cannot assess whether expectations were met as no formal targets have been established.
- Although some arterial projects were delayed, costs were under budget.
- The one City of Phoenix arterial streets project we reviewed has employed standard project management practices.
- Several local jurisdictions capture common internal project management and delivery efficiency measures such as construction bid versus final cost, construction bid versus engineer's estimate, submittal or request for information review turnaround time, baseline schedule milestones to actual, and budget-to-actual by project phases.

Recommendations

- Maricopa Association of Governments (MAG) should work with the local jurisdictions to gather and make available local performance indicators related to pavement and bridge deck condition at the Maricopa County or Phoenix-Mesa Urbanized Area level on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.

Arterial Street System Performance Data Suggests Crashes and Congestion Increases

According to the 2035 RTP updated in January 2014, the "continued expansion and improvement of the arterial street system will be vital to the functioning of the regional transportation system" as the region grows in the future. With only 10.5 percent of the $14.3 billion of Prop 400 funding dedicated to arterial street projects—local and other funding sources are also used to enhance the arterial network.

Although local jurisdictions manage and construct capital arterial projects, MAG captures performance outcome data on the arterial streets network using indicators related to congestion (travel time, speed, or delays) and safety (crashes, incidents, and fatalities). MAG identified 21 primary roadways as the major arterial corridors of the region based on highest volume of travel and proximity to freeways such that the corridor is used as an alternative route.

MAG Primary Arterial Street Corridors

1. 19th Avenue
2. 44th Street/Tatum Boulevard
3. 59th Avenue
4. 7th Street
5. Apache Boulevard / Main Street
6. Arizona Avenue/Country Club Drive
7. Baseline Road
8. Bell Road
9. Buckeye Road/County Road 85
10. Chandler Boulevard
11. Dysart Road
12. Frank Lloyd Wright Boulevard
13. Gilbert Road
14. Glendale Avenue/Lincoln Drive
15. Grand Avenue
16. Indian School Road
17. McDowell Road
18. Power Road
19. Scottsdale Road/Rural Road
20. Shea Boulevard
21. Southern Avenue

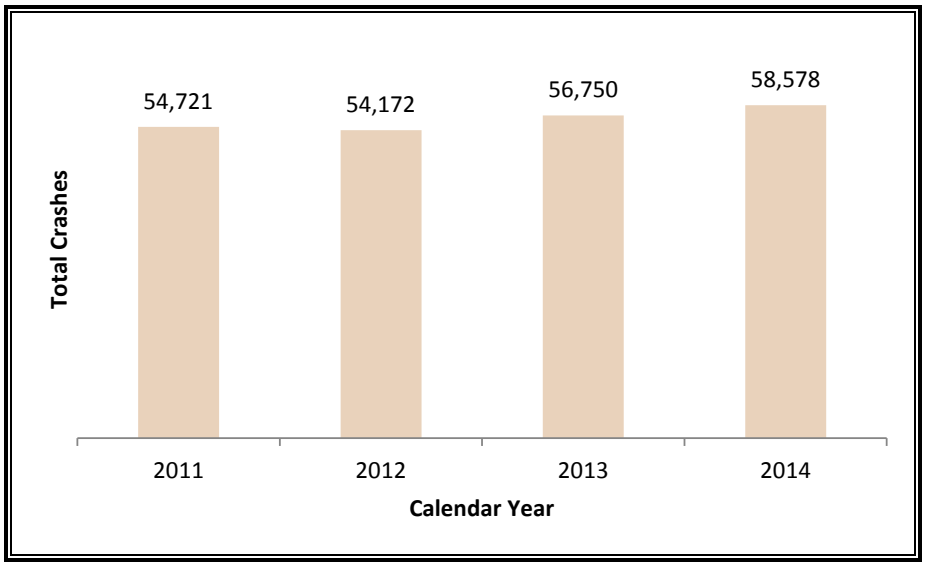
To understand potential impacts of arterial street project expenditures over the five-year audit period, we reviewed changes in system performance using data from MAG's MAGnitude dashboard reported between calendar years 2011 and 2014 based on three widely-accepted performance indicators used in industry—crashes, congestion, and speed. While we were asked to examine performance of arterial streets systemwide, MAG also has voluminous data available to examine the arterial corridors separately by time of day and in all directions (northbound, southbound, westbound, and eastbound). Audit results are discussed in the sections that follow.

Crashes on Primary Arterial Street System Have Increased, but Vehicle Miles Traveled have Also Risen

One key arterial street performance indicator of safety is crash rate. According to data collected by Arizona Department of Transportation (ADOT) through its Accident Location Identification Surveillance System, there were 58,578 crashes based on performance data for all arterial streets

in the region in calendar year 2014—which was 7.0 percent greater than the 54,721 recorded in calendar year 2011 as shown in Chart 4.[56]

Chart 4: Total Crashes per Year Have Increased Between Calendar Years 2011 and 2014



Source: Crash data collected by ADOT, provided by MAG

Although arterial street crashes in total were greater in calendar year 2014 than in calendar year 2011, when normalized by the rate of volume of traffic, there was a downward trend. Specifically, as shown in Table 10, the rate of crashes per thousand miles of vehicle travel was 4.6 percent less in calendar year 2014 than calendar year 2011 because the increase in vehicle miles of travel outpaced the increase in the number of crashes.

Table 10: Rate of Total Crashes per Thousand Vehicle Miles of Travel on Arterial Streets, Calendar Years 2011–2014

	2011	2012	2013	2014	Percent Change from 2011 to 2014
Total Arterial VMT	21,194,451	21,651,648	23,403,357	23,792,514	12.3%
Arterial Street Crashes	54,721	54,172	56,750	58,578	7.0%
Crashes per Thousand VMT	2.582	2.502	2.425	2.462	-4.6%

Source: MAG Performance Measurement website at http://performance.azmag.gov/ and crash data provided by MAG

When these arterial street results are compared to the freeway system results presented in Chapter 1 of this report, the data reveals that crashes are much more common on arterial streets. In calendar year 2014, there were approximately 2.462 crashes per thousand vehicle miles of

[56] When compared with newly released calendar year 2015 data, the increase in crashes is even greater; there were 61,416 total crashes on the Maricopa County freeway system in calendar year 2015 which was 12.2 percent greater than the number of total crashes in calendar year 2011.

travel on the arterial system, but only 0.684 crashes per thousand vehicle miles of travel on the freeway system.

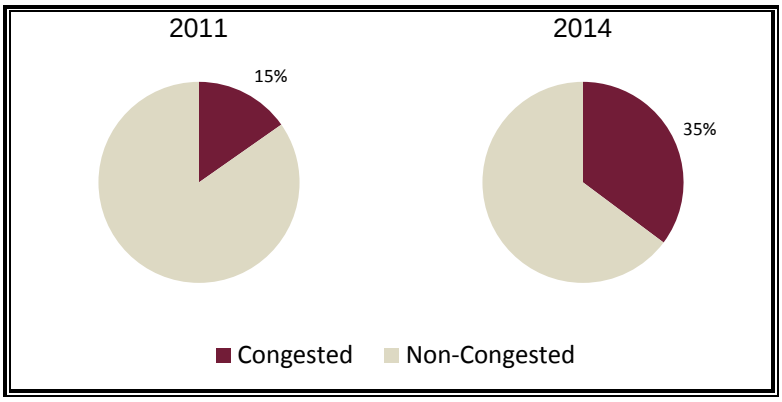
When considered against overall national trends, the Maricopa County arterial streets had a higher level of fatal crashes as a rate of vehicle miles of travel. Further, the rate of fatal crashes per vehicle miles of travel for the Maricopa County arterial system was slightly higher in calendar year 2014 when compared to calendar year 2011—a trend that differs from national results where fatalities have been slightly decreasing since calendar year 2011.[57]

Congestion has Increased on Primary Arterial Streets

Another key performance indicator on arterial streets relates to congestion. Congestion data for arterials is tracked and displayed on the MAGnitude dashboard as calculated by a "congested mile." According to MAG, a road is considered congested if average speeds were less than 75 percent of the posted speed limit.[58] MAG's performance data indicates congested miles have increased on arterial streets between calendar years 2011 and 2014 by more than 130 percent. As noted in Table 10, there were also more vehicle miles of travel on the arterial system between 2011 and 2014. However, the portion of congested miles increased much more than compared to the 12.3 percent increase in vehicle miles of travel.

Specifically, in calendar year 2011, the average for all time periods of the day was 633 congested miles out of an approximate 4,150 total miles revealing that nearly 15 percent of the arterial network was congested. In comparison, for calendar year 2014, the average percent of congested miles grew to 35 percent as shown in Chart 5. However, the reduction is also influenced by the additional arterial street miles of roadway added through completed Prop 400 projects. According to MAG, the number of intersection improvements have made travel on major arterial streets more desirable and that a significant portion of the increased vehicle miles of travel relates to this increased demand.

Chart 5: Percent of Congested Arterial Street Miles Calendar Years 2011 and 2014



Source: MAG Performance Measurement website http://performance.azmag.gov/

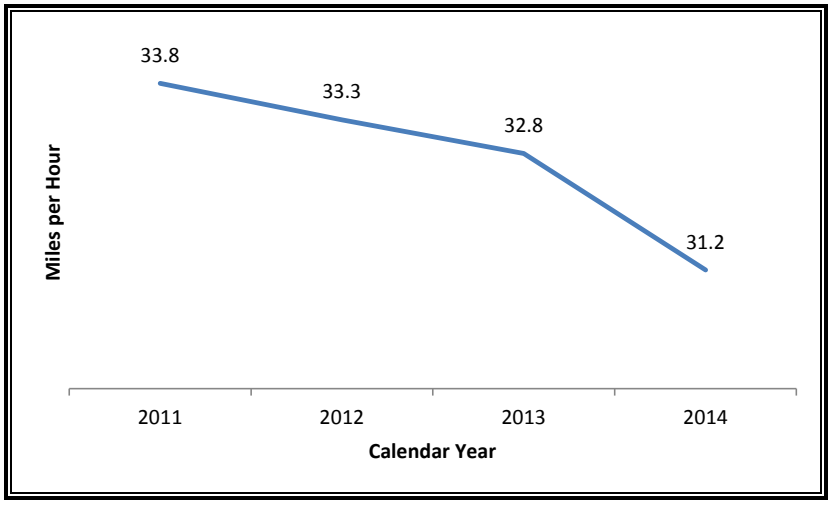
[57] National Highway Traffic Safety 2014 Traffic Administration's Safety Facts, Published July 2016 did not distinguish between arterial and freeway, but the overall trend was decreasing.
[58] MAG calculates the average speed for morning (6a.m. to 9a.m.), midday (9a.m. to 3p.m.) and afternoon (3p.m .to 6p.m.).

The biggest increase was seen during the morning peak hours where congestion grew more than 200 percent over the four-year period from 11 percent in calendar year 2011 to 34 percent by calendar year 2014. While the trend of congestion is worsening with impacts of more unproductive time in traffic and more pollutants from car exhaust, the increase in congestion may also be a sign of a stronger economy as more people move to the area and need to drive to job sites. Yet, we cannot conclude on whether the trend is within acceptable limits because MAG and its local RTP partners have not set specific targets to assess performance against what they expected to occur in the region.

Speed Levels for Key Arterial Corridors have Slowed Down

Average speed for afternoon travel on the 21 primary arterial street corridors was slower in calendar year 2014 when compared to calendar year 2011.[59] Specifically, as shown in Chart 6, the average speed in calendar year 2011 was 33.8 miles per hour, while the average speed decreased in calendar year 2014 to 31.2 miles per hour—approximately 7.8 percent slower.

Chart 6: System Wide Average Afternoon Speeds on Arterials
Calendar Years 2011 through 2014



Source: Summary analysis of data provided by MAG Performance Program

This decreasing trend was observed for each of the 21 key corridors of the arterial system with speeds decreasing more on some corridor than on others. For instance, we found that the 19th Avenue arterial corridor running 20 miles north-to-south from Deer Valley Road to Southern Avenue through downtown Phoenix experienced the largest decrease in afternoon speeds between calendar years 2011 and 2014. In fact, the average afternoon speed in the northbound direction along the entire corridor between calendar years 2011 and 2014 dropped 16.6 percent from 32.1 miles per hour in calendar year 2011 to 26.7 miles per hour in calendar year 2014. However, for part of the time period, there was construction of the 3.2 mile light rail extension that began in January 2013 extending north on 19th Avenue from Montebello to Dunlap Avenue

[59] Results based on speed data collected by third party providers and analyzed by MAG staff to calculate the average speed for the afternoon period (3:00 p.m. to 6:00 p.m.).

that was not opened to traffic until 2016. According to MAG, this construction affected the arterial corridor through flow disruptions, access diversions, and lane closures. Speed data for another arterial corridor—Power Road that runs 10 miles north-to-south through the City of Mesa and along the eastern edge of the Town of Gilbert—showed a much smaller 5.5 percent reduction in speed from 33.8 miles per hour in calendar year 2011 to 31.9 miles per hour in calendar year 2014.

Six Local Jurisdictions Report the Majority of Arterial Street Pavement is in Good or Excellent Condition

In addition to these performance indicators, the health of local roadways is an important factor impacting congestion, speed, and safety. For roadways, a pavement condition index is a widely-accepted measure for roadways that is also used by the local jurisdictions in Maricopa County. Typically, a pavement condition index is captured in categories ranging from a low of 0 to a high of 100 to indicate the general condition of pavement as shown in Figure 9.

Figure 9: Typical Pavement Condition Index Thresholds

Source: Adapted from U.S Corps of Engineers

Although performance data related to pavement and bridge condition is captured at the local jurisdiction level, the data was not available for the specific Maricopa County or the Phoenix-Mesa Urbanized Area. Thus, to assess arterial street pavement conditions, we distributed a survey to 12 local jurisdictions[60] in Maricopa County who had current projects in the arterial life cycle program. While we only received responses from seven local jurisdictions, several of the more largely populated jurisdictions were part of those that responded. Only six of those seven jurisdictions provided comments on pavement conditions. Based on the six responses received from Fountain Hills, Maricopa County, Mesa, Peoria, Phoenix and Scottsdale, local jurisdictions use a variety of pavement management systems to evaluate pavement condition.[61] Half of the entities reported assessing pavement on an annual basis.

Moreover, as shown in Table 11, five of the six jurisdictions stated that they are meeting their current pavement condition goals with a pavement condition index rating of 75 or higher indicating pavement was in the good or excellent range.

[60] Survey was sent to Carefree, Chandler, El Mirage, Fountain Hills, Gilbert, Maricopa County, Mesa, Peoria, Phoenix, Salt River Pima Maricopa Indian Community, Scottsdale, and Queen Creek.

[61] Pavement management systems cited included Micropaver and Lucity—two proprietary software tools that are common pavement management planning tools used in industry to evaluate pavement condition and make improvement decisions.

Table 11: Pavement Condition is Generally Good as Reported by Six Local Jurisdictions

	Fountain Hills	Maricopa County	Mesa	Peoria	Phoenix	Scottsdale
Goal	At-Risk	Good	Good	Excellent	Good	Good
Actual	At-Risk	Excellent	Good	Good	Good	Good

Source: Pavement Condition responses received from jurisdictions shown in chart.

Note: A "at-risk" goal typically represents a pavement management strategy of maintaining roads at a level that prevents them from further deteriorating (through pothole repairs), but the improvement is not significant enough to improve conditions.

When comparing the Maricopa County survey responses to other urban metropolitan areas, we found that several regions throughout the U.S. had pavement conditions in worse shape than Maricopa County with road pavement condition reported to be in the at-risk category.[62] For instance, San Francisco Bay Area roads have an average pavement condition index of 67, Chicago reported a pavement condition index of 63, and Seattle's pavement condition index was 69—which are all in the at-risk range.[63] In another example, a comprehensive roads and streets assessment conducted in California in 2014[64] covering 99 percent of the State's arterial network classified the statewide pavement condition as at-risk with an average pavement condition index rating of 66. Thus, the Maricopa County region has reported better pavement condition than several others in the country.

Locals Jurisdictions Reveal Good Bridge Condition on Arterial Streets

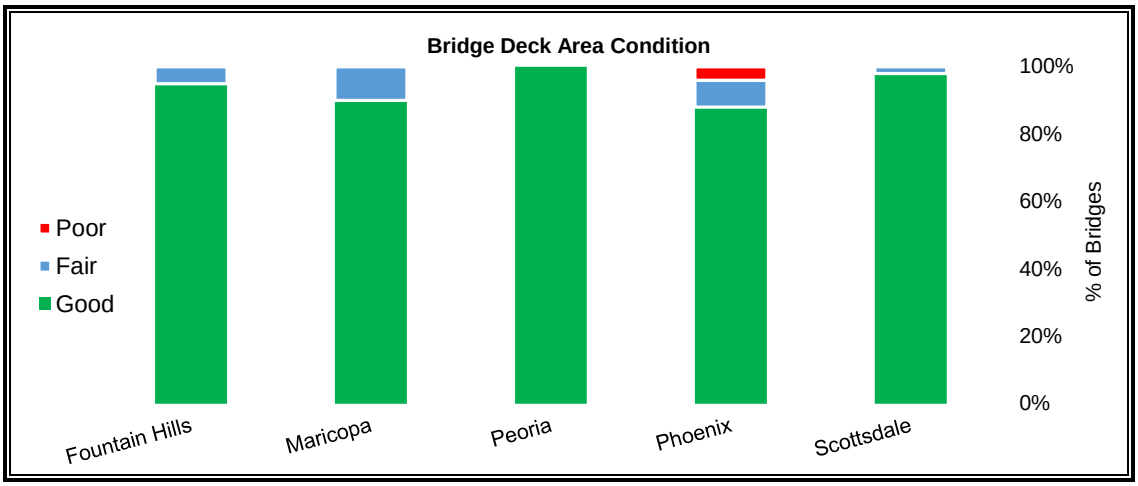
Similar to pavement condition data, the health and condition of arterial street bridges are generally tracked at the local jurisdiction level and summarized statewide by ADOT. Because the bridge condition data is not segregated by Maricopa County or the Phoenix-Mesa Urbanized Area, we surveyed 12 local jurisdictions to assess the condition of bridges in Maricopa County. While we received responses from 7 jurisdictions that included several of the more highly populated jurisdictions, only five of these seven jurisdictions provided comments on bridge deck conditions. Survey results from five reporting areas stated that bridge deck condition is "good" for over 88 percent of bridges as shown in Chart 7. Moreover, bridge conditions are assessed, at a minimum, every five years with 30 percent of the survey respondents assessing bridge condition on an annual basis.

[62] Other urban metropolitan areas include those areas with population greater than 3 million as identified by the Texas A&M Transportation Institute's 2015 Urban Mobility Scorecard. For this comparison, the urban areas include San Francisco Bay Area, Dallas, and Seattle.

[63] San Francisco results reported by the Metropolitan Planning Commission covering nine San Francisco Bay Area counties.

[64] Per the California Local Streets & Roads Needs Assessment 2014 Report sponsored by all 58 California counties, 43 California Regional Transportation Planning Agencies, and 343 California cities and towns.

Chart 7: Bridge Conditions in Five Local Jurisdictions



Source: Bridge deck area condition survey responses received from local jurisdictions.

Note: "Good" condition means primary structural bridge elements have no problems or only minor deterioration. "Fair" condition means primary structural bridge elements are sound, but may have minor section loss, deterioration, cracking, spalling or scour. "Poor" condition means bridges have advanced deficiencies such as section loss, deterioration, scour, cracking or spalling, but bridge is still safe for travel.

A Quarter of Arterial Street Projects Have Been Completed with Prop 400 Funding, But Many Projects Remain to be Completed

Over the last decade, the 95 arterial street projects listed in the original 2003 RTP were more uniquely defined into 200 individual projects with an estimated cost of approximately $1.5 billion. As of June 30, 2015, at least 54 of those 200 projects have been completed at a cost of $658 million—with the majority, or 34 projects totaling $461 million, completed between July 1, 2010 and June 30, 2015.[65] MAG anticipates that future arterial streets funding of approximately $1 billion available between fiscal years 2015-2016 and 2025-2026 will cover the costs of the remaining projects—bringing in the arterial streets component of the Prop 400 program close to original amounts budgeted in the 2003 RTP.

Of the 34 arterial streets projects completed between July 1, 2010 and June 30, 2015, 19 projects experienced an average delay of 231 days.[66] For projects where the baseline schedule was developed when design was nearing completion, delays were shorter. Similarly, while projects took longer to complete than initially expected, the final costs were within the original budget amounts. In fact, those 34 completed projects were budgeted at $484 million, but delivered for $461 million—a 4.6 percent savings from expectations.

[65] According to MAG's 2015 Proposition 400 Update Report.

[66] Average delays were gathered by auditors using project documents submitted by local jurisdictions to MAG such as project overviews, agreements, and payment requests. Auditors did not review each project for specific causes for the delays. Data was available to calculate this information for all completed arterial projects, as such auditors considered the entire completed project universe for this statistic. Of the 34 arterial projects completed between July 1, 2010 and June 30, 2015, 19 were delayed. For the remaining 15 projects, two were early and for five projects, documents were submitted by local jurisdictions to MAG after the project was completed—and for all five instances, the documentation indicated actual completion met baseline schedules.

While the 54 completed projects completed to-date added more than 74 arterial miles,[67] a significant number of projects remain to be constructed. Specifically, with roughly a quarter of the projects completed at this halfway mark in the Prop 400 timeframe, an additional 207 arterial miles promised under Prop 400 still need to be constructed by the local jurisdictions.

With the recession during the first half of the Prop 400 program, many local jurisdictions delayed projects mainly due to funding issues. However, it appears that the current upturn in the economy has positively impacted arterial project construction with an additional 53 arterial projects totaling $432.3 million scheduled for funding during Phase III between July 1, 2015 and June 30, 2020 as shown in more detail in Appendix C. This is nearly as many projects as were completed over the past 10 years. Of those 53 projects, 22 projects were planned for Phase III, while 23 projects were delayed to Phase III from Phase I or II. Five projects were advanced from Phase IV and two projects (not listed in 2003 RTP) were subsequently added. For approximately half of those 53 Phase III projects, the majority of upcoming activity relates to actual project construction.

If this historic under-budget pattern continues, it appears that MAG's $1 billion in expenditure projections for completing the remaining Prop 400 arterial streets projects will be sufficient to cover the expected costs. However, local jurisdictions will be challenged to complete all projects within the Prop 400 timeframe if project schedules are not closely monitored.

Local Jurisdictions Deliver Capital Projects Following Standard Industry Practices

While MAG oversees the arterial street program from a programming and administrative perspective, the implementation and construction of arterial streets capital projects are the responsibility of local jurisdictions. To assess the type of local project management in place, we conducted a survey of 12 cities, towns, and communities with RTP projects funded by Prop 400. Of the 12 surveys distributed, we received responses from seven that indicated most follow common and leading practices in capital project management and delivery as presented in Table 12. For full survey results, refer to Appendix B.

For instance, all reporting jurisdictions require at least two of the following types of documentation before approving progress payments—schedule of values, certified payroll, or field inspection reports—in accordance with best practices. Further, four of the seven local jurisdictions require formal change order supporting documentation such as request for information; proposed change order; evidence of scope, schedule, or cost negotiations; and final change order approval—all strong practices to have in place. Moreover, all seven survey responders cited that they employed value engineering activities during a project, most commonly during design.

[67] New roadways or widening existing roadways increase the number of miles in an arterial roads network.

Table 12: Local Jurisdictions Employ Widely-Accepted Capital Project Management Practices[68]

	Fountain Hills	Gilbert	Maricopa County	Mesa	Peoria	Phoenix	Scottsdale
1. Use of single project manager, cradle-to-grave	✓	✓	✓	✓	✓		✓
2. Project management tools/software used:							
▪ Automated (Primavera, Microsoft Project, In-House System)		✓	✓	✓	✓	✓	
▪ Manual (Excel, Word, Microsoft Outlook)	✓		✓	✓	✓	✓	✓
3. Management plans prepared and used:							
▪ Project management plan	✓	✓	✓		✓	✓	✓
▪ Design quality management plan			✓			✓	
▪ Construction quality management plan			✓	✓		✓	
4. Baseline-to-actual schedule milestones tracked:							
▪ Right-of-way		✓	✓	✓	✓	✓	
▪ Environmental		✓	✓	✓	✓	✓	
▪ Design	✓	✓	✓	✓	✓	✓	✓
▪ Construction (contract award)	✓	✓	✓	✓	✓	✓	✓
▪ Open to public		✓		✓	✓	✓	✓
5. Budget-to-actual costs tracked:							
▪ Right-of-way		✓	✓	✓	✓	✓	✓
▪ Environmental		✓	✓		✓	✓	
▪ Design	✓	✓	✓	✓	✓	✓	✓
▪ Construction	✓	✓	✓	✓	✓	✓	✓
▪ Construction Support		✓	✓		✓	✓	
▪ Administration		✓		✓		✓	✓
6. Documentation considered when approving construction progress payments:							
▪ Schedule of values	✓			✓	✓	✓	✓
▪ Certified payroll			✓	✓	✓		
▪ Field inspection reports	✓		✓	✓	✓	✓	✓
7. Documentation used in change order approval:							
▪ Request for information	✓			✓	✓		✓
▪ Proposed change order	✓			✓	✓	✓	✓
▪ Scope, schedule, cost negotiations	✓		✓	✓	✓		✓
▪ Final change order approval	✓		✓	✓	✓	✓	✓
8. Project phase using value engineering	Design, Const.	Cont.	Design	As needed	Design	Const.	Cont.

Source: Survey responses from local jurisdictions; ✓ Indicates Practice in Place

[68] Local jurisdiction project management practices were compared against a variety of sources including the Construction Management Association of America's Construction Management Standards of Practice, Federal Highway Administration guidance, and American Institute of Architects guidance.

Several Local Jurisdictions Measure Internal Project Delivery Performance

In addition to measuring performance in terms of outcomes of what a region wants to achieve—such as reduced congestion—and outputs (such as number of projects completed), entities also measured internal project delivery performance to indicate how well project managers are delivering individual projects. Local jurisdictions we surveyed reported tracking the following industry-standard metrics to some extent: [69]

- Construction bid compared to engineer's estimates
- Construction bid compared to final cost
- Submittal/request for information review turnaround time[70]
- Number or percent of projects completed within original schedule
- Number or percent of projects completed within original cost

Review of City of Phoenix Project Reveals Good Practices to Control Cost and Schedule

For a more thorough review of local arterial project delivery performance and to confirm that reported practices are in use, we selected the Sonoran Boulevard project managed by the City of Phoenix that built approximately seven miles of roadway with one lane in both directions and three bridges with drainage culverts. Based on our file review, we did not find any significant departures from common practice in public construction. For instance, all project files were available in an electronic document storage warehouse and contained expected information as suggested by industry leading practices such as procurement documents, cost estimates, schedules, change order information, progress payments, and field reports. Further, we found evidence of strong project management practices in file documentation indicating local project managers reviewed contractor progress payment requests against the contract's schedule of values and daily reports from field inspectors before authorizing payment. Moreover, this particular project was also subject to a performance audit from the Phoenix City Auditor. The City Auditor's report found a lack of formal policies and procedures related to project delivery method selection, determinations of fairness and reasonableness of costs, and insurance approval processes. The City of Phoenix addressed all issues noted through development of the recommended policies and procedures, including a project delivery decision matrix flowchart.

[69] Industry-standard metrics are based on practice standards drawn from a variety of sources such as the Project Management Institute's Project Management Body of Knowledge, Construction Management Association of America's Construction Management Standards of Practice, American Institute of Architects, and American Public Works Association.

[70] Submittals are construction documents such as shop drawings, material samples, or schedules that the contractor is required to submit to the project owner. Requests for information are used to formally document communication between the contractor and project owner related to project scope and/or deliverables that can require negotiation and potentially halt a project until resolved. Tracking the review turnaround time on these documents would enable the project manager to measure how efficiently questions are addressed and potential project delays are minimized.

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Chapter 4: Transit Performance

CHAPTER SUMMARY

Through the regional transportation plan (RTP), Proposition 400 (Prop 400) funds are leveraged with other funding sources for bus operations, paratransit (dial-a-ride) services, and on capital investments for high capacity transit/light rail transit, facilities, fleet, and infrastructure needs.

Prop 400/RTP Improvements Proposed

Of the $14.3 billion of Prop 400 funding expected in 2005, more than $4.8 billion was allocated toward light rail and bus transit projects and operations.

Initial plan was to construct 27.7 miles of high capacity/light rail transit as well as add more than 1,200 bus stops and pullout improvements, and several park and rides, transit centers, and maintenance yards. Additionally, 42 new routes were planned for local bus service, circulators, rapid or express buses, and rural buses.

Status of Projects and Activities

As of June 2015, more than 26 miles of high capacity/light rail transit has been constructed and another 11 miles of light rail and a 2.6 mile streetcar route are projected to be completed by fiscal year 2025-2026. To date, 666 buses, 623 vanpool vans, and 244 paratransit vehicles have been purchased as well as 6 Park-and-Ride lots, 2 transit centers, and 2 maintenance facilities were completed. However, 9 transit centers and 2 park-and-ride lots have been deferred beyond fiscal year 2025-2026.

Program Performance

- ✓ Transit systemwide bus and light rail ridership grew by nearly 5 percent over the audit period to nearly 71 million boardings in fiscal year 2014-2015.
- ✓ Light rail generally performed better than six peers in each fiscal year between 2011-2012 and 2013-2014. For instance, in fiscal year 2013-2014, Valley Metro reported 5.77 boardings per revenue mile—whereas the six-peer average was only 3.45 boardings per revenue mile.[71]
- ✓ Maricopa County systemwide fixed route bus service outperformed peers for each of the three fiscal years reviewed between 2011-2012 and 2013-2014. For instance, in fiscal year 2013-2014, the operating cost per revenue mile for Maricopa County was $7.65—or $1.22 less than the peer average.
- ✓ Both light rail and systemwide fixed route bus service maintained on-time performance 92 percent of the time—or more—between fiscal years 2010-2011 and 2014-2015.
- ✓ Five capital construction projects reviewed were completed or are projected to be completed within 10 percent of budgeted amounts.

Audit Results Highlights

- Transit light rail and bus operations demonstrate generally strong performance and outperform peers.
- More than 400 projects were completed between fiscal years 2010-2011 and 2014-2015, with 3.1 miles of light rail extensions, 16 bus routes added or frequency increased (some of which were subsequently eliminated), approximately 3,500 vehicles purchased, 424 bus stops completed, and 8 transit shelters and park and rides built.
- Transit employs many leading project management practices on transit capital construction projects.

Recommendations

- No recommendations for this chapter, but refer to Chapter 1 for transit-related recommendations.

[71] A revenue mile is a mile traveled when the vehicle is available to the general public and there is an expectation of carrying passengers.

Transit Still Outperforms Peers, Although Ridership has Slightly Decreased

In 2012, the Regional Public Transportation Authority (RPTA) and Valley Metro Rail, Inc. combined certain administrative functions under the name Valley Metro that is now overseen by one chief executive officer. Although the Regional Public Transportation Authority is responsible for distribution of Prop 400 and other sources of money deposited in the public transportation fund, the separate public nonprofit corporation Valley Metro Rail, Inc., was created to construct and operate the light rail system through partnership with the cities of Chandler, Glendale, Mesa, Phoenix, and Temple. Together, Valley Metro is responsible for transit services such as:

- ✓ **Fixed Route**: Bus service provided on a repetitive, fixed schedule basis along a specific route.
- ✓ **Bus Rapid Transit (BRT)**: Fixed route bus mode where a majority of each line operates in a separated right-of-way dedicated for public transportation use during peak periods and includes features that emulate services provided by rail, such as defined stations and traffic signal priority.
- ✓ **Express**: Bus service intended to run faster than normal bus services between specific commuter or destination points.
- ✓ **Supergrid**: Bus service providing frequent local service throughout the day and evening.
- ✓ **Light rail/high capacity**: Urban rail system that uses light rail vehicles on fixed rails in a dedicated right-of-way space.
- ✓ **Paratransit (dial-a-ride)**: Transit service that is more flexible than conventional fixed route service, including dial-a-ride services throughout Maricopa County. These services provide Americans with Disabilities Act paratransit service to individuals with disabilities that cannot access the fixed route bus and rail system.

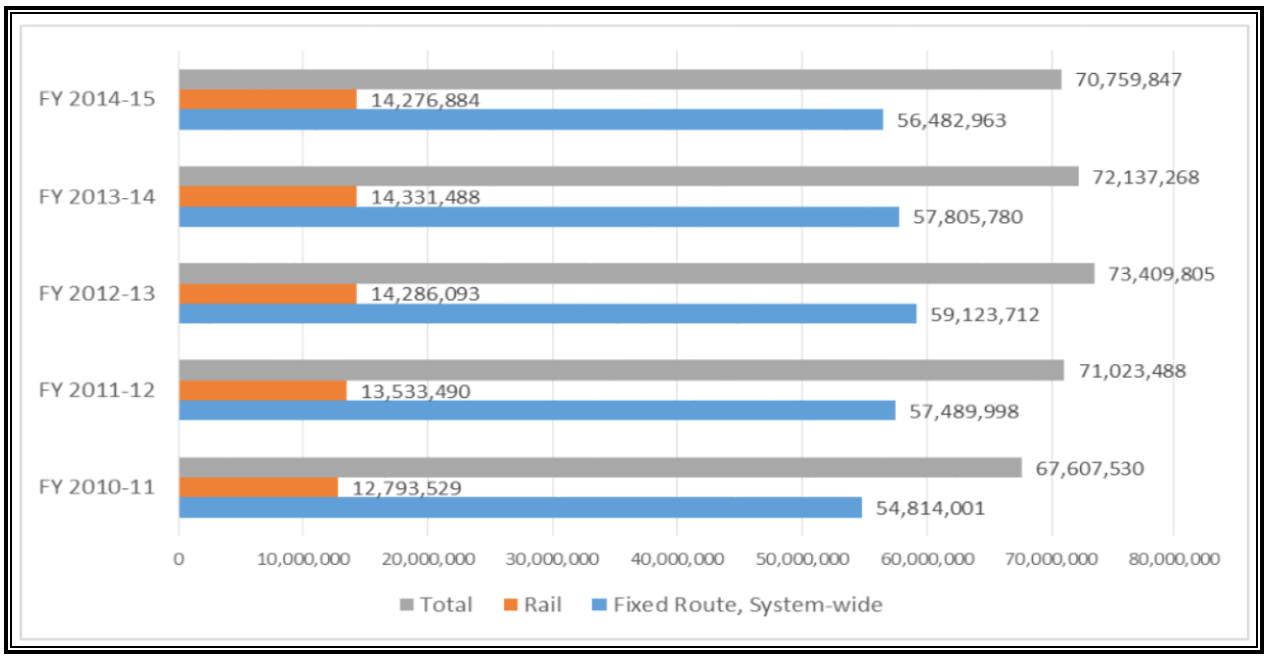
As part of Valley Metro's performance monitoring and reporting, Valley Metro compares its light rail and fixed route bus system performance to a six-peer average using transit agencies identified as part of the Regional Transit Standards and Performance Measure study.[72] Results show that Maricopa County's fixed route and light rail performed better than the six-peer average for the five key performance measures reviewed—although transit ridership has declined in recent years as discussed in the following section.

Ridership Shows Growth over the last 5 Years, but has Declined from Peak Period

One of the industry standard measures of transit performance is ridership that can indicate interest and use of the transit system. Although transit systemwide ridership declined in recent years, systemwide ridership was still nearly 5 percent greater in fiscal year 2014-2015 than in fiscal year 2010-2011, as reflected in Chart 8. Specifically, systemwide ridership declined from a high of 73.4 million boardings in fiscal year 2012-2013 to nearly 70.8 million boardings in fiscal year 2014-2015, a decrease of more than 2.6 million boardings or nearly 4 percent.

[72] The Regional Transit Standards and Performance Measure study is a performance-based planning tool that established an approach for managing regionally funded transit services and capital investments in bus stops and park-and-ride facilities.

Chart 8: Transit System-wide Ridership, Fiscal Years 2010-2011 through 2014-2015



Source: Valley Metro Transit Ridership Reports.

Several factors contributed to the decline in ridership over recent years, including:

- **Improved Economy and Lower Gas Prices:** Nationally, operators are experiencing decreased ridership in transit—particularly bus ridership—as the economy improves and gas prices decline causing a shift in those choosing to drive vehicles rather than taking public transit. According to the American Public Transportation Association's quarterly Transit Ridership Report, bus ridership is down nearly 2 percent nationally for the first quarter of fiscal year 2015-2016 when compared to the first quarter of fiscal year 2014-2015. These trends are similar to those experienced by Valley Metro.
- **Declined student ridership from Arizona State University:** Beginning in Fiscal Year 2009-2010, university transit pass yearly sales have begun to decline from approximately 18,000 in fiscal year 2009-2010 to approximately 8,000 in fiscal year 2013-2014—a decline of more than 55 percent. Valley Metro estimates that it has lost about 15,000 student trips per day—mostly on light rail—believed to be caused by more students taking online courses, availability of free student shuttles, increased cost of the student transit pass, and growth of student housing closer to campus.

Ridership Survey Indicates Declining Satisfaction, but Increased Likelihood To Continue Transit Use

On an annual basis, Valley Metro conducts a Rider Satisfaction Survey designed to capture demographic characteristics, ridership patterns, and general levels of satisfaction of those people using Valley Metro's bus, light rail, and paratransit services. In the most recent survey conducted in 2014, more than 75 percent of current riders indicated a high likelihood to continue using

public transit although overall system satisfaction slightly declined to 70 percent in 2014. For those riders that indicated dissatisfaction, primary reasons reported were the need for increased service frequency or longer hours of operation, lack of on-time performance, and rude or unprofessional drivers.

Light Rail and Fixed Route Bus Service Generally Perform Better than Peers

To perform peer comparisons, we used data from the National Transit Database—the most available and widely-used transit performance comparison data in the nation. While National Transit Database data is well used, there is some risk of inaccuracy given that data is self-reported by transit agencies and remains unaudited. Valley Metro also uses National Transit Database data to perform its own peer comparisons and report on results in annual Transit Performance Reports. Based on National Transit Database performance data for light rail and systemwide fixed route bus service for five specific performance metrics between fiscal years 2011-2012 and 2013-2014, results show that transit in Maricopa County generally performed better than its peers.

Specifically, as shown in Table 13, Valley Metro light rail outperformed the six-peer average for four of the five categories. For instance, Valley Metro was able to recover a greater proportion of total operating costs through passenger fares than the six-peer average over all three years. For all three years, Valley Metro's farebox recovery was more than 10 percentage points higher than the six-peer average. Valley Metro's operating cost per boarding, a metric assessing operational efficiency, also outperformed the six-peer average for all three years examined.

Table 13: Comparison of Valley Metro Light Rail, Inc. Performance with Six National Peers, Fiscal Years 2011-2012 through 2013-2014[73]

Performance Measure	2012			2013			2014		
	Valley Metro	Peer Average	% Variance	Valley Metro	Peer Average	% Variance	Valley Metro	Peer Average	% Variance
Operating Cost per Revenue Mile[A]	$11.87	$10.89	9.0%	$11.81	$10.84	8.9%	$12.60	$11.84	6.4%
Boardings per Revenue Mile[B]	5.56	3.59	54.9%	5.88	3.29	78.7%	5.77	3.45	40.2%
Farebox Recovery[C]	41.1%	31.0%	32.6%	44.6%	34.0%	31.2%	40.0%	30.0%	25.0%
Operating Cost per Boarding[D]	$2.13	$4.43	-51.9%	$2.01	$3.30	-39.1%	$2.18	$3.43	-57.3%
Subsidy per Boarding[E]	$1.26	$2.08	-39.4%	$1.11	$2.17	-48.8%	$1.31	$2.41	-84.0%

Source: Valley Metro Transit Performance Reports, fiscal years 2011-2012 through 2013-2014

Notes: [A] Operating Cost per Revenue Mile = Operating Expenses/Annual Revenue Miles; [B] Average Boardings per Revenue Mile = Total Boardings/Annual Revenue Miles; [C] Farebox Recovery Ratio = Fare Revenue/Operating Expenses; [D] Operating Cost Per Boarding = Operating Expenses/Total Boardings; [E] Subsidy per Boarding = (Operating Expenses net Fare Revenue)/ Total Boardings

[73] Dallas Area Rapid Transit (Dallas, TX); METRO Rail (Houston, TX); Regional Transportation (Denver, CO); San Diego Metro Transit (San Diego, CA); Regional Transit (Sacramento, CA); and Utah Transit Authority (Salt Lake City, UT).

Similarly, as illustrated in Table 14, fixed route bus service in Maricopa County outperformed the six-peer average for all five performance measures between fiscal years 2011-2012 and 2013-2014. For instance, Valley Metro outperformed the six-peer average for two metrics capturing operational efficiency—operating costs per revenue mile and operating cost per boarding—indicating it costs less to operate fixed route bus service in Maricopa County than in other peer transit systems. In particular, the operating cost per boarding was approximately 16 percent less than peers between fiscal years 2011-2012 and 2013-2014.

Table 14: Comparison of Maricopa County Systemwide Fixed Route Bus Performance with 6 National Peers, Fiscal Years 2011-2012 through 2013-2014[74]

Performance Measure	2012			2013			2014		
	Valley Metro	Peer Average	% Variance	Valley Metro	Peer Average	% Variance	Valley Metro	Peer Average	% Variance
Operating Cost per Revenue Mile [A]	$7.47	$8.83	-15.4%	$8.09	$8.98	-9.9%	$7.65	$8.87	-13.8%
Boardings per Revenue Mile [B]	2.00	1.99	0.5%	2.10	1.95	7.7%	2.00	1.95	2.6%
Farebox Recovery [C]	22.2%	20.0%	11.0%	21.6%	18.9%	14.3%	21.9%	19.4%	12.9%
Operating Cost per Boarding [D]	$3.73	$4.43	-15.8%	$3.85	$4.59	-16.1%	$3.83	$4.55	-15.8%
Subsidy per Boarding [E]	$2.90	$3.53	-17.8%	$3.02	$3.73	-19.0%	$3.00	$3.67	-18.3%

Source: Valley Metro Transit Performance Reports

Notes: [A] Operating Cost per Revenue Mile = Operating Expenses/Annual Revenue Miles; [B] Average Boardings per Revenue Mile = Total Boardings/Annual Revenue Miles; [C] Farebox Recovery Ratio = Fare Revenue/Operating Expenses; [D] Operating Cost Per Boarding = Operating Expenses/Total Boardings; [E] Subsidy per Boarding = (Operating Expenses net Fare Revenue)/Total Boardings

Light Rail Continues to Outpace Its Own Expectations

Over the audit period, the performance of Valley Metro's light rail system generally improved as shown in Table 15. With the exception of on-time performance, we found favorable trends across each of the performance metrics. For instance, total boardings increased by nearly 12 percent from fiscal year 2010-2011 to fiscal year 2014-2015, from nearly 12.8 million boardings to 14.3 million boardings. While total boardings increased over the audit period, boardings have remained fairly constant over the last three years. Other performance measures indicate the strength and operation of the system, such as the farebox recovery that shows the portion of total operating expenses covered by passenger fares. In Maricopa County, the light rail system's farebox recovery increased by more than 24 percent over the five-year audit period from nearly 33 percent in fiscal year 2010-2011 to 41 percent in fiscal year 2014-2015.

Moreover, light rail performed well when measured against each of the following indicators.

[74]Dallas Area Rapid Transit (Dallas, TX); King County Metro Transit (Seattle, WA); Regional Transportation (Denver, CO); San Diego Metro Transit (San Diego, CA); Tri-Met (Portland, OR); Utah Transit Authority (Salt Lake City, UT)

- Service Levels

  While light rail on-time performance has remained at 92 percent or higher for the audit period, it has declined from a peak on-time performance reported at 97.5 percent in fiscal year 2010-2011 to 92.1 percent in fiscal year 2014-2015.

Table 15: Light Rail System Performance, Fiscal Years 2010-2011 through 2014-2015

Performance Measure	Fiscal Year 2010-11	Fiscal Year 2011-12	Fiscal Year 2012-13	Fiscal Year 2013-14	Fiscal Year 2014-15	Percent Change Over 5-Year Period
Operating Cost per Revenue Mile	$12.90	$11.87	$11.81	$12.60	$12.60	-2.3%
Boardings per Revenue Mile	5.32	5.56	5.88	5.77	5.75	8.1%
Farebox Recovery	33.0%	41.1%	44.6%	40.0%	41.0%	24.2%
Operating Cost per Boarding	$2.42	$2.13	$2.01	$2.18	$2.19	-9.5%
Subsidy per Boarding	$1.62	$1.26	$1.11	$1.31	$1.29	-20.4%
Total Boardings	12,793,529	13,553,490	14,286,093	14,331,488	14,276,884	11.6%
Vehicle Revenue Miles	2,405,140	2,435,946	2,430,774	2,481,951	2,482,556	3.2%
Average Fare[75]	$0.80	$0.88	$0.90	$0.87	$0.90	12.5%
On-time Performance	97.5%	97.2%	94.7%	93.5%	92.1%	-5.5%
Mechanical Failures	117	85	82	67	71	-39.3%

Source: Valley Metro Annual Transportation Performance Reports

- Light Rail Capital Project Costs

  Between fiscal years 2010-2011 and 2014-2015, no new light rail capital construction projects were completed. However, Valley Metro Rail, Inc. recently completed construction of the federally funded Central Mesa 3.1 mile light rail extension with passenger operations that started in August 2015—three months ahead of schedule and within budget. Also, Valley Metro Rail, Inc. began construction of the Northwest light rail extension with one 3.2 mile stretch scheduled for completion in 2016. As of June 30, 2015, Valley Metro Rail Inc. had spent $894.5 million of the $2.9 billion scheduled to be spent through fiscal year 2025-2026.

- Valley Metro Rail, Inc. Operations and Maintenance Costs

  In terms of operational costs, Valley Metro Rail, Inc. was under its budget by nearly $868,000, or 3 percent, in fiscal year 2013-2014 and more than $1.3 million under budget for fiscal year 2014-2015. For the same timeframe, vehicle maintenance labor and material costs were more than $1 million, or 60 percent, lower than budget in fiscal year 2013-2014. However, Valley Metro Rail, Inc. experienced higher costs in fiscal year 2014-2015 where expenses were

[75] Average fare reported is the average of all fares collected, which includes a combination of standard fares, reduced fares, youth fares, and passes.

over budget by more than $294,000 due to expensive bumper and brake replacement parts as well as a heating and air conditioning overhaul according to Valley Metro staff.

- Light Rail Transit Ridership

  Over the five-year audit period, total boardings increased by nearly 12 percent between fiscal years 2010-2011 and 2014-2015, from 12.8 million to 14.3 million—but remained fairly constant between fiscal years 2012-2013 and 2014-2015.

Bus Transit Shows Generally Consistent Performance

Between fiscal years 2010-2011 and 2014-2015, fixed route bus system performance showed improvements in certain areas and slight decreases in performance in other areas as shown in Table 16. For instance, we noted improvements in five of the 12 metrics reviewed—total boardings, boardings per revenue mile, safety incidents, security incidents, and mechanical failures. While fixed route bus service out performed peers as discussed earlier in this chapter, metrics related to service efficiency—such as operating cost per revenue mile and operating cost per boarding—showed an increase between fiscal years 2010-2011 and 2014-2015. With costs increasing and the average fare remaining relatively consistent, the farebox recovery declined by nearly 7 percent and the subsidy per boarding increased by more than 10 percent.

Table 16: Fixed Route System-wide Performance, Fiscal Years 2010-2011 through 2014-2015

Performance Measure	Fiscal Years 2010-2011	Fiscal Years 2011-2012	Fiscal Years 2012-2013	Fiscal Years 2013-2014	Fiscal Years 2014-2015	Percent Change Over 5-year Period
Operating Cost per Revenue Mile	$7.08	$7.47	$8.09	$7.65	$7.90	11.6%
Boardings per Revenue Mile	1.88	2.00	2.10	2.00	1.94	3.2%
Farebox Recovery	22.00%	22.20%	21.60%	21.90%	20.50%	-6.8%
Operating cost per Boarding	$3.77	$3.73	$3.85	$3.83	$4.07	8.0%
Subsidy per Boarding	$2.94	$2.90	$3.02	$3.00	$3.24	10.2%
Total Boardings	54,814,001	57,489,998	59,123,712	57,805,780	56,482,963	3.0%
Vehicle Revenue Miles	29,216,449	28,686,261	28,152,162	28,963,377	29,089,942	-0.4%
Average Fare	$0.83	$0.83	$0.83	$0.84	$0.83	0%
On-time Performance	95.60%	96.20%	95.00%	93.70%	92.70%	-3.0%
Total Safety Incidents	48	95	31	17	23	-52.1%
Total Security Incidents	11	33	16	0	0	-100.0%
Total Mechanical Failures[76]	-	-	4,046	4,665	3,627	-10.4%

Source: Valley Metro Transit Performance Reports

[76] According to Valley Metro, mechanical failures were not consistently reported in FY 2010-2011 and FY 2011-2012; therefore, amounts reported were not used for audit purposes to assess trends.

On a positive note, bus passengers experienced increased levels of safety while using fixed route bus services. In particular, safety and security incidents have significantly declined with safety incidents dropping 52 percent from 48 reported incidents in fiscal year 2010-2011 to just 23 in fiscal year 2014-2015. Security incidents similarly dropped from a high of 33 reports in fiscal year 2011-2012 to no incidents reported at all for the last two fiscal years. Additionally, metrics related to bus vehicle mechanical failures decreased more than 10 percent over the 3-year period where data was available from an approximate 4,000 failures or breakdowns in fiscal year 2012-2013 down to an approximate 3,600 failures by fiscal year 2014-2015.

Many Transit Projects Are Being Completed, Although Some Projects Are Deferred Beyond Fiscal Year 2025-2026

As of June 30, 2015, nearly $1.9 billion had been spent on transit capital construction projects and transit operations since fiscal year 2005-2006. As shown in Table 17, while progress has been made to complete projects originally promised in Prop 400, several projects and new or improved routes have been deferred beyond fiscal year 2025-2026. During Phase II, from fiscal year 2010-2011 to 2014-2015, several park-and-ride lots were constructed and three large capital construction projects were completed including the Central Station Rehab, Arizona Avenue Bus Rapid Transit, and Central Mesa light rail extension. In addition, 35 new routes or route enhancements were implemented—although 14 routes were subsequently eliminated and 10 routes were adjusted through service or trip reductions.

Table 17: Status of Prop 400 Transit Projects as of June 30, 2015

Improvements proposed by Prop 400 in 2004	Project Status as of June 30, 2015
Regional Transit Improvements – Transit Capital Projects	
Construct 26 New Passenger Facilities including:	
• 13 Park-and-Ride Lots	• 6 Park-and-Ride Lots completed, 5 additional park-and-rides scheduled to be completed by fiscal year 2025-2026—2 deferred beyond fiscal year 2025-2026
• 13 Transit Centers	• 1 transit centers completed, 3 additional transit centers scheduled to be completed by fiscal year 2025-2026—9 deferred beyond fiscal year 2025-2026
Purchase:	
• 2,978 Buses	• To-date 666 buses and 623 vanpool vans purchased—a total of 1,446 buses and 1,500 vanpool vans scheduled to be purchased through fiscal year 2025-2026
• 1,000 Dial-A-Ride Vehicles	• To-date 244 paratransit vans purchased—a total of 580 paratransit (dial-a-ride) buses scheduled to be purchased through fiscal year 2025-2026
Improve:	
• 1,200 Bus Stop Pullouts and Improvements	• 424 bus stops completed
Upgrade and Construct Transit Maintenance and Operations Facilities	2 maintenance facilities have been completed to date, with no additional facilities through 2025-2026. Remaining facilities (2 dial-a-ride, 1 rural, 2 bus, 2 bus expansions, and 1 vanpool facility) were deferred beyond fiscal year 2025-2026

Improvements proposed by Prop 400 in 2004	Project Status as of June 30, 2015
Improve High Capacity/Light Rail Transit including: • Construct 27.7 miles of high capacity transit/light rail extensions between: ○ Downtown Phoenix to 79th Avenue aka I-10 West (11 miles) ○ Apache Boulevard to Southern Avenue aka Tempe Streetcar (2 miles) ○ Central Phoenix to Paradise Valley Mall aka Northeast Corridor (12 miles) ○ Sycamore to Mesa Drive aka Central Mesa Corridor (2.7 miles) • Regional Support Infrastructure for light rail system (maintenance facilities, bridges, rail cars)	○ Scheduled to open Phase IV between fiscal years 2020-2021 and 2025-2026 ○ Scheduled to open Phase III between fiscal years 2015-2016 and 2019-2020, although it is now identified as a streetcar at 2.6 miles ○ Deferred beyond fiscal year 2025-2026 ○ Opened in Phase II, identified as a 3.1 mile light rail extension • On-going expenditures are made in these areas
Regional Transit Improvements - Transit Bus Operations	
Provide New or Enhance Existing Regional Bus Service on: • 12 New Routes • 28 Existing Routes	• 14 freeway express/BRT and 19 supergrid routes implemented • 16 freeway express/BRT and 11 supergrid routes deferred beyond fiscal year 2025-2026 • 4 implemented freeway express/BRT routes eliminated in fiscal year 2010-2011
Provide Rural Bus Routes to: • Wickenburg • Gila Bend	2 rural bus routes implemented – Wickenburg eliminated in fiscal year 2012-2013 due to low ridership.
Other Transit Bus Operations Improvements: • Triple Dial-A-Ride Para-transit Services for ADA riders • Triple Vanpool Services • Improve Transit Security	Expenditures in these areas include: • $141.1 million on ADA services • $66.8 million on regional passenger support services • $4.3 million on safety Vanpool services are funded entirely by fares.

Source: Prop 400 Proposed Projects; 2003 RTP, and 2015 Prop 400 Status Update Report

When looking at projects initially scheduled for completion between fiscal years 2015-2016 and 2019-2020 in Phase III, we found that a lot of movement has occurred. Some projects are still scheduled for completion or will be advanced during that time frame, but others have been deferred to the final five-year phase of Prop 400 or beyond fiscal year 2024-2025 due to funding shortfalls. For instance, the Interstate-10 West Link light rail project initially scheduled to be completed in Phase III was deferred to the last Prop 400 phase, as shown in Table 18. Also, the Glendale Link light rail project was deferred out past fiscal year 2024-2025. In addition to the deferred light rail projects, 13 bus projects scheduled for completion in Phase III were also deferred beyond the Prop 400 timeframe into fiscal year 2024-2025 or later due to funding shortfalls.

Table 18: Light Rail Projects Initially Scheduled vs Currently Scheduled For Completion in Phase III

Project	Phase Initially Scheduled for Completion	Initial Cost (in millions) 2002 $	Current Phase Scheduled for Completion	Current Cost (in millions) 2015 $	Comments
Glendale Link	III	180	Fiscal year 2025-2026 (outside the Prop 400 window)	6.15	In final phase of identifying locally preferred alternative, but now called West Phoenix/Central Glendale Extension.
I-10 West Link	III	660	IV	13.32	2016 transit life cycle program update split project into two phases, with the environmental work nearly complete. Also, project renamed as Capitol/I-10 West Extension.
Northwest Extension Phase I	I	180	III	174.4	Originally called Metro Center Link, but as project was split into two phases and renamed to Northwest Extension.
Tempe Streetcar	II	120	III	105.9	2016 transit life cycle program update pushed completion to fiscal year 2018-2019. Currently completing preliminary engineering.
Gilbert Road	Not initially in Prop 400 Plan	Not initially in Prop 400 Plan	III	122.8	Not mentioned in 2003 RTP, but amended into RTP in 2014. Project funded with federal funds from the arterial life cycle program and local funds from City of Mesa.

Source: 2003 RTP and 2015 Prop 400 Status Update Report

Transit Activities Are Regularly Audited for Compliance with Federal Requirements

With a large portion of transit capital projects funded with federal monies, transit projects and related operations are regularly audited by a variety of oversight agencies. For instance, Valley Metro receives federal funding through the City of Phoenix, which is the region's designated recipient of federal transit funds related to the federal new starts and small starts transit programs. Use of these federal funds is subject to review by the City of Phoenix on behalf of the federal government. Valley Metro and local jurisdictions must comply with a variety of administrative requirements related to allowable costs, procurement, cash management, and financial reporting in addition to programmatic requirements, such as utility relocation and alternative analysis provisions.

To assess compliance, the Federal Transit Administration conducts triennial audits of the City of Phoenix as the designated recipient for federal transit funds. In the most recent triennial audit conducted for fiscal year 2014-2015, auditors identified several findings and recommended corrective action related to federal financial reports, Americans with Disabilities Act activities, procurement, and drug-free workplace requirements—although auditors concluded that there was general compliance with requirements. In October 2015, the City of Phoenix provided the Federal Transit Administration with a formal response describing the City of Phoenix Public Transit Department's implementation of corrective action and demonstration of new practices employed to address issues identified.

In addition, the Federal Transit Administration requires the Arizona Department of Transportation (ADOT) to ensure that subrecipients of federal assistance distributed through ADOT comply with requirements. As such, ADOT conducted a site review of Valley Metro's compliance with federal requirements and issued a report in March 2016 identifying issues related to legal requirements, governance, service provision, and Americans with Disabilities Act requirements. According to Valley Metro, it has addressed the findings and is in the process of developing refined procedures.

Further, federally funded transit capital projects are required to use an independent project management oversight contractor and submit regular reports to the Federal Transit Administration. Four of the five projects we selected for review as part of our RTP performance audit used federal funding and, thus, were subject to the oversight contractor requirement. Upon review of project files, we found records of the required reports that provided a summary of the topics discussed, meeting attendees, and efforts taken to help adhere to federal requirements and reduce the risk of non-compliance. Based on our review of these reports, we did not find any significant compliance areas that were not being addressed. Moreover, it seemed that Valley Metro and the local entities responsible for transit capital construction appear to have employed many best practices to reduce the risk of non-compliance—or, when issues were noted during oversight reviews, implemented practices and formal procedures for immediate corrective action.

Transit Employs Leading Capital Project Management Practices

While rail capital projects are managed and overseen by Valley Metro Rail, Inc. most bus transit capital projects for transit centers and park-and-rides are managed and overseen by local jurisdictions. In recent years, Valley Metro has been working more closely with local jurisdictions on bus transit capital projects to provide informal project feedback and assistance when needed to enhance regional coordination and connectivity.

As shown in Table 19, we reviewed project management and delivery practices employed on five transit capital construction projects that were completed or were in-progress over the last five

years. Projects selected included a variety of project delivery methods, including construction manager at-risk, design-bid-build, and design-build.[77]

Table 19: Transit Capital Construction Projects Selected for Review

	Project	Project Delivery Method	Agency Overseeing Project
1	Northwest Light Rail Extension Phase I	Construction Manager at Risk	Valley Metro Rail
2	Central Mesa Light Rail Extension	Design Build	Valley Metro Rail
3	Arizona Avenue Bus Rapid Transit	Design-Bid-Build	Valley Metro RPTA
4	West Mesa Park-and-Ride Lot	Design-Bid-Build	City of Mesa
5	Desert Sky Transit Center	Design-Bid-Build	City of Phoenix

Source: Auditor generated based on project files.

Our review found that many leading project management practices were employed over transit capital construction projects through Valley Metro's and the local jurisdictions' use of a variety of automated and manual project management tools. For example, Valley Metro used a widely-known and accepted Primavera project management software for document control and project administration during the audit period and recently transitioned to Aconex Project Management software for current capital construction projects. Although the City of Mesa employed manual processes to oversee and manage its projects, it began implementing a new capital improvement program planning software in 2014. This software will be used to manage projects from design to completion, including modules for contract management, once fully implemented—and would be in line with standard project management practices.[78]

Transit Employs Leading Project Delivery Practices

- ✓ Cradle-to-grave project management structure
- ✓ Project Management Plan at Valley Metro
- ✓ Budget to actual monitoring
- ✓ Regular project development team meetings to discuss cost, schedule, and issues
- ✓ Value assessment reviews
- ✓ Daily inspections of quality and compliance
- ✓ Quality assurance and quality control practices
- ✓ Punch lists and close out reports

Further, many of the practices employed align with nationally recognized protocols of the Project Management Institute's Project Management Body of Knowledge Guide and Standards (known as PMBOK) that includes widely-accepted guidelines, rules, and practices over project management that identify generally accepted

[77] Design-bid-build is the typical project delivery method where the design and construction is sequenced with the project owner hiring a contractor after design is complete. Design-build allows for closer cooperation between the engineer/architect and construction contractor as those are normally joint venture partners for design-build. Construction manager at-risk project delivery, also known as CMAR or construction manager/general contractor (CM/GC), is a project delivery method which entails a commitment by the construction manager to deliver the project within a guaranteed maximum price.

[78] Leading industry project management practice standards are drawn from a variety of sources such as the Project Management Institute's PMBOK, Construction Management Association of America's Construction Management Standards of Practice, Federal Highway Administration and Federal Transit Administration reports and guidance.

standards as well as how those standards apply within the unique realm of construction project management. For example, Valley Metro created project management plans for each of the rail projects that described how the project would be executed, monitored, and controlled as suggested by PMBOK guidance. Project files included documentation demonstrating that project managers generally followed the project integration management processes identified in PMBOK, including documentation supporting project initiation, plans, execution, monitor and control, change control, and project closeout. At the City of Phoenix, files maintained held key change management documentation, including change order logs, request for information, records of negotiation, pending change orders, justification for the change, and the final authorized change order.[79]

We also found that project management files maintained by lead entities were well organized and generally followed a logical indexing system established by the entity. Project files included documentation supporting key decisions and project milestones, project team meeting minutes, project baseline and current schedules, initial project budgets and actual costs to date, future cost estimates, and reports submitted to oversight agencies as part of grant funded projects.

Transit Capital Construction Projects Generally Completed under Budget

Our review of five capital construction projects found that projects were generally completed or are projected to be completed within budget, as shown in Table 20.

Table 20: Transit Capital Construction Project Costs Reviewed were within 10 percent of Budget

Project Name	Initial Budget	Actual Expenditures as of June 30, 2015	Projected Costs FY 2015-16 thru 2019-20	Projected Total Cost at Completion	Percent Over/(Under) Budget at Completion
Central Mesa Light Rail Extension [A]	$199,010,443	$181,934,517	$8,867,926	$190,802,443	-4%
Northwest Light Rail Extension Phase I [B]	$326,591,900	$269,575,899	$57,016,142	$326,592,041	0%
Arizona Avenue BRT [C]	$15,000,000	$11,062,810	$0	$11,062,810	-26%
West Mesa Park and Ride (City of Mesa) [D]	$6,834,500	$5,494,384	$0	$5,494,384	-20%
Desert Sky Transit Center (City of Phoenix) [E]	$12,740,236	$4,422,126	$4,000,000	$8,422,126	-34%

Source: Valley Metro Project Status Spreadsheet

Note: [A] Central Mesa Light Rail Extension extended service from the Sycamore Transit Center to Main Street and Mesa Drive in Mesa; [B] Northwest Light Rail Extension Phase I extended service along 19th Ave, from Montebello to Dunlap Avenue in Phoenix; [C] Arizona Avenue BRT runs along Arizona Ave from Chandler Blvd in Chandler to Main Street in Mesa; [D] The West Mesa Park and Ride is located at the intersection of W Juanita and S Vineyard; [E] The Desert Sky Transit Center is located at the corner of 79th Ave and W. Thomas Road adjacent to the Desert Sky Mall, but was not part of the original Transit Life Cycle Program.

[79] Best practices over change orders are gathered from a variety of sources including Federal Transit Administration guidance and Construction Management Standards of Practice.

For instance, the Arizona Avenue bus rapid transit project was completed within the initial project budget of $15 million with only approximately $11.1 million expended on the project as of June 30, 2015. Similarly, with a budget for the Central Mesa Light Rail Extension of $199 million in fiscal year 2013-2014, only $181.9 million, or 91 percent, has been spent to date. Even with an additional $8.8 million in costs expected to be spent between fiscal years 2014-2015 and 2018-2019, the project should still be 4.6 percent under budget with total costs of $190 million. In another example on the Northwest Light Rail Extension Phase I, Valley Metro has spent $269.6 million of the approximate $326.6 million budgeted as of June 30, 2015—83 percent of the budget. Again, even with Valley Metro estimates of $57 million more to be spent between fiscal years 2015-2016 and 2019-2020, the project is expected to be completed within budget.

Bus transit projects reviewed have also been delivered under budget. For instance, the West Mesa Park and Ride project was initially budgeted at $6.8 million; however, the project was completed under budget at nearly $5.5 million—less than 20 percent lower than the budgeted amount. According to the City of Mesa, construction bids were significantly lower than expected due to the economic recession.

Light Rail Project Delivered on Schedule, but Bus Transit Experienced Some Delays

As discussed in more detail in the bullets that follow, light rail projects reviewed were all delivered on or earlier than scheduled. While bus transit capital projects experienced delays and began service later than planned, the delays were reasonable and documented.

- **Northwest Light Rail Extension Phase I:** The Northwest Light Rail Extension was broken into two phases with the first phase completed in 2016 adding 3.2 miles to the existing light rail and extending service into North Central Phoenix. The project also included construction of three stations and a park-and-ride lot. As shown in Figure 10, a screenshot of the project scorecard indicates the project was completed approximately four months ahead of schedule when it opened for revenue service on March 19, 2016.

Figure 10: Northwest Light Rail Extension Phase I Project Schedule Baseline vs. Actual

SCHEDULE			
Description	Baseline	Current	% Complete
Construction	04.26.2016	03.18.2016	98.0%
Utilities	06.30.2014	07.15.2015	100.0%
Right of Way	10.30.2013	08.15.2015	100.0%
Public Art	11.30.2015	02.29.2016	100.0%
Design/Management	07.30.2015	06.30.2016	90.0%
Testing/Start-up	07.25.2016	03.19.2016	100.0%

Source: Screenshot of Valley Metro Project Scorecard March 2016

Note: Baseline, a commonly used terminology in industry, marks the planned or anticipated completion of a project milestone and current indicates the status of activities or when actually completed.

- **Central Mesa Light Rail Extension:** As part of another light rail extension, the Central Mesa project extended the main operating segment of light rail by 3.1 miles, bringing service through downtown Mesa to Mesa Drive. The project also included construction of four stations and a park-and-ride. Like the Northwest Extension project, this Central Mesa Extension was also completed three months ahead of schedule—as shown the screenshot of the project scorecard in Figure 11.

Figure 11: Central Mesa Light Rail Extension Project Schedule Baseline vs. Actual

SCHEDULE			
Description	Baseline	Current	% Complete
Construction	08.01.2015	08.06.2015	100.0%
Utilities	04.08.2015	07.27.2015	100.0%
Right of Way	07.15.2013	10.01.2014	100.0%
Public Art	04.30.2015	07.15.2015	100.0%
Design/Management	05.29.2015	12.31.2015	98.0%
Testing/Start-up	11.15.2015	8.21.2015	100.0%

Source: Screenshot of Valley Metro Project Scorecard September 2015

Note: Baseline, a commonly used terminology in industry, marks the planned or anticipated start of a project milestone and current indicates the status of activities or when actually completed.

- **Arizona Avenue Bus Rapid Transit:** BRT uses buses or specialized vehicles on roadways or dedicated lanes to quickly transport passengers to their destinations. Although the Arizona Avenue project was initially envisioned to be a BRT route, the project scope was revised to an express service, or LINK, between the Chandler park-and-ride at Tumbleweed Park and the Sycamore/Main Street Transit Center in Phoenix. LINK vehicles are equipped with traffic signal priority technology allowing better mobility through communication with traffic signals to stay green longer for buses to pass through as well as provide streamlined routes and service. The project was initially scheduled to begin in November 2009, with an expected completion date in September 2010; however, the project was delayed by roughly 14 weeks in order to address design issues with local jurisdictions and complete right of way acquisition. These delays resulted in revenue service beginning several months late on January 24, 2011. However, documents detailing the delays were appropriately supported, managed, and discussed.

- **West Mesa Park and Ride:** Also known as Country Club Park-and-Ride, the West Mesa Park-and-Ride was initiated by the City of Mesa's Transit Department and led by the Engineering Design Department. Work on the project began in 2009 with site alternatives analysis, followed by a construction start on June 13, 2011, and expectations for project completion on October 11, 2011. In March 2012, the prime contractor abruptly ceased construction and ultimately went out of business, resulting in several months delay as the City of Mesa worked with the bonding company to hire a new contractor to complete

construction. Ultimately, the West Mesa Park and Ride opened for service on November 21, 2012 with a notice of substantial completion issued on November 26, 2012. Due to the unexpected complications with the prime contractor, the project was completed 407 days after it was initially scheduled to finish. Project file documents showed adequate management and justification of the delay.

- **Phoenix Desert Sky Transit Center:** Although the Desert Sky Transit Center was not included in the 2003 RTP, this project was identified by the City of Phoenix and approved for inclusion in the 2010 transit life cycle program funded with a combination of sale tax revenue and federal funds. Construction began on February 2, 2015, and was originally scheduled to be completed by November 30, 2015. While the transit center opened for public service close to schedule on December 8, 2015, the notice of final completion was not issued until June 12, 2016. Although the project was completed significantly under budget, the project final acceptance was delayed by six months. According to the City of Phoenix, warranty information was not provided in a timely manner and delayed the notice of project completion. Project files showed appropriate management and responses to the delay.

Change Orders Were Generally Appropriately Supported and Approved

Construction change orders and contract amendments are standard practice for capital projects where varying circumstances require changes to scope, schedule, or cost. We reviewed two change orders for each of the five transit capital construction projects, for a total of 10 change orders. Our review found that nine of the ten change orders examined had appropriate and reasonable documentation, such as a detailed explanation for the change order, request for information or owner requests for proposals to initiate changes, records of negotiation between the contractor and owner, and authorization from agency staff discussed in the bullets that follow:

- **Light Rail Projects:** For the two capital construction projects to extend light rail—namely, the Central Mesa Rail Extension and Northwest Rail Extension Phase I—change orders reviewed were reasonable, appropriately supported, and approved by Valley Metro Rail, Inc. staff. However, for one change order on the Northwest Rail Extension Phase I project, Valley Metro Rail, Inc. staff approving the change order did not provide the date the change order was signed for approval; thus, we could not determine whether changes were appropriately authorized before the contractor began work. Specifically, before a contractor begins work, Valley Metro Rail, Inc. staff should sign and date the change order indicating its approval. However, the change order log indicated the change was approved several days after the contractor's signature. Thus, there were no issues with these change orders.

- **Transit Projects:** For the remaining three capital construction projects, each project was managed by a different entity—RPTA the City of Mesa, or the City of Phoenix. Four of the six change orders on these three projects appeared reasonable and were approved by the agency. However, for one change order related to the Arizona Avenue BRT project, RPTA

approved the change order before the contractor. By allowing the contractor to approve the change order after RPTA, it increases the risk of the contractor making changes or modifications that were not approved by RPTA management and these changes going undetected by RPTA staff. However, we did not identify any modifications made to the change order by the contractor after RPTA's signature and, thus, there were no identified negative impacts on the project.

For the second change order reviewed on the Desert Sky project overseen by the City of Phoenix, we noted a significant time delay between the date the initial pending change order was approved and the date the final change order was approved. Specifically, the change order approval was delayed by approximately 3.5 months. While industry practices often allow approval authority to be delegated within certain threshold amounts as part of established project contingency amounts, the City of Phoenix requires all change orders to be approved by the City Council regardless of dollar amount. Because work technically should not start until final change order approval is received, these delays can potentially have negative impacts on overall project timelines.

Practices Employed Ensure Accurate and Appropriate Construction Payments

We tested two progress payments for each of the five transit capital construction projects selected for review, for a total of ten progress payments. Our review found that invoices were mathematically accurate, agreed with contract terms and conditions, included a schedule of values that aligned with the scope of work established in the contract, and were approved by agency staff prior to payment—all practices aligned with leading industry guidance. Moreover, all payments conformed to the Maricopa Association of Government's Uniform Standard Specifications and Details for Public Works Construction § 109.7 requiring a 10 percent retention until the project is 50 percent complete.

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Chapter 5: Multimodal Management and Operations

CHAPTER SUMMARY

In addition to projects on freeways, arterial streets, and transit routes, the Regional Transportation Plan (RTP) sets aside funding for the management and operation of systemwide activities over multiple modes of transportation in Maricopa County. One goal of this regionally integrated approach is to optimize performance of the multimodal system by implementing and monitoring intelligent transportation system technology and operating transportation operations and management centers.

Prop 400/RTP Improvements Proposed

As part of the RTP and Proposition 400 (Prop 400) funding, money is spent to optimize the performance of the multimodal transportation system through intelligent transportation system management.

Multimodal Efforts

- ✓ Region has initiated many steps towards moving traffic more efficiently using existing roadway capacity.
- ✓ RTP and Prop 400 funds have been allocated and spent on establishing a solid technological foundation and planning to enable use of multimodal management techniques—such as active traffic management—where the system is dynamically monitored and managed on a real-time basis.
- ✓ Opportunities exist to enhance active management techniques within and across freeways, arterial streets, and transit networks.

Audit Results Highlights

- Financial investments have been made for intelligent transportation systems technology on freeways, arterial streets, and transit networks.
- Freeway traffic activities are monitored through the Arizona Department of Transportation (ADOT)'s traffic operation center 24-hours a day.
- Department of Public Safety officers located in the ADOT traffic operation center to monitor traffic incidents have reduced crash response time by nearly 50 percent.
- There are 13 transportation management centers in operation with staff monitoring arterial streets in local jurisdictions, but they primarily operate only during regular business hours.
- ADOT, Valley Metro, and the local jurisdictions have taken several steps towards implementing ATM, but its use is not widespread.
  - No freeway ATM tools are in place—although ADOT uses existing freeway ramp meters to address the flow of traffic, ADOT cannot dynamically regulate traffic based on real-time changing conditions until their meter technology is more advanced.
  - Some ATM in use on arterial streets such as traffic signal synchronization and reversible lanes.
  - Transit priority signal and bus queue jumping are used at some intersections. [80]
- These same entities are working toward integrating ATM and managing corridors across the freeway, arterial streets, and transit networks.

[80] Bus queue jumping refers to an additional bus-only lane approaching a traffic signal with its own signal allowing the bus to jump ahead of other vehicles stopped at the intersection.

Recommendations

- ADOT should continue its efforts currently underway to scientifically explore, evaluate, and implement active traffic management techniques where practical or feasible, including continued efforts to work with RTP partners on considering and prioritizing the maintenance of the communication infrastructure to remain functional and current.

Components of Integrated Multimodal Management

Traffic congestion continues to grow every year, creating continued problems for counties, states, and countries. To solve a region's congestion challenges, transportation and transit agencies have a variety of options at their disposal. Some options involve capacity building approaches such as adding lanes to a freeway, widening streets, implementing a light rail system, or buying additional buses and adding routes. Other approaches focus on managing congestion and mobility within the existing roadways through the use of technology and multimodal coordination to optimize investments in roadways already made in a particular area. Yet, there is no one solution or correct combination of strategies for addressing a region's transportation needs.

Multimodal Management Tools

- **Intelligent Transportation Systems** refers to the technology used to monitor and manage the safety and reliability of transportation. Traffic data is provided by this technology.
- **Traffic Operation Centers and Traffic Management Centers** use specialized staff to monitor information and data provided through intelligent transportation systems technology and adjust the transportation network in response to traffic incidents.
- **Active Traffic Management** uses intelligent transportation systems tools in combination with operational management employed by traffic operations and management centers to dynamically adjust the transportation system on a real-time basis, using predictive methods, and 24-hours a day operations.

When voters passed Prop 400 in 2004 authorizing additional funding of the RTP, the plan included a variety of transportation choices from new freeways, arterial streets, and transit projects to funding for technology projects and management systems. These financial investments in technology solutions focus on better utilization and management of existing infrastructure and the leveraging of under-used capacity across modes of transportation. Intelligent transportation systems help entities manage traffic conditions across multiple modes of transportation for improving system efficiency and reducing congestion. Techniques known as active traffic management (ATM) bring together these technology tools through the operational management of that technology to make real-time decisions on the freeway, arterial streets, and transit networks. Specifically**,** the foundation of ATM is built upon intelligent transportation systems components that include a combination of items such as conduit, sensors, cameras, signals, controls, electronics, and telecommunication devices to collect and report traffic data as well as control traffic. Once an infrastructure is in place, trained staff monitor and manage traffic data from intelligent transportation systems technology. This monitoring is done by staff located at traffic operation centers or transportation management centers to take action as needed to address

traffic needs and ensure continued mobility throughout a region. While some traffic operation centers and transportation management centers nationally take on a reactive basis in response to a traffic incident, others operate their centers on a proactive basis anticipating events and using predictive tools to estimate traffic and influence traveler behavior.

Examples of ATM strategies used by transportation agencies nationwide include:

- ✓ Adaptive ramp metering to smartly control the rate of vehicles entering a freeway depending on current levels of congestion;
- ✓ Dynamic lane reversal to better match the direction of traffic demand to roadway capacity;
- ✓ Adaptive traffic signal controls to continuously monitor traffic and wait times as well as adjust signal timing at intersections to adjust for real-time traffic volumes; and
- ✓ Dynamic transit signal priority using probe vehicle technology on buses or light rail vehicles to turn traffic signals green as the transit vehicle nears a signal controlled intersection.[81]

RTP Partners Have Installed a Solid Technology Foundation that is used to Monitor Transportation Network

More than ten years ago, the RTP partners identified a need for a more collaborative approach to transportation operations.[82] As a result, in November 2003, the Maricopa Association of Governments (MAG) developed a Regional Concept of Transportation Operations document which outlines several initiatives for coordinating operations in the region and utilizing intelligent transportation systems technology to better manage the system. MAG continues to work toward this goal through its systems management and operation projects supporting the funding of cross-jurisdictional systems and services. Through this regional approach, dedicated RTP funding is used for technology infrastructure and regionally focused operational activities that require collaboration between ADOT, Regional Public Transportation Authority (RPTA), Valley Metro Rail, Inc.,[83] and the local jurisdictions.

For ATM to be successful, it uses an intelligent transportation systems foundation to communicate real-time travel information through roadway loop detectors and advanced sensors measuring speed and traffic volume, closed circuit television cameras, traffic signal controllers, variable message signs, and wired and wireless communication technologies. [84] We found that Maricopa County has these systems and components in place on freeways, arterial streets, and transit.

[81] Probe vehicle technology relies on global positioning systems or other methods such as cellular geolocation and ground-based radio navigation data to communicate with signals.
[82] RTP partners refers to MAG, ADOT, Valley Metro, and local jurisdictions in Maricopa County.
[83] RPTA and Valley Metro Rail, Inc. are administratively combined under one chief executive officer and known as Valley Metro, except when discussing light rail only activities. For those areas pertaining solely to light rail, we use Valley Metro Rail, Inc.
[84] Variable message signs, also known as dynamic message signs, are electronic traffic signs used on roadways to give travelers information about incidents and traffic conditions.

Freeway Intelligent Transportation Systems

Established in 1996, ADOT's freeway management system uses an integrated package of intelligent transportation systems and strategies including surveillance, incident management, travel time displays, and traveler advisory functions. According to ADOT, it has a robust technology network in place throughout Maricopa County and is using fiber optic technology to upgrade system reliability and prepare for future active traffic management activities. As part of the upgrade, all new regional freeway construction includes installation of basic intelligent transportation system communication and infrastructure components.

Currently, the intelligent transportation systems on ADOT's regional freeways cover approximately 200 miles of freeway although coverage is expected to increase to more than 225 miles, or more than 80 percent of the 275 miles in the region, by calendar year 2023. ADOT's intelligent transportation systems network is enhanced by their purchase of third party private sector data[85] that relies on probe vehicle data; thus, real-time freeway speed information is available beyond the freeway management system coverage area.[86]

In addition to in-ground technology and equipment, ADOT uses 226 closed-circuit television cameras and more than 130 digital message signs that utilize traffic speed, volume, and road conditions to capture and communicate traffic data. Moreover, it has 370 ramp meters on the regional freeway system. Current ramp meters only use fixed-time algorithms meaning that signal times are set depending on times of the day, rather than adjusted by real-time traffic conditions. Additional technology would be needed to convert the fixed ramp meters to "smart" meters capable of making real-time adjustments, and ADOT has plans to make the conversions as described later in this chapter.

Arterial Intelligent Transportation Systems

According to data gathered by MAG and AZTech, local jurisdictions in the region have a wide range of intelligent transportation systems technologies in use on their arterial streets.[87] For instance, as shown in Table 21, approximately 1,100 arterial closed-circuit television cameras and dynamic message signs provide information to travelers on the road regarding construction or emergency conditions to assist with mobility. Communications are aided by fiber, copper, and wireless connections. On an annual basis, MAG makes funds available to local jurisdictions for intelligent transportation systems planning and technology including items such as conduit, fiber optic enhancements, closed-circuit television cameras, and dynamic message signs.

[85] Two private data providers were under contract with MAG, including NAVTEQ a provider of base electronic navigable maps.
[86] Probe vehicle data is from global positioning systems or other methods such as cellular geolocation and ground-based radio navigation data to communicate with signals.
[87] AZTech is an informal coalition of federal, state, local, and private entities focused on regional traffic operations, incident management, and telecommunications for the entire Maricopa County region.

Table 21: Arterial Intelligent Transportation Systems in Place

Jurisdiction	CCTV Cameras (Owned)	DMS (Permanent & Portable)	Miles of Fiber and Copper Connections	Number of Wireless Devices
Avondale	6	0	1	33
Buckeye	0	2	0	0
Chandler	29	3	82	10
Gilbert	87	2	29	135
Glendale	115	14	62	26
Goodyear	63	2	20	0
Maricopa County	53	3	12	44
Mesa	193	2	155	106
Peoria	61	2	32	46
Phoenix	200	13	70	615
Queen Creek	30	0	3	0
Scottsdale	134	34	85	15
Surprise	47	8	18	9
Tempe	71	0	0	0
Youngtown	0	0	0	0
Totals	**1,089**	**85**	**569**	**1,039**

Source: MAG Regional Traffic Signal Management Optimization, 2011 and AZTech 2015 Traffic Management & Operations Performance Indicators Book

Note: CCTV = Closed-circuit television cameras; DMS = Dynamic message signs

Transit Intelligent Transportation Systems

Similar to freeway and arterial street modes, Valley Metro has also built an intelligent transportation systems technology foundation on its bus and light rail transit network through the purchase and installation of a fiber optic network of loop detection and vehicle communication technology. Much of the management and operation of a public transit system relies on technologies known as advanced public transportation systems. These technologies include real-time schedule updates and vehicle dispatch based on remote monitoring of the electrical and mechanical health of transit vehicles.

Since 2005, Valley Metro has followed a vehicle management master plan guiding the implementation of advanced public transportation systems applications within Maricopa County. As part of this plan, Valley Metro has integrated its communication system for 750 fixed route buses, 200 paratransit (dial-a-ride) vehicles, and 60 support vehicles—covering more than 84 percent of the entire Maricopa County transit network. Specifically, Valley Metro uses a computer-aided dispatch system to track and manage transit fleet operations. The system includes radio communication, an automatic vehicle location system using global positioning system satellite receivers, automatic passenger counting systems, and next stop announcement systems.

Regional Coordination of Intelligent Transportation Systems is in Progress

Historically, states and local agencies across the nation have developed and operated their own separate and independent technology systems for freeways, arterial streets, and transit. As such,

a freeway operator might focus solely on relieving freeway congestion through ramp metering without considering the impact metering may have on adjacent arterial streets and transit services on those streets. In this instance, a freeway operator could safely divert travelers through message signs onto arterial streets to bypass an incident. Yet, if the local jurisdictions are not aware that additional traffic is being detoured to their arterial streets, the roads could become congested and transit using the roads could also be delayed—in essence defeating the purpose of using intelligent transportation systems technology. Thus, solutions are needed to bridge the gap between the disparate systems allowing them to function as an integrated system.

Similar to other transportation regions in the nation, individual entities in Maricopa County operate and maintain their own intelligent transportation systems networks. Most of the local jurisdictions in Maricopa County, as well as ADOT, have their own intelligent transportation systems policies for operating their networks tailored to their individual system or mode of transportation. One challenge with having multiple local entities constructing, operating, and maintaining individual infrastructures is aligning fragmented local area goals with the larger regional goals to ensure that investments are successful.

While there is no single entity responsible for operating and coordinating the freeway, arterial streets, and transit systems at the regional level, MAG focuses on regional long-term planning and coordination in Maricopa County through its Intelligent Transportation Systems Committee. Over the last five years, MAG has issued guidance such as its 2012 Intelligent Transportation Systems Strategic Plan that established regional priorities and directed intelligent transportation systems infrastructure investments. Additionally, MAG has created a Regional Intelligent Transportation Systems Architecture document outlining technology requirements and best practices based on federal guidelines to provide a common framework for planning and integrating intelligent transportation systems across the region. The most recent update to the architecture guidelines occurred in 2013. MAG also leads a regional community network that addresses coordination issues by identifying the telecommunication needs for linking MAG member agencies.

Another opportunity for regional coordination is provided through AZTech. With members from MAG, ADOT, local jurisdictions, and private firms, AZTech provides a forum for these entities to discuss regional issues related to traffic operations, incident management, and communication practices throughout Maricopa County. Although AZTech does not have formal authority, representatives from each agency can leverage AZTech discussions by influencing change within their individual agencies to ensure entity-specific activities are conducted with a regional focus in mind. As these discussions occur, continued focus should be on ensuring the detection and communication infrastructure remains functional and current. Additionally, the RTP partners should continue considering the impact of connected and self-driving vehicles on existing technology and the need for vehicle-to-vehicle and vehicle-to-infrastructure data exchange. With technology rapidly evolving, the RTP partners are proactively considering, evaluating, and planning for these future technologies as well as monitoring the dynamically-changing landscape of related technology developments. In fact, ADOT and Maricopa County are participating in a national pilot project testing connected vehicle concepts for emergency vehicles. Further, MAG

has begun discussions at the regional level on possible future planning scenarios involving connected and highly automated vehicles and continue to monitor related developments and national advances in this area.

ADOT Uses its Traffic Operation Center to Monitor Freeway Network

To best utilize an intelligent transportation systems network, dynamic management is needed through the creation and use of a traffic operation center or transportation management center that continuously monitors the freeway system. These centers are responsible for managing and operating the intelligent transportation systems network including controlling devices and responding to incidents. As such, these centers are a critical piece of a region's strategy to improve mobility and optimize existing roadway capacity.

ADOT operates a traffic operation center staffed 24-hours seven days a week to monitor, manage, and respond to traffic and improve mobility. Like others across the nation, ADOT has dedicated management and staff with specialized skills and training in its traffic operation center and uses standard strategies such as incident management and response as well as display of travel information on dynamic message signs. Since 2014, when two specialized Department of Public Safety Troopers were moved onsite to the ADOT traffic operation center, the average time taken to clear a crash site has been reduced by nearly one hour between calendar years 2014 and 2015 increasing mobility and preventing possible secondary collisions. Specifically, the time needed to clear crashes was reduced between 48 and 65 percent according to the Department of Public Safety Director. In October 2015, ADOT's traffic operation center was moved under a newly created Transportation Systems Management and Operations Division that manages the current infrastructure and new technologies as well as combines technology and engineering capabilities with traffic management and maintenance.

While ADOT is continually monitoring the freeway system, it is not yet actively managing and adjusting traffic on a real-time basis using predictive methods. Current standard practices are reactive to changing conditions, rather than proactively anticipating and managing the system in real-time. Yet, ADOT continues to technically consider and evaluate these priorities as part of its operational activities.

Local Jurisdictions Operate Multiple Traffic Management Centers

In Arizona and across the nation, the management of traffic flow on arterial streets is typically the responsibility of individual local jurisdictions. In Maricopa County, local jurisdictions own and operate 13 separate transportation management centers over nearly 75 percent of the approximately 3,000 traffic signals in Maricopa County as shown in Table 22.[88] Most of the centers operate during traditional business hours, although some traffic management centers also house local law enforcement units to quickly assist with incident dispatch for safety and mobility purposes. Yet, unlike the ADOT's traffic operation center, none of the local jurisdictional

[88] According to a 2011 survey conducted by MAG and documented in its Regional Transportation Systems Management and Operations Report.

transportation management centers operate continually 24-hours a day to actively manage congestion. As such, most activity is in response to traffic congestion rather than predicting events and making proactive changes.

Table 22: Signals Operated by Traffic Management Centers in the Maricopa County, as of calendar year 2014

Jurisdiction/Agency	Number of Signals Owned	Number of Signals Operated by TMC	Percent of Signals Managed
Avondale	46	0	0%
Chandler	199	187	94%
Gilbert	174	167	96%
Glendale	193	130	67%
Goodyear	74	18	24%
Maricopa County	154	93	60%
Mesa	379	404	107%
Peoria	108	105	97%
Phoenix	1,092	615	56%
Queen Creek	34	12	35%
Scottsdale	301	280	93%
Surprise	41	25	61%
Tempe	221	199	90%
Totals	**3,026**	**2,235**	**74%**

Source: MAG 2035 RTP

Note: The RTP did not provide an explanation for reported numbers where "number operated" are greater than "number owned."

While MAG provides funding through the RTP to help with implementation costs of setting up the transportation management centers, ongoing operation and maintenance costs associated with data gathering and technology upgrades are mostly paid through local general funds, local sales tax, and local construction funding source.

To operate efficiently in the region, these individual transportation management centers must focus on two essential elements—data gathering and communication. First, local agencies must gather data on the current status of traffic and delays. According to MAG, most local jurisdictions in the region use loop detectors and video image detection to gather data although more than 40 percent use more advanced detection technology.

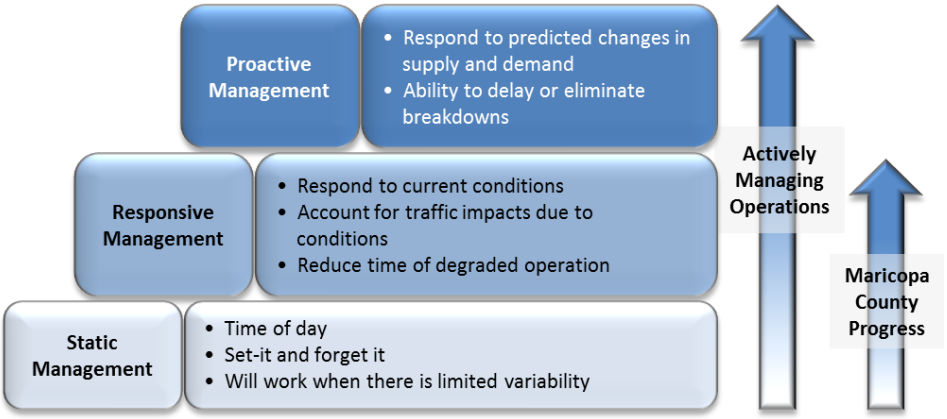
Additionally, local transportation management centers must be able to communicate with one another and share traffic information. Toward that end, MAG developed a Regional Transportation Systems Management and Operations program to set the long-term vision for arterial streets. According to MAG, the first efforts to establish regional intelligent transportation systems communications to link 10 local agencies through leased telecommunication lines began in 1998—although, the leases were allowed to expire before 2001. Subsequent efforts over the years included a 2001 MAG study outlining concepts for the public sector agencies to share information across boundaries as well as a 2007 MAG-approved regional community network to support data and video transmission related to these local traffic management activities.

Further, in 2009, ADOT completed a project connecting its traffic operation center with eight local transportation management centers in Chandler, Gilbert, Glendale, Maricopa County, Mesa, Peoria, Phoenix, and Surprise. ADOT has continued to connect to other transportation management centers across the region. As such, the majority of entities can share traffic data captured by all connected cameras to support regional management activities.

Region is still Developing ATM Practices, Although Some Basic Use Exists

As described earlier in this chapter, ATM uses dynamic and proactive activities to impact travel conditions on a real-time basis. For the most part throughout the nation, ATM has been implemented primarily on limited access freeway corridors. The Federal Highway Administration has described steps involved with evolving from a static management environment to a proactive state as shown in Figure 12. At the lowest step, traffic management is static—this could include using ramp meters that have fixed-basis timing or arterial street signals with set green light and red light timing patterns. Next steps in the active management evolution involve staff from traffic operation centers and transportation management centers reviewing traffic data and reacting to current conditions such as sending emergency vehicles and other response teams to a traffic incident to minimize related road delays. Later steps include proactively using technology such as adaptive ramp meters or smart signals to predict travel and inform travel behavior by regulating vehicle speed, rate of vehicles entering a roadway, or green conditions of signal lights. These steps help avoid traffic delays and incidents.

Figure 12: Process Evolution toward Active Management



Source: Federal Highway Administration's Active Transportation Demand Management Overview at http://ops.fhwa.dot.gov/atdm/about/overview.htm

With a solid foundation in place and commitment towards exploring more real-time techniques, ADOT, Valley Metro, and the local jurisdictions have some examples of ATM techniques in practice as described in detail in the sections that follow. While there can be dispute as to the specific advanced practices that can be classified as ATM, there is general agreement in the industry that it involves a higher level of control and response. Most importantly, the Maricopa County RTP partners are considering and planning to move toward more active and advanced techniques.

Freeway ATM Tools are not yet in Place

In Maricopa County, ADOT has not yet incorporated ATM tools into the freeway system although ADOT continues to technically evaluate projects or scenarios where ATM could be feasibly put into use. Instead, ADOT continues to use more traditional programs such as those activities employed through its traffic operation center monitoring and management of congestion as well as it incident response practices.

For instance, ADOT makes extensive use of traditional freeway ramp metering to regulate the volume of vehicles entering a freeway at a given time. ADOT has approximately 370 basic ramp meters in place throughout the county. Although these are in place at more than half of the freeway traffic interchanges,[89] ADOT is aware of the limitations with its current ramp metering software and has goals of having more dynamic on- and off-time monitoring rather than fixed time at some point in the future. Specifically, ADOT intends to deploy "smart" meters, or adaptive freeway ramp meters, that will allow staff to control the "rate of vehicles entering the freeway utilizing advanced algorithms that change vehicle release rates based on the level of congestion on the mainline freeway." For instance, ADOT is currently implementing corridor adaptive ramp meters on SR 51 southbound over the fall of 2016 and has plans to monitor ramp performance with before and after studies. Other planned efforts include enhancements to ADOT ramp metering strategies through integration with the arterial street network.

Freeway ATM Examples:

- ✓ **Adaptive ramp metering** using special algorithms to control rate of vehicles entering the freeway
- ✓ **Dynamic lane assignment** to open or close lanes and provide advance driver warning through sign controls
- ✓ **Dynamic lane reversal** to better match capacity with traffic demand
- ✓ **Variable Speed limits** adjusted based on real-time conditions through speed limit displays
- ✓ **Dynamic shoulder lane** use based on real-time congestion

Yet, ADOT is similar to many other departments of transportation across the nation that are still using fixed-time ramp meters and have not yet incorporated ATM practices. For instance, a 2014 Transportation Review Board research survey found that strategies such as dynamic ramp metering are only in place in 30 to 50 percent of states. More advanced types of ATM strategies, such as high occupancy toll lanes, bus-only shoulder lanes, and dynamic priced shoulder use, are deployed in less than 30 percent of states responding to the survey.[90]

As ADOT begins to incorporate ATM techniques, it should continue its focus on being nimble and reshaping historical practices with a more proactive mindset. Currently, ADOT is actively focused

[89] Traffic interchange is a combination of ramps and grade separations at the junction of two or more highways to reduce or eliminate traffic issues. In Maricopa County, examples of traffic interchanges include the stack connecting Interstate-10 and Interstate-17, mini-stack linking Interstate-10 to State Route 51 and Loop 202, and the split where the Interstate-10 splits or merges with Interstate-17 near the airport.

[90] High occupancy toll lane is a lane of traffic available to high occupancy vehicles and other exempt vehicles without charge, but other vehicles pay a variable price adjusted by demand. Bus-only shoulder lane are used by buses to get around stationary traffic during congested periods. Dynamic priced shoulder use works similarly when general purpose lanes are congested, the shoulder is opened and vehicles pay a price for use—although some carpools can use the shoulder at no cost.

on technically studying and evaluating the implementation of ATM techniques on the freeway system as feasible. For instance, ADOT examined lessons learned and conducted peer exchanges with entities across the nation when considering the deployment of variable speed limits on the Insterstate-17.

Locals Report Use of ATM Tools at the Arterial Streets level

To better manage traffic flow and improve safety within arterial street capacity, federal experts suggest arterial ATM techniques such as adaptive traffic control signals, transit signal priority, reversible lanes, and dynamic turn restrictions.[91]

Arterial ATM Examples:

- ✓ **Adaptive traffic control signals** where traffic and the queuing at intersections is continuously monitored to dynamically adjust signal timing
- ✓ **Signal priority** uses sensors to detect when a transit or emergency vehicle approaches an intersection and turns signals to green sooner or extends the green phase
- ✓ **Reversible lanes** where vehicle direction is changed depending on demand
- ✓ **Dynamic turn restrictions** that prevent certain turning restrictions when necessary to improve safety or operation of an intersection

In Maricopa County, some basic arterial ATM strategies are in place such as adaptive traffic control, signal priority, and reversible lanes. For example, reversible traffic lanes are used on 7th Avenue in Phoenix where lane direction is altered during peak commute times to open more lanes to heavier traffic patterns. Lane direction is communicated to drivers through dynamic message signs on the roadway.

Further, according to results received from 7 of the 12 local jurisdictions auditors surveyed, signal synchronization and traffic signal priority were cited as the most prevalent ATM strategy used by more than half of the respondents, as shown in Table 23. On average, the survey respondents reported annual costs spent on ATM ranging from less than $250,000 to more than $1 million. In fact, the cities of Mesa and Peoria along with Maricopa County each responded that their entities spent more than $1 million on ATM strategies annually.

Table 23: ATM Strategies in Place at 7 Local Jurisdictions Surveyed

	Fountain Hills	Gilbert	Maricopa County	Mesa	Peoria	Phoenix	Scottsdale
Active Traffic Management Technologies							
• Traffic signal synchronization			✓	✓	✓	✓	✓
• Traffic signal prioritization			✓	✓	✓	✓	
• Emergency/Transit priority			✓	✓		✓	✓

Sources: Survey responses, unaudited.

[91] Federal experts include the Transportation Research Board and the Federal Highway Administration.

While the responsibility for operating traffic signal systems falls on the local jurisdictions, there have been long-term planning efforts to improve regional strategies through data sharing and cross-jurisdictional collaboration. For example, MAG has sponsored a Regional Traffic Signal Optimization Program providing technical assistance to local agencies for improving traffic signal operations through signal timing software and requisite training for agency personnel. On-call consultants hired by MAG provided traffic engineering assistance to refine signal operations with the best timing settings to minimize traveler stops and delays as well as to maximize mobility along an arterial street. Since 2004, this Traffic Signal Optimization Program has involved more than 110 projects and 1,100 signaled intersections. With projects ranging from $30,000 to $50,000, MAG has provided more than $1 million of funding between fiscal years 2010-2011 and 2014-2015 for this effort.

However, MAG believes these existing traffic management practices have been around for several years and are not considered advanced practice. MAG believes that ATM requires a much higher level of control and response than exists now and that no current arterial streets technology systems applications are ATM. Nonetheless, MAG has long-term planning priorities and the local jurisdictions have operational priorities to incorporate more real-time management into current practices with the belief that ATM strategies are the next logical step to combat worsening travel conditions.

Transit Uses Several ATM techniques

To be efficient along the roadway corridors, Valley Metro uses two primary types of ATM techniques in Maricopa County—signal priority and bus queue jumping.

For signal priority, certain local traffic signals across the region are equipped with priority capability for bus transit and light rail vehicles as shown in Table 24. These tools allow transit vehicle-to-traffic signal communication to keep a green light on longer or cause a red light to turn green sooner allowing for the efficient movement of transit along a corridor. Communication at these intersections happens through an intelligent transportation systems foundation built by Valley Metro using an Ethernet network and controllers connected to electronic switches that enable signals and vehicles to talk to each other. Additionally, there is signage at intersections to assist transit vehicles in knowing when they can turn on red signals and guiding car or motorcycle drivers around transit vehicles in other situations.

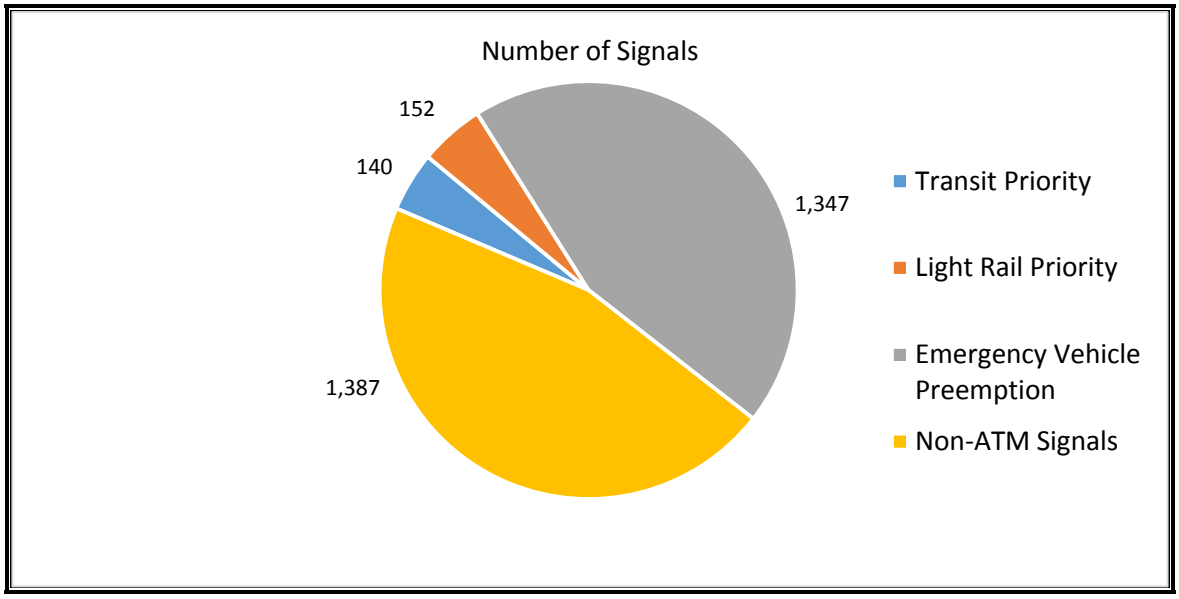
Transit ATM Examples:

- ✓ **Transit signal priority** manages traffic signals by using sensors or probe vehicle technology (based on global positioning systems or other methods) to detect when a transit or emergency vehicle approaches an intersection and turning signals to green sooner or extending the green phase
- ✓ **Bus-only shoulder lanes** allow buses to use lanes to pass stationary traffic when general lanes are congested
- ✓ **Bus queue jumping** where separate signals are provided for transit only lanes that displays a green for the transit lane before it turns green for vehicles in the other roadway lanes

Source: FHWA

Valley Metro also uses bus queue jumping ATM techniques to reduce the effects of congestion. For example, on one of its bus routes—the Arizona Avenue LINK bus—the vehicle is equipped with intelligent transportation systems technology to utilize queue jump at four intersections to reduce delay. At these intersections, vehicles use bus-only lanes while approaching an intersection and communicate with dedicated bus-only traffic signals through cameras and technology. This communication enables the bus to get an earlier green signal before other vehicles allowing the bus to "jump" ahead of the vehicles in queue. Although Valley Metro has not measured the effect of this technique, officials believe queue jumping inherently saves time because the bus does not have to wait in a line of traffic.

Table 24: Number of Signals across Region with Priority Capability



Source: MAG Regional Systems Management and Operations site, 2016, and MAG 2035 RTP, page 17-8

Others Entities Use of ATM Techniques Have Reported Benefits

Throughout the country, other agencies are realizing benefits in employing ATM techniques on freeways, arterial streets, and transit systems. For instance, several other states that employ dynamic freeway metering techniques have shown speed increases ranging from approximately 10 percent in Seattle to more than 170 percent reported in Portland. Further, reported travel times were reduced by at least 20 percent in Minneapolis/St. Paul, Long Island, and Denver areas. Collision reductions ranging from 15 percent in Long Island to more than 40 percent in Denver were also reported.

Like freeways, several entities across the U.S. are experiencing decreased travel times on arterial streets through the use of adaptive traffic control systems that actively monitor and adjust arterial street signal timing on a real-time basis given current traffic conditions, demand, and system capacity. For instance, in Los Angeles, the Department of Transportation first implemented an automated traffic surveillance and control system in the 1980's and now 70

percent of the city's 4,300 traffic signals are included in its adaptive traffic control systems. Studies have shown a 15 percent decrease in travel times and 20 to 30 percent decrease in vehicle stops or signal delays. Another reported benefit of the Los Angeles system is the ability to add new traffic control features through software rather than incurring significant hardware or infrastructure costs when modifications are needed. While adaptive traffic control systems show favorable mobility performance, there are no signals currently operating under adaptive traffic control systems in Maricopa County.

In 2010, the National Cooperative Highway Research Program surveyed 38 domestic and foreign agencies to determine whether agencies operated signals under this approach. The percent of an agency's signals using adaptive traffic control systems varied widely, with some using adaptive traffic control systems on well over half of their signals, such as the City of Los Angeles at 70 percent, Victoria Roads in Australia at 83 percent, and Southhampton in the United Kingdom at 100 percent. Most of the domestic agencies in the U.S. had much lower percentages with some examples shown in Table 25.

Table 25: Examples of Adaptive Traffic Control Systems Signals Operated by Other Entities

Jurisdiction/Agency	Number of Signals Operated	Number of Signals Using ATCS	Percent of Signals Using ATCS
Anaheim, CA	300	0	0%
Minnesota State DOT	675	0	0%
Utah State DOT	1,100	16	1.5%
Washington State DOT	520	10	1.9%
Tucson, AZ	375	15	4%
Longview, TX	132	16	12%
Ann Arbor, MI	150	34	23%
Oakland County, MI	1,500	650	43%
Los Angeles, CA DOT	4,300	3,000	70%
Victoria Roads, Australia	3,000	2,500	83%
Southampton, UK	200	200	100%

Source: National Cooperative Highway Research Program Synthesis 403: Adaptive Traffic Control Systems (ATCS) Domestic and Foreign State of Practice, 2010

Several reasons may explain why adaptive traffic control systems are not more widely utilized including estimated adaptive traffic control systems installation costs per intersection at approximately $65,000—ongoing maintenance, operation, and management costs escalate the costs even higher.[92] Other challenges for implementing adaptive traffic control systems include hiring or training staff skilled with the requisite expertise in dynamically operating traffic signals.

[92] National Cooperative Highway Research Program, Synthesis 403, Adaptive Traffic Control Systems: Domestic and Foreign State of Practice, 2010.

RTP Partners are Working on Integrating ATM across Multiple Modes of Transportation

While certain ATM techniques are being used in individual transportation modes in Maricopa County, MAG and its RTP partners are also working collaboratively towards planning and integrating active management along multimodal corridors. One approach being considered that is used across the U.S. to connect and coordinate freeway, arterial streets, and transit modes is known as integrated corridor management. This practice shifts the focus from traditional approaches of individually managing roadways toward a regional focus on managing transportation corridors as a system through the use of technology and operational strategies. A benefit of this approach is that individual freeway, arterial, and transit mode networks can be integrated across entities to improve incident management, safety, and mobility.[93]

For instance, in 2014, MAG initiated a study on one of its busiest corridors—the Interstate-10/Interstate-17 or "Spine" Corridor—that runs through the center of Maricopa County and handles more than 40 percent of all daily freeway traffic in the region. This study is exploring and creating multimodal solutions for congestion in the region and is expected to combine intelligent transportation systems technology and ATM techniques on multiple modes along the corridor. The multimodal study is part of a phased plan that will likely span several years before full implementation. While outcomes of the Spine Corridor study are expected to guide RTP partners toward developing ultimate solutions for the future, several near term improvement projects are planned to be constructed by 2020 such as braiding ramp improvements that separate the merging traffic for a smoother transition between the State Route 143 and US 60 freeways.

1-10/1-17 "Spine" Corridor

Source: MAG Spine Study
https://www.azmag.gov/transportation/The_Spine_Study.asp

In addition, according to AZTech, there is an integrated corridor program in place for the Loop 101 Corridor in Scottsdale. Specifically, this program includes several regional agencies that help manage congestion and construction detours of the State Route 101 widening/high occupancy vehicle lane project using tools such as arterial signal control and freeway digital messaging signs. Traveler information is provided through various avenues including telephone, website, and dynamic message signs.

[93] U.S. Department of Transportation website.

Reported benefits indicate significant reductions in travel time as reflected in performance measures provided by Maricopa County Department of Transportation as shown in Table 26—although some of the reduction could be attributed to lower traffic volumes in the area. Given the reported levels of success, Maricopa County is moving forward with plans to implement similar integrated practices for other parts of the State Route 101 in 2016.

Table 26: Integrated Corridor Management Project on Bell Road Corridor (Grand Avenue to Loop 101) Shows Reduction in Travel Times between 2012 and 2014

Year	Reduction in Travel Time	Reduction in Traffic Volumes
2012	22.5%	6%
2013	27.8%	5.7%
2014	28.5%	4.2%

Source: Maricopa County Department of Transportation, intelligent transportation systems Branch Manager

Other Agencies Nationwide are Realizing Benefits of ATM Use and Integrated Corridor Management

Others have noted great successes with integrated corridor management strategies deployed in regions across the U.S. at pioneer sites such as Dallas, Minneapolis, Oakland, San Diego, San Francisco, and Seattle. Reports quantify annual travel time savings in person-hours ranging from 132,000 in Minneapolis to 740,000 in Dallas. Travel time reliability improvements ranged from 3 percent in Dallas to 10.6 percent in San Diego. Moreover, benefit-cost ratios of employing the integrated corridor management strategies ranged from 7:1 to 25:1.

These early adopters offer several lessons learned for getting started with integrated corridor management. If and when the RTP partners in Maricopa County implement integrated corridor management practices within its region, the following key operational lessons identified at the national level would assist the RTP partners—many of which the RTP partners are technically evaluating or beginning to consider for the Maricopa County region.[94]

- ✓ Define corridor and system assets, identify corridor needs, and develop common vocabulary among partners for existing systems and proposed capabilities.
- ✓ Develop a systems engineering management plan for achieving quality and write well-formed system requirements that are concise with data elements that are identifiable.
- ✓ Create a list of short-term and long-term factors and metrics to analyze system performance and determine how well a corridor is operating.
- ✓ Adequately train all operations and maintenance personnel.
- ✓ Manage project procurements, costs, schedules, and risks across the project and partners, and schedule team meetings to improve processes and procedures.

[94] According to the U.S. Department of Transportation.

Chapter 6: Conclusion and Recommendations

Transportation planning and project implementation is as much art as it is science where the correct mix of tools and approaches that a region can employ to address congestion and mobility needs will vary, evolve, and morph over time. Yet, during the five-year audit period between fiscal years 2010-2011 and 2014-2015, the Maricopa Association of Governments (MAG), Arizona Department of Transportation (ADOT), Regional Public Transportation Authority (RPTA), Valley Metro Rail, Inc.[95] and their local jurisdiction partners have operated the Proposition 400 (Prop 400) program through challenges creating a strong framework for completing promised projects.

Our audit found that, with half of the 20-year program elapsed, many good practices have been built into the Regional Transportation Plan (RTP) foundation relating to performance measurement, project management and delivery, cost and schedule control, and intelligent transportation systems.

Additionally, we identified certain opportunities for improvement and made several recommendations that MAG, ADOT, and Valley Metro should consider to improve efficiency, effectiveness, and accountability for the taxpayers in Maricopa County as follows.

	Recommendation	MAG	ADOT	Valley Metro
Chapter 1: Regional Efforts and Progress Since 2011 Audit				
1.	MAG should work with ADOT and the local jurisdictions to enhance freeway and arterial project cards by including baseline budgets and baseline schedules to allow comparisons against actual.	X	X	
2.	Valley Metro should strengthen current capital construction project scorecards by including the initial baseline budget for the project as well as develop consistent project scorecard formats for all transit capital construction projects, regardless of whether Valley Metro oversees the project or a local jurisdiction is managing the project.			X
3.	Valley Metro and MAG should work together to make available transit project scorecards on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.	X		X
4.	RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance.	X	X	X

[95] RPTA and Valley Metro Rail, Inc. are administratively combined under one Chief Executive Officer, except when discussing light rail only activities. For those areas pertaining solely to light rail, we use Valley Metro Rail, Inc.

	Recommendation	MAG	ADOT	Valley Metro
5.	ADOT should work with the Citizens Transportation Oversight Committee to ensure responsibilities, such as annual reporting, are fulfilled and methods of committee operations are changed to be more effective in meeting statutory requirements.		X	
6.	ADOT, as the Citizens Transportation Oversight Committee's administrative support, should encourage the County Board of Supervisors and the Governor's Office to fill vacancies on the Citizens Transportation Oversight Committee and encourage the committee to meet on a regular basis as statutorily required.		X	
	Chapter 2: Freeway Performance			
7.	ADOT should report freeway bridge and pavement condition data at the Maricopa County or Phoenix-Mesa Urbanized Area level, in addition to current statewide data already available.		X	
8.	ADOT should track and report internal project delivery performance metrics at the Maricopa County or Phoenix-Mesa Urbanized Area level.		X	
9.	ADOT should consider using additional project delivery metrics including "project administrative costs as a percent of budget."		X	
10	With many innovative project management practices employed on the South Mountain Freeway project, ADOT should consider applying techniques and tools from this project to other ADOT freeway projects, as appropriate.		X	
	Chapter 3: Arterial Street Performance			
11	MAG should work with the local jurisdictions to gather and make available local performance indicators related to pavement and bridge deck condition at the Maricopa County or Phoenix-Mesa Urbanized Area level on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.	X		
	Chapter 4: Transit Performance			
	No recommendations for this chapter, but refer to Chapter 1 for transit-related recommendations.			
	Chapter 5: Multimodal Systems Management and Operations			
12	ADOT should continue its efforts currently underway to scientifically explore, evaluate, and implement active traffic management techniques where practical or feasible, including continued efforts to work with RTP partners on considering and prioritizing the maintenance of the communication infrastructure to remain functional and current.		X	

Appendix A: Audit Scope and Methodology

As specified in Arizona Revised Statutes (A.R.S.) §28-6313, beginning in 2010 and every fifth year thereafter, the Arizona Auditor General shall contract with a nationally recognized independent auditor with expertise in evaluating multimodal transportation systems and in regional transportation planning, to conduct a performance audit of the Regional Transportation Plan (RTP) and projects scheduled for funding during a five-year period. In 2016, the Auditor General contracted with Sjoberg Evashenk Consulting, Inc. to conduct the second performance audit of the RTP.

Seven primary objectives were identified by the Auditor General as follows:

1. Examine past expenditures of RTP projects previously funded between fiscal year 2010-2011 through fiscal year 2014-2015, and a project's impact on relieving congestion and improving mobility, and performance of the system.
2. Review future RTP projects scheduled for funding during fiscal years 2015-2016 through 2019-2020 based on the performance factors in statute, the RTP, the federal New and Small Starts Criteria, and in context of the transportation system.
3. Confirm whether light rail systems met prescribed federal funding criteria.
4. Assess whether light rail systems have met standards and performance measures related to service levels, capital costs, operation and maintenance costs, transit ridership, and farebox revenues in addition to how performance compares to peer agencies.
5. Identify the extent to which Active Traffic Management technology has been, and is being, effectively used to manage congestion and optimize existing freeway, road, and transit capacity as well as its impact on previously funded projects and future projects scheduled for funding.
6. Evaluate changes to federal or state laws that may have a significant impact on the RTP.
7. Make recommendations on whether further implementation of a project or a transportation system is warranted, warranted with modifications, or not warranted.

Our audit encompassed the five-year period under Proposition 400 from July 1, 2010 through June 30, 2015, although we reviewed related studies and efforts as far back as 2000 and current practices in place through August 31, 2016.

To gain an understanding of the environment and changes over the last five years, we reviewed federal and state laws and regulations related to sales tax revenues, freeway and arterial street capital project implementation, performance measures, and regional public transportation. In particular, we analyzed provisions of the federal Moving Ahead for Progress in the 21st Century (MAP-21) Act and the Fixing America's Surface Transportation (FAST) Act. Additionally, we reviewed provisions pertaining to the Federal Transit Administration "New and Small Starts" program related to mobility improvements, land use, environmental benefits, cost effectiveness, and operating efficiencies (pursuant to 49 USC 5309(e)(1)(b)). We assessed regional

transportation plans and updates, transportation improvement plans, short range transit plans, Proposition 400 annual reports, life cycle reports, customer satisfaction surveys, board and committee agendas and meeting minutes, board and committee presentations and staff reports, and a variety of publications, brochures, and fact sheets. Additionally, we interviewed officials, management, and staff from MAG, ADOT, Valley Metro, Maricopa County, City of Phoenix, and City of Mesa.

As required by A.R.S. §28-6313(C)(2), we reviewed RTP expenditures incurred during fiscal years 2010-2011 through 2014-2015 to examine the performance of the system in relieving congestion and improving mobility in terms of outcomes and outputs. Specifically, we:

- Reviewed factors currently used to measure congestion and mobility goals and targets for each transportation mode as well as overall system, corridors, segments, transit lines and routes, and individual projects.
- Assessed how processes and activities are tracked against baselines and targets as well as whether indicators and measures are analyzed over time to identify any significant trends and program or project impacts.

To evaluate performance related to RTP projects, we reviewed the most recent data available and captured on the RTP partner websites, dashboards, project cards, performance reports, and national databases and assessed vehicle miles of travel, speed, congestion, and crashes, looking for trends over the last five years. Depending on the source, some data was available on a calendar year basis and other data was available on a fiscal year basis. Performance data is tracked and captured using sophisticated loop detectors; also, certain performance data is purchased from third-party vendors[96] for those freeway and arterial streets not covered by loop detection. Without re-performing MAG's geographic information system (GIS) analytic steps, it is difficult to determine the absolute reliability with full certainty. However, to form a basis for us to rely on the performance data we gained a thorough understanding of the GIS methodology employed by MAG. Further, when analyzing data, we vetted missing or inconsistent metrics to better understand the reliability of the data. Moreover, this is the best available performance data for Maricopa County.

Further, we compared performance measures and practices employed with those used by other similar transportation and transit entities in the nation using data from the National Transit Database, Urban Mobility Report, and Urban Congestion Report among other documents. For transit projects, we compared transit activity in Maricopa County with other peer systems in Dallas, Denver, Houston, Sacramento, San Diego, and Utah. These reported results could not be verified as they were either self-reported by agencies not subject to this audit, or were analyzed and correlated by the specific industry entity reports results. In these instances, we attribute the data to the sources as appropriate. However, this is the best available and most widely-used comparable performance data in industry.

[96] Two private data providers were under contract with MAG, including NAVTEQ a provider of base electronic navigable maps.

Additionally, we created and distributed a survey to the local jurisdictions in Maricopa County to ascertain information about performance practices, actual performance indicators, pavement maintenance, active traffic management practices, and project management and delivery practices on arterial street and transit capital projects.

To evaluate variances between budget cost and actual expenditures as well as baseline schedule and actual completion, we:

- Identified the universe of projects and related expenditures incurred between July 1, 2010 and June 30, 2015 as well as those planned between July 1, 2015 and June 30, 2020, using data from Proposition 400 annual reports, freeway, arterial, and transit life cycle program reports, federal project management reports, and financial data to identify budget and actual costs as well as schedule information within modes of transportation and individual projects. While the 2011 RTP Performance Audit determined the reliability of cost and schedule data, we ensured that data sources and processes used to gather and report data had not significantly changed since the prior audit and, thus, determined we could rely on the data.
- Additionally, we used arterial project overview documents to identify baseline budgets and the stage at which the baseline was established as well as ADOT's internal data warehouse and several spreadsheets and reports from Valley Metro.
- Selected a sample of freeway, arterial, and transit projects to compare planned expenditures with actual results and identify methods used, and frequency of, communications and reports on schedule, cost, and progress of projects. Additionally, we considered comparing variances between engineer's estimates and bids. Specifically,
    - For freeway, we selected one completed freeway loop corridor (consisting of several projects) and one large project in progress and planned for completion in the next five years each employing a different project delivery method.
    - For arterial, we selected one of the largest projects completed during the last five years and administered a survey to the remaining jurisdictions related to project management practices.
    - For transit, we selected five capital construction projects that were either completed or in-progress between July 1, 2010 and June 30, 2015, ensuring projects selected included a mix of bus and light rail capital projects. Because bus capital construction projects are primarily completed by local jurisdictions, we selected bus projects managed by different entities including Valley Metro, City of Phoenix, and City of Mesa.
- For the projects in our sample with significant variance in project costs or schedules, we identified the reason(s) to determine reasonableness and whether they were supported. However, we did not evaluate the appropriateness of individual project design concepts or second guess the precision of related project cost estimates prepared by expert transportation engineering consulting firms, nor did we assess whether the right decisions

were made based on the information since projects were presumably discussed and vetted through the MAG committee process.

- Additionally, for the same sample of freeway, arterial, and transit projects, we compared actual schedule to interim internal milestones such as preliminary engineering, environmental, right-of-way, design, advertise bid, start construction, open to traffic, and substantial completion, where practical.

To assess project management practices employed on the individual projects, we reviewed status reports, design concept reports, change orders, project management plans, invoices, cost and schedule tools, engineer's estimates, punch lists, notices to proceed, inspections, grant reporting (where applicable), and other project file documentation at an overall agency level as well as for our project sample items. Specifically, we assessed the project management techniques used and followed during all stages and phases of the lifecycle—including project scoping, design, construction, operation, and maintenance—in comparison with industry standards, federal requirements, and the Project Management Institute's Project Management Body of Knowledge (PMBOK).

To evaluate light rail compliance with federal requirements, we considered the criteria used by the Federal Transit Administration (FTA) related to mobility improvements, land use, environmental benefits, cost effectiveness, and operating efficiencies (pursuant to 49 USC 5309(e)(1)(b) and the interrelationship among the criteria to provide federal funding for light rail systems including the FTA's "new starts" program. Additionally, we:

- Identified federal grants received for Maricopa County's light rail and transit system, and reviewed applicable Federal Transit Administration Triennial Audits and Section 5311 assistance compliance review for findings and corrective actions.
- Reviewed and assessed applicable project management plan reports completed by Valley Metro and any reviews conducted on improving mobility, achieving environmental benefits, cost or operational efficiencies, and project effectiveness.

As required by A.R.S 28-6313(B), we considered light rail performance related to service levels, capital costs, operation and maintenance costs, transit ridership, and fare box revenues as well as significant changes or patterns through a review of project management documentation, project management office reports, and performance data reported in Valley Metro Transit Performance Reports as well as in the National Transit Database for the following indicators:

- Operating cost per vehicle service hour or revenue mile
- Operating cost per boarding
- Passenger trips per revenue mile
- Passenger trips per vehicle service hour

Using qualitative and quantitative measures, we evaluated the extent to which active traffic management (ATM) technology has been used to manage road and freeway congestion as well as

optimize existing transit, road, and freeway capacity. Further, we reviewed technology strategic plans, concepts of operations, and inventory data, as well as results from our survey of local jurisdictions to identify local practices. We also reviewed MAG guidance and reports, AZTech publications, and ADOT documents. Where applicable, we gathered quantitative measures captured to assess benefits of ATM usage in terms of mobility, delay, and, safety. Further, we identified future short-term and long-term plans to use ATM as well as researched national studies, reports, and evaluations of ATM across the country to identify best practices to compare against Maricopa County's plans.

As required by A.R.S 28-6313(c)(3), we considered whether recommendations regarding further implementation of the transportation system was warranted, warranted with modifications, or not warranted. Specifically, we:

- Identified progress made since the 2011 RTP Performance Audit including improvements made to enhance compliance, effectiveness, or efficiencies related to components of the regional transportation system through interviews and documentary review as well as assessed corrective actions taken, status of unresolved issues, estimated time of completion to resolve outstanding issues, matters of concern, ongoing non-compliant issues, and obstacles or impediments to full implementation.
- Determined the impact and effect of the current audit findings on the transportation system components, performance of the system, adherence to Prop 400, and projects accomplished to date to assess whether modifications were necessary.

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Appendix B: Local Jurisdiction Survey Results

	Fountain Hills	Gilbert	Maricopa County	Mesa	Peoria	Phoenix	Scottsdale
I. Capital Project Management & Delivery							
1. Average annual CIP budget for street improvements, traffic reduction, and transit improvements.	<$10M		>$50M	>$50M	$26-50M	>$50M	$26-50M
2. Use of single project manager, cradle-to-grave	✓	✓	✓	✓	✓		✓
3. Most common project delivery method employed.[97]	DBB	CMAR	DBB	DBB	DBB	DBB	DBB
4. Project management tools/software used:							
▪ Automated (Primavera, Microsoft Project, In-House System)		✓	✓	✓	✓	✓	
▪ Manual (Excel, Word, Microsoft Outlook)	✓		✓	✓	✓	✓	✓
5. Final project file storage method:							
▪ Central repository (scanned)	✓	✓	✓		✓	✓	
▪ Central repository (mix of scan/hard copies)				✓			✓
6. Management plans prepared and used:							
▪ Project management plan	✓	✓	✓		✓	✓	✓
▪ Design quality management plan			✓			✓	
▪ Construction quality management plan			✓	✓		✓	
7. Baseline-to-actual schedule milestones tracked:							
▪ Right-of-way		✓	✓	✓	✓	✓	
▪ Environmental		✓	✓	✓	✓	✓	
▪ Design	✓	✓	✓	✓	✓	✓	✓
▪ Construction (ready to advertise)		✓	✓	✓		✓	
▪ Construction (contract award)	✓	✓	✓	✓	✓	✓	✓
▪ Open to public		✓		✓	✓	✓	✓
8. Budget-to-actual costs tracked:							
▪ Right-of-way		✓	✓	✓	✓	✓	✓
▪ Environmental		✓	✓		✓	✓	
▪ Design	✓	✓	✓	✓	✓	✓	✓
▪ Construction	✓	✓	✓	✓	✓	✓	✓
▪ Construction Support		✓	✓		✓	✓	
▪ Administration		✓		✓		✓	✓
9. Documentation considered when approving construction progress payments:							
▪ Schedule of values	✓			✓	✓	✓	✓

[97] DBB = Design-Bid-Build; CMAR = Construction Manager At-Risk

	Fountain Hills	Gilbert	Maricopa County	Mesa	Peoria	Phoenix	Scottsdale
▪ Certified payroll			✓	✓	✓		
▪ Field inspection reports	✓		✓	✓	✓	✓	✓
10. Documentation used in approving change orders:							
▪ Request for information (RFI)	✓			✓	✓		✓
▪ Proposed change order (PCO)	✓			✓	✓	✓	✓
▪ Scope, schedule, cost negotiations	✓		✓	✓	✓		✓
▪ Final change order approval	✓		✓	✓	✓	✓	✓
▪ Other						✓	
11. Stage of design-bid-build project using value engineering	Design, Const.	Cont.	Design	As needed	Design	Const.	Cont.
12. Use of value engineering on design-build projects	✓			✓		✓	✓
13. Types of risk analyses performed			Risk Register				
14. Metrics tracked at an individual project level:							
▪ Description of change order categories	✓		✓	✓	✓	✓	✓
▪ Construction bid v. final cost (change order percentage)	✓		✓	✓	✓	✓	✓
▪ Submittal/RFI review turnaround time	✓			✓		✓	
▪ Construction bid v. Engineer's Estimate	✓		✓	✓	✓	✓	✓
15. Metrics tracked across all projects:							
▪ Description of change order categories	✓		✓		✓	✓	✓
▪ Construction bid v. final cost (change order percentage)	✓		✓		✓	✓	✓
▪ Submittal/RFI review turnaround time	✓					✓	
▪ Construction bid v. Engineer's Estimate	✓			✓	✓	✓	✓
▪ # and/or % projects done within original amount	✓		✓	✓	✓		
▪ # and/or % projects done within original schedule	✓		✓	✓	✓		
II. Pavement Condition, Maintenance & Rehabilitation							
16. Pavement assessment frequency	5-yr		Annual	Other	Annual	2-yr	Annual
17. Pavement condition goal	58-74		75-85	75-85	86-100	75-85	75-85
18. Pavement condition currently	58-74		86-100	75-85	75-85	75-85	75-85
19. Pavement management system used	Manual		GBA	Micro-paver	Other	Aran/ Vision, DTIMS	Lucity
III. Bridge Condition							
20. Bridges responsible for maintaining	<50	<50	>200	<50	101-150	151-200	151-200

	Fountain Hills	Gilbert	Maricopa County	Mesa	Peoria	Phoenix	Scottsdale
21. Bridge assessment frequency	5-yr	5-yr	2-yr	Annual	2 to 4-yr	2 to 4-yr	Annual
22. Bridge deck area by condition:							
▪ Good	95%		90%		100%	88%	98%
▪ Fair	5%		10%			8%	2%
▪ Poor						4%	
IV. Active Traffic Management Technologies							
23. ATM strategies in place:							
▪ Traffic signal synchronization			✓	✓	✓	✓	✓
▪ Traffic signal adaptation/prioritization			✓	✓	✓	✓	
▪ Dynamic geometric controls						✓	
▪ EMS/Transit priority			✓	✓		✓	✓
▪ None	✓						
24. Average annual amount spent on ATM	<$250K		>$1M	>$1M	>$1M	$500K -1M	<$1M
25. Monitoring devices in place			✓	✓	✓	✓	✓
V. Safety							
26. Measures tracked to assess fatalities and serious injuries:							
▪ Number of fatalities			✓	✓	✓	✓	✓
▪ Rate of fatalities per VMT			✓		✓		✓
▪ Number of serious injuries			✓	✓	✓	✓	
▪ Rate of serious injuries per VMT			✓		✓		
▪ Number of non-motorized fatalities and serious injuries			✓	✓	✓	✓	✓
▪ None	✓						
▪ Other					✓		✓

Note: Shaded Fields = No Answer Provided; Blank = Not Used

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Appendix C: Planned Prop 400 Projects for Phase III 7/1/2015 through 6/30/2020

#	LEAD AGENCY	LOCATION per 2015 ALCP	Original 2003 RTP Phase per 2015 ALCP	Planned Activity 2016-20 per 2015 ALCP	Planned Expenses FY2016-20 per 2015 ALCP	Total Project Cost in Millions per Prop 400 2015 Annual Report	Final FY for Construct-ion per Prop 400 2015 Annual Report
1	Chandler	Chandler Blvd/Alma School Rd	I	Const.	$ 2.094	$ 9.869	2017
2	Chandler	Gilbert Rd: Ocotillo Rd to Chandler Heights	IV	Const.	$ 6.160	$ 8.908	2015
3	Chandler	Chandler Heights Rd: Arizona Avenue to McQueen Road	III	Design; ROW	$ 1.288	$ 10.464	2019
4	Chandler	Ocotillo Road: Arizona Avenue to McQueen Road	III	Const.	$ 0.939	$ 9.047	2016
5	Chandler	Ocotillo Road: Cooper Road to Gilbert Road	III	Design; ROW; Const.	$ 4.388	$ 9.285	2020
6	Chandler	Old Price Rd at Queen Creek Rd: Intersection Improvements	III	ROW; Const.	$ 2.505	$ 3.414	2016
7	Chandler	Mc Queen Rd: Chandler Heights to Riggs Rd	III	Const.	$ 0.590	$ 10.956	2016
8	Chandler	Ocotillo Rd: Gilbert Rd to 148th Street	not in 2003	Design	$ 0.364	$ 11.404	2024
9	Chandler	Cooper Rd: South of Queen Creek Rd to Chandler Heights	not in 2003	Const.	$ 4.202	$ 8.066	2019
10	Chandler/ Gilbert	Queen Creek Rd: McQueen Rd to Gilbert Rd (CHA)	II	ROW; Const.	$ 3.069	$ 19.016	2018
11	El Mirage/ County	El Mirage Rd: Northern Ave to Peoria Ave (MC)	II	Const.	$ 7.788	$ 14.753	2017
12	El Mirage/ County	Thunderbird Rd: 127th Ave to Grand Avenue (ELM)	II	Const.	$ 1.965	$ 5.704	2017
13	El Mirage/ County	El Mirage Rd: Peoria Ave to Cactus Rd (ELM)	II	Const.	$ 4.936	$ 9.194	2017
14	Fountain Hills	Shea Blvd: Technology Dr to Cereus Wash	I	Const.	$ 0.194	$ 4.464	2016

#	LEAD AGENCY	LOCATION per 2015 ALCP	Original 2003 RTP Phase per 2015 ALCP	Planned Activity 2016-20 per 2015 ALCP	Planned Expenses FY2016-20 per 2015 ALCP	Total Project Cost in Millions per Prop 400 2015 Annual Report	Final FY for Construct-ion per Prop 400 2015 Annual Report
15	Gilbert	Elliot Rd at Cooper Rd: Intersection Improvements	I	Design; ROW; Const.	$ 4.140	$ 7.615	2018
16	Gilbert	Elliot Rd at Gilbert Rd: Intersection Improvements	III	Design; ROW; Const.	$ 3.775	$ 9.382	2021
17	Gilbert	Germann Rd: Gilbert Rd to Val Vista Dr	I	Design; ROW	$ 0.210	$ 11.967	2022
18	Gilbert	Germann Rd: Val Vista Dr to Higley Rd	I	Const.	$ 2.407	$ 17.816	2015
19	County	Dobson Rd: Bridge over Salt River	I	ROW	$ 2.800	$ 47.802	2023
20	County	El Mirage Rd: Bell Rd to Deer Valley Drive	III	Const.	$ 9.725	$ 12.600	2010
21	County	Gilbert Rd: Bridge over Salt River	II	Design; Const.	$ 14.005	$ 66.773	2020
22	County	McKellips Rd: SR-101L to SRP-MIC/Alma School Rd	IV	Design; ROW; Const.	$ 8.035	$ 24.534	2020
23	County	Northern Parkway: Dysart to 111th	III	ROW; Const.	$ 26.912	$ 38.213	2016
24	County	Northern Parkway: Northern Ave to Loop 101	III	Design; ROW; Const.	$ 8.449	$ 12.069	2017
25	County	Northern Parkway: Dysart Overpass	III	Design; Const.	$ 23.356	$ 33.367	2017
26	County	Northern Parkway: 111th to Grand	III	ROW	$ 10.199	$ 2.000	2017
27	Mesa	Country Club/University Dr Intersection Improvements	III	PE; Design	$ 0.137	$ 21.282	2022
28	Mesa	Mesa Dr: 8th Avenue to Main Street	I	ROW; Const.	$ 7.563	$ 16.690	2016
29	Mesa	Pecos Rd: Ellsworth Rd to Meridian Rd	I	Design; ROW	$ 7.565	$ 22.158	2021
30	Mesa	Southern/Country Club Dr	I	Design; ROW; Const.	$ 6.469	$ 12.605	2021

#	LEAD AGENCY	LOCATION per 2015 ALCP	Original 2003 RTP Phase per 2015 ALCP	Planned Activity 2016-20 per 2015 ALCP	Planned Expenses FY2016-20 per 2015 ALCP	Total Project Cost in Millions per Prop 400 2015 Annual Report	Final FY for Construct-ion per Prop 400 2015 Annual Report
31	Mesa	Southern Ave/Stapley Dr	I	Design; ROW; Const.	$ 10.288	$ 21.744	2021
32	Mesa	Stapley Dr/University Dr	IV	Design; ROW; Const.	$ 7.785	$ 30.534	2022
33	Mesa	Mesa Main Street: Mesa Dr to Gilbert Rd Light Rail Extension	III	Flex	$ 102.606	$ 162.637	2020
34	Scottsdale/ Carefree	Pima Rd: Pinnacle Peak to Happy Valley Rd (SCT)	II	Design; ROW; Const.	$ 15.990	$ 22.844	2018
35	Scottsdale/ Carefree	Pima Rd: Dynamite Blvd to Stagecoach Rd (SCT)	II	Design; ROW; Const.	$ 21.616	$ 55.270	2022
36	Scottsdale	Pima Rd: Via Linda to Via De Ventura	I	Const.	$ 1.236	$ 1.913	2016
37	Scottsdale	Pima Rd: Krail to Chaparral	I	Design; Const.	$ 9.463	$ 11.041	2021
38	Scottsdale	Pima Rd: Chaparral Rd to Thomas Rd	I	Design; Const.	$ 6.326	$ 8.761	2022
39	Scottsdale	Pima Rd: Thomas Rd to McDowell Rd	I	Design; Const.	$ 6.129	$ 16.551	2019
40	Scottsdale	Frank Lloyd Wright - Loop 101 Traffic Interchange	III	Design; ROW; Const.	$ 5.983	$ 8.547	2021
41	Scottsdale	Raintree - Loop 101 Traffic Interchange	III	Pre-Design; Design; ROW; Const.	$ 3.166	$ 4.524	2019
42	Scottsdale	Frank Lloyd Wright Frontage Rd: Northsight to Greenway-Hayden Loop	III	Design	$ 0.704	$ 11.065	2022
43	Scottsdale	Raintree/Redfield Rd: Scottsdale Rd to Hayden	III	Design; ROW; Const.	$ 1.500	$ 22.820	2017
44	Scottsdale	Raintree Drive Extension: 76th Pl to Hayden Rd	III	ROW; Const.	$ 14.918		2017
45	Scottsdale	Raintree Drive: Loop 101 to Hayden	III	Design; ROW; Const.	$ 6.304	$ 6.036	2020
46	Scottsdale	Southbound Loop 101 Frontage Road Connections	III	ROW; Const.	$ 2.700	$ 4.360	2017

#	LEAD AGENCY	LOCATION per 2015 ALCP	Original 2003 RTP Phase per 2015 ALCP	Planned Activity 2016-20 per 2015 ALCP	Planned Expenses FY2016-20 per 2015 ALCP	Total Project Cost in Millions per Prop 400 2015 Annual Report	Final FY for Construct-ion per Prop 400 2015 Annual Report
47	Scottsdale	Scottsdale Rd: Thompson Peak Pkwy to Pinnacle Peak Pkwy Phase II	II	Design; ROW; Const.	$ 6.128	$ 18.000	2020
48	Scottsdale	Scottsdale Rd: Pinnacle Peak Pkwy to Jomax Rd	II	Design	$ 1.800	$ 36.937	2022
49	Scottsdale	Scottsdale Rd: Jomax Rd to Dixileta Dr	III	Design; ROW	$ 3.073	$ 18.801	2021
50	Scottsdale	Scottsdale Rd: Dixileta Dr to Ashler Hills Dr	III	Design	$ 1.095	$ 16.624	2023
51	Scottsdale	Shea Auxiliary Lane from 90th St to Loop 101	IV	Design; ROW; Const.	$ 6.390	$ 9.129	2020
52	Scottsdale	Shea Blvd at Frank Lloyd Wright Blvd Intersection Improvements	IV	Design; ROW; Const.	$ 0.665	$ 1.489	2025
				Total without ITS	**$ 412.094**	**$ 981.044**	
53	Multi-Agency	ITS Program	n/a	n/a	$ 20.178	not available	
				Total with ITS	**$ 432.272**	**$ 981.044**	

MARICOPA ASSOCIATION of GOVERNMENTS

302 North 1st Avenue, Suite 300 ▲ Phoenix, Arizona 85003
Phone (602) 254-6300 ▲ FAX (602) 254-6490
E-mail: mag@azmag.gov ▲ www.azmag.gov

50th Anniversary
1967–2017

November 7, 2016

Ms. Cathy Brady
Sjoberg Evashenk Consulting
455 Capitol Mall, Suite 700
Sacramento, CA 98514

Dear Ms. Brady:

The Maricopa Association of Governments (MAG) has completed its review of the final draft report of the 2016 Regional Transportation Plan Performance Audit received November 4, 2016. This response includes comments to four recommendations which apply uniquely to MAG or apply to MAG and partner agencies.

MAG appreciates the auditor's efforts to constructively comment on the performance of the Regional Transportation Plan (RTP) and offers the response to the general findings of the audit in Appendix A and specific responses to audit recommendations as follows:

Recommendation #1: MAG should work with ADOT and the local jurisdictions to enhance freeway and arterial project cards by including baseline budgets and baseline schedules to allow comparisons against actual.

The finding is agreed to and the audit recommendation will be implemented. MAG already has initiated work toward implementation of this recommendation. It is anticipated that the enhanced RTP Project Cards for the Freeway and Arterial Life Cycle Programs will be published online on MAG's website during the month of December 2016.

Recommendation #3: Valley Metro and MAG should work together to make available transit project scorecards on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.

The finding is agreed to and a different method of dealing with the finding will be implemented. MAG will continue to reserve web space and resources in order to co-locate multimodal performance information. Currently, Valley Metro's performance reports are linked to the MAG Performance Dashboard (MAGnitude) website.

Recommendation #4: RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance.

The finding is agreed to and a different method of dealing with the finding will be implemented. MAG already has employed best practices and developed proposed targets for the regional freeway and arterial systems pursuant to the process required by the Federal Highway Administration (FHWA) Metropolitan Planning Rules and System Congestion Notice of Proposed Rulemaking. MAG has completed its component of the target setting process and is currently anticipating coordination sessions with the Arizona Department of Transportation (ADOT) in order to move forward with the final component of regional target determination. Per Federal Transit Administration (FTA) rules, transit performance targets are required to be set by regional transit agencies and operators.

Recommendation #11: MAG should work with the local jurisdictions to gather and make available local performance indicators related to pavement and bridge condition at the Maricopa County or Phoenix-Mesa Urbanized Area level on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.

The finding is agreed to and a different method of dealing with the finding will be implemented. Per federal legislation, state departments of transportation are responsible for monitoring and reporting on metrics, measures and targets included in the Asset Management Rule and Pavement and Bridge Condition Rule. The recommendation states that these indicators need to be made available on MAG's website which can be implemented fully when data collection efforts can ensure consistency and completeness.

MAG again thanks you and your audit team for your efforts and recommendations on how MAG, along with our RTP Partners, can improve the delivery of the Proposition 400 program and improve the regional transportation system; we believe the audit recommendations are a positive step toward improving transportation in the region.

If you have any questions, please contact me or Eric Anderson, MAG Transportation Director, at the MAG Office.

Sincerely,

Dennis Smith
Executive Director

cc: Eric J. Anderson

APPENDIX A

MAG General Comments

A. Report page 2

"While methodologies and preliminary targets have been created, no formal or official performance targets have been established as suggested by best practices. Consequently, it is not possible at this point to determine whether actual performance met expectations for the region and whether the mix of transportation and transit strategies is accomplishing RTP performance goals".

And

B. Report page 3

"RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance".

MAG Response

Statewide and metropolitan transportation planning processes are governed by federal law. Pursuant to federal rulemaking, within one year of the effective date of the rules, State departments of transportation (DOTs) are required to establish two-year and four-year targets. One hundred and eighty days after the DOT establishes targets, Municipal Planning Organizations (MPOs) are required to establish targets by agreeing to support the statewide targets or establishing their own. To date, numerous peer agencies have revisited existing target setting methodologies and reconsidered adopted regional targets in light of new federal rules.

Notwithstanding, draft targets have been developed by MAG for the System Congestion, Freight, and Congestion Mitigation and Air Quality (CMAQ) Notice of Proposed Rulemaking (NPRM) in collaboration with member jurisdictions and the local FHWA office. Complete information detailing the process and methodology followed to establish proposed targets per federal rules was shared with the auditor's team on May 17, 2016. MAG is looking forward to the coordination of target setting with the Arizona Department of Transportation (ADOT) before targets are finalized,

C. Report Page 3

"Significant investment has been made in intelligent transportation system technology and the management and use of that technology, but regional operational coordination is still in progress; and

Some active traffic management tools, such as traffic signal synchronization and transit signal priority, are in place to enhance mobility. However, the region is still moving toward more active real-time monitoring and dynamic, proactive adjustment of the system to meet traffic conditions on a 24-hour a day basis".

MAG Response

Traffic signal systems and related operations at RTP partner agencies rely heavily on vehicle detectors and the communications infrastructure being functional. When either of these components fail, the system fails and RTP partner agencies hear directly from citizens in the form of complaints. All RTP partners already recognize the need to ensure a high degree of reliability for these components as important agency goals. However, many RTP partners have expressed difficulty in obtaining adequate local funds to reach this goal. The RTP does not provide any funds to RTP partners for the maintenance of either vehicle detection devices or communications infrastructure, both of which are critical for the operation of traffic control systems.

D. Report page 4

"MAG should work with the local jurisdictions to gather and make available local performance indicators related to pavement and bridge deck condition at the Maricopa County or Phoenix-Mesa Urbanized Area level on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters".

MAG Response

As part of its responsibility to provide the Federal Highway Administration with critical information, ADOT develops and maintains the Highway Performance Management System (HPMS) for Arizona. HPMS, which includes statistics for the Phoenix-Mesa Urbanized area, is a spatial database that houses key pavement information on all roadways in the State that are functionally classified as major collector or above. Once HPMS data is made available by ADOT, MAG will post this content on the Transportation section of the MAG website.

Additionally, MAG member agency bridges and bridges on the State Highway System are included in the National Bridge Inventory (NBI). On an annual basis, MAG publishes a listing of member agency bridge data from the NBI in its MAG Transportation Programming Guidebook, which is available on the MAG website.

E. Report page 5

".....However, in another national comparison, Phoenix trends are worsening indicating that congestion may be a significant challenge for the region moving forward".*

**2015 United States Department of Transportation Federal Highway Administration Urban Congestion Report.*

MAG Response

The Urban Congestion Report (UCR) measure equivalent to the congestion hours of delay is based on two-way Annual Average Daily volumes reported on the HPMS database. These volumes are partially based on observed data; the majority of the volumes in the HPMS formulas are estimated, which has to be considered when using it in comparison with other congestion measures. Additionally, the UCR bases their analysis on speed data from the NPMRDS (National Performance Management Research Data Set) reporting only on the NHS (National Highway System), which only includes 40 percent of the arterial network in the MAG region. Taking into account traffic count sampling error and variation in traffic estimation, data collection and the size of NHS networks among urban areas, direct comparisons among urban areas using the UCR congestion measures is questionable. http://www.ops.fhwa.dot.gov/perf_measurement/ucr/

F. Report page 11

".....Yet, aligned with best practices, several transportation entities in the country already use targets to measure performance related to crash, speed, ride quality, and congestion goals".

Agencies in the U.S. that have developed targets are largely DOT's, which are agencies that implement projects and are in control of and responsible for delivering new construction, modernization and preservation projects.

MPOs that have established targets typically have jurisdiction over land use planning and in some cases operation of transit services.

Furthermore, to date, numerous peer agencies have revisited existing target setting methodologies and reconsidered adopted regional targets in light of new federal rules.

G. Report page 17

"We found examples in the nation where other transportation entities regularly reported performance targets as shown in the sections that follow".

MAG Response

The examples cited belong to entities that are not MAG peers. They are either:

- A consortium of an MPO and a Transit providing agency with a completely different legal structure, jurisdiction and mandate, or a State DOT.
- An MPO with Land-Use jurisdiction.

H. Report page 36

"Impact of Individual RTP Projects on Travel Time is Difficult to Evaluate without Targets"

MAG Response

Measuring project level performance as it relates to overall system performance has to recognize that often the performance analysis of a single project may significantly over- or underestimate the project's contribution to system performance. For example, a project to add high-occupancy vehicle (HOV) lanes on one section of freeway may appear to perform poorly when analyzed in isolation with the overall system, when in fact the single project is part of a series of system improvements to build the HOV network. Measuring performance by quantifying results of individual highway and or arterial projects tends to render inconsistent and sometimes unexplainable results.

November 8, 2016

Ms. Catherine M. Brady, Director
Sjoberg Evashenk Consulting, Inc.
455 Capitol Mall, Suite 700
Sacramento, CA 95814

Dear Ms. Brady:

ADOT has completed its review of the Revised Draft Report of the Performance Audit of the Maricopa County Regional Transportation Plan by Sjoberg Evashenk Consulting, Inc., dated October 28, 2016.

We have carefully reviewed all of the recommendations contained in the Revised Draft Report. We have included a response to each recommendation that is directed to the Arizona Department of Transportation.

Chapter 1: Regional Efforts and Progress Since 2011 Audit

Recommendation #1: MAG should work with ADOT and the local jurisdictions to enhance freeway and arterial project cards by including baseline budgets and baseline schedules to allow comparisons against actual.

ADOT Response to Recommendation #1: The finding is agreed to and the audit recommendation will be implemented.

ADOT will provide MAG with the baseline budget and baseline schedule information that is needed to enhance the Project Cards.

Recommendation #4: RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance.

ADOT Response to Recommendation #4: The finding is agreed to and the audit recommendation will be implemented.

ADOT started working with regional partners on establishing performance targets per USDOT Notice of Proposed Rulemaking. ADOT will continuously coordinate with MAG in setting performance targets for freeway as soon as USDOT issues publication of final rules.

Recommendation #5: ADOT should work with the Citizens Transportation Oversight Committee to ensure responsibilities, such as annual reporting, are fulfilled and methods of committee operations are changed to be more effective in meeting statutory requirements.

ADOT Response to Recommendation #5: The finding is agreed to and the audit recommendation will be implemented.

Recommendation #6: **ADOT, as the Citizens Transportation Oversight Committee's administrative support, should encourage the County Board of Supervisors and the Governor's Office to fill vacancies on the Citizens Transportation Oversight Committee and encourage the committee to meet on a regular basis as statutorily required.**

ADOT Response to Recommendation #6: The finding is agreed to and a different method of dealing with the finding will be implemented.

ADOT will comply with the statutory requirements of ARS 28-6356 and will notify appointing bodies when vacancies occur.

Chapter 2: Freeway Performance

Recommendation #7: **ADOT should report freeway bridge and pavement condition data at the Maricopa County or Phoenix-Mesa Urbanized Area level, in addition to current statewide data already available.**

ADOT Response to Recommendation #7: The finding is not agreed to, but the recommendation will be implemented.

There is no significant value in separating out Maricopa County from a system performance perspective. We will start separating out Urban vs. Rural.

Recommendation #8: **ADOT should track and report internal project delivery performance metrics at the Maricopa County or Phoenix-Mesa Urbanized Area level.**

ADOT Response to Recommendation #8: The finding is not agreed to and the recommendation will not be implemented.

There is no significant value in separating out Maricopa County from a system performance perspective.

Recommendation #9: **ADOT should consider using additional project delivery metrics including "project administrative costs as a percent of budget."**

ADOT Response to Recommendation #9: The finding is not agreed to, but the recommendation will be implemented.

Starting in FY17, ADOT will track Project Development Cost as a % of Construction Cost. Right-of-Way Acquisition will be either separated or included in the Construction Cost.

Recommendation #10: **With many innovative project management practices employed on the South Mountain Freeway project, ADOT should consider applying techniques and tools from this project to other ADOT freeway projects, as appropriate.**

ADOT Response to Recommendation #10: The finding is agreed to and the audit recommendation will be implemented.

Best practices will be implemented on other projects as applicable.

Chapter 5: Multimodal Systems Management and Operations

Recommendation #12: ADOT should continue its efforts currently underway to scientifically explore, evaluate, and implement active traffic management techniques where practical or feasible, including continued efforts to work with RTP partners on considering and prioritizing the maintenance of the communication infrastructure to remain functional and current.

ADOT Response to Recommendation #12: The finding is agreed to and the audit recommendation will be implemented.

ADOT will continue its efforts currently underway to scientifically explore, evaluate, and implement active traffic management techniques where practical or feasible, including continued efforts to work with RTP partners on considering and prioritizing the maintenance of the communication infrastructure to remain functional and current.

The audit team from Sjoberg Evashenk Consulting, Inc. and the Auditor General's staffs has been very accommodating during the course of the audit and their diligence and expertise in assisting the Department throughout the auditing process are appreciated.

Sincerely,

John S. Halikowski
Director

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VALLEY METRO

Valley Metro.org | 101 N. First Avenue | Suite 1300 | Phoenix, AZ 85003
T 602.262.7433 F 602.262.2682 TTY 602.251.2039

November 1, 2016

Ms. Catherine Brady, Director
Sjoberg Evashenk Consulting, Inc.
455 Capitol Mall, Suite 700
Sacramento, CA 98514

Subject: Response to revised draft Performance Audit Report

Dear Ms. Brady:

Valley Metro has completed its review of the revised draft Performance Audit Report dated October 28, 2016. Our responses are outlined below and on the subsequent pages for each audit recommendation. Please note our responses are contingent upon Valley Metro Board of Directors approval.

Recommendation Response

Recommendation 2. *Valley Metro should strengthen current capital construction project scorecards by including the initial baseline budget for the project as well as develop consistent project scorecard formats for all transit capital construction projects, regardless of whether Valley Metro oversees the project or a local jurisdiction is managing the project.*

Response: The finding is agreed to and the audit recommendation will be implemented. A procedure will be developed to establish when the baseline budget is determined depending on the type of project. The baseline budget for capital construction projects will be included in the project scorecards. Valley Metro will work with the jurisdictions to ensure a consistent project scorecard format is used.

Recommendation 3. *Valley Metro and MAG should work together to make available transit project scorecards on MAG's website, so performance data can be more centrally accessible and transparent to the Prop 400 voters.*

Response: The finding is agreed to and the audit recommendation will be implemented. Valley Metro transit project scorecards are currently linked to MAG's website. Valley Metro will work with the jurisdictions that sponsor transit projects to ensure they are also linked to MAG's website.

Recommendation 4. *RTP partners should fully employ best practices and establish performance targets for key indicators for freeway, arterial streets, and transit performance.*

Response: The finding is agreed to and the audit recommendation will be implemented.

Valley Metro and its partner agencies have several system-wide performance targets incorporated into service provider contracts. These targets and the system's performance compared to them will be reported in the TPR going forward.

- On-time performance (≥ 92%)
- Fare box recovery (≥ 25%)
- Customer complaints (≤ 45 per 100,000 revenue miles)
- Percentage of scheduled trips operated (≥ 99.95%)

Beginning with the FY16 Report, the TPR will also include narrative describing what the performance and trend data indicate, which will assist taxpayers in understanding whether transit is achieving its stated goals for the region.

Thank you for allowing Valley Metro the opportunity to respond to the revised draft Performance Audit Report findings. If you have any questions, please don't hesitate to contact me at 602.495.8205.

Sincerely

Scott W. Smith
Interim Chief Executive Officer

c: Document Control
A. DeVore
J. Farry
P. Hodgins