FINAL REPORT

SR 64 Corridor Profile Study

I-40 to Grand Canyon National Park

PREPARED FOR ADOT MARCH 2018

ADOT WORK TASK NO.
MPD 0040-17

ADOT CONTRACT NO.
18-177972

Prepared by

SR 64 CORRIDOR PROFILE STUDY

I-40 TO GRAND CANYON NATIONAL PARK

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ARIZONA DEPARTMENT OF TRANSPORTATION

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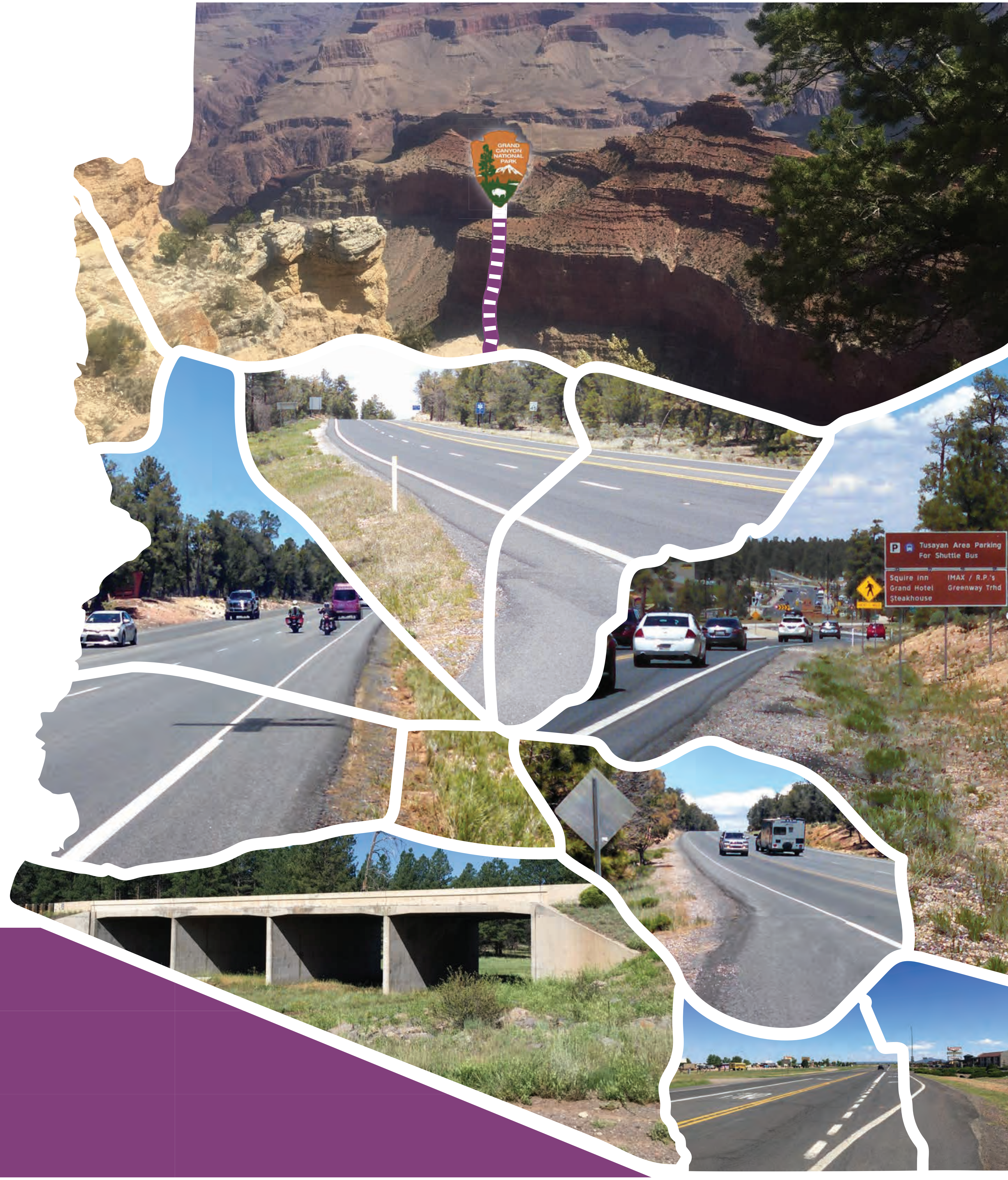
ACRONYMS & ABBREVIATIONS

AADT	Average Annual Daily Traffic
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
ASLD	Arizona State Land Department
AZTDM	Arizona Travel Demand Model
BCA	Benefit-Cost Analysis
BLM	Bureau of Land Management
BNSF	Burlington Northern Santa Fe
BQAZ	Building a Quality Arizona
CCTV	Closed Circuit Television
CR	Cracking Rating
DMS	Dynamic Message Sign
DCR	Design Concept Report
FR	Forest Road
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HERE	Real time traffic conditions database produced by American Digital Cartography Inc.
HPMS	Highway Performance Monitoring System
I	Interstate
IRI	International Roughness Index
ITS	Intelligent Transportation System
LCCA	Life-Cycle Cost Analysis
LOS	Level of Service
LRTP	Long Range Transportation Plan
MAP-21	Moving Ahead for Progress in the 21st Century
MP	Milepost
MPD	Multimodal Planning Division
NACOG	Northern Arizona Council of Governments
NB	Northbound
NPV	Net Present Value
OP	Overpass
PA	Project Assessment
PARA	Planning Assistance for Rural Areas
PeCoS	Performance Controlled System
PES	Performance Effectiveness Score
P2P	Planning to Programming
PDI	Pavement Distress Index
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
RTP	Regional Transportation Plan
RWIS	Road Weather Information System
SAT	Small Area Transportation Study
SB	Southbound
SERI	Species of Economic and Recreational Importance
SGCN	Species of Greatest Conservation Need
SHCG	Species and Habitat Conservation Guide
SHSP	Strategic Highway Safety Plan
SR	State Route
SWAP	State Wildlife Action Plan
TAC	Technical Advisory Committee
TI	Traffic Interchange
TIP	Transportation Improvement Plan
TPTI	Truck Planning Time Index
TTI	Travel Time Index
TTTI	Truck Travel Time Index
UP	Underpass
US	United States Route
USDOT	United States Department of Transportation
V/C	Volume to Capacity Ratio
VMT	Vehicle-Miles Travelled
WIM	Weigh-in-Motion



Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 64 (SR 64) between Junction Interstate 40 (I-40) and Grand Canyon National Park. This study examines key performance measures relative to the SR 64 corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT has completed 21 CPS within four separate groupings or rounds. The SR 64 corridor, depicted in **Figure ES-1**, was one of the strategic statewide corridors identified and the subject of this CPS.

Corridor Study Purpose, Goals and Objectives

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

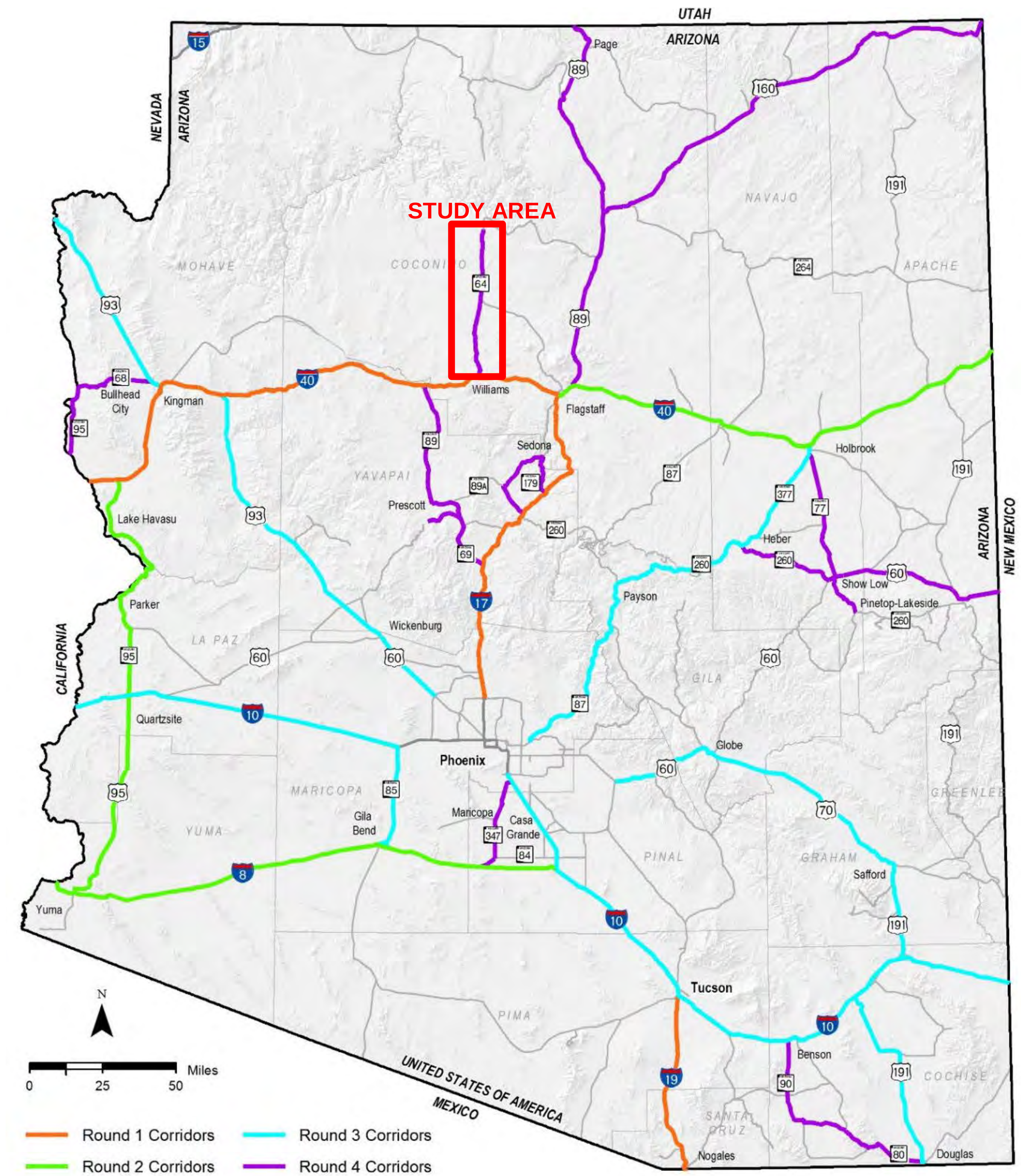
- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The SR 64 CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals are identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

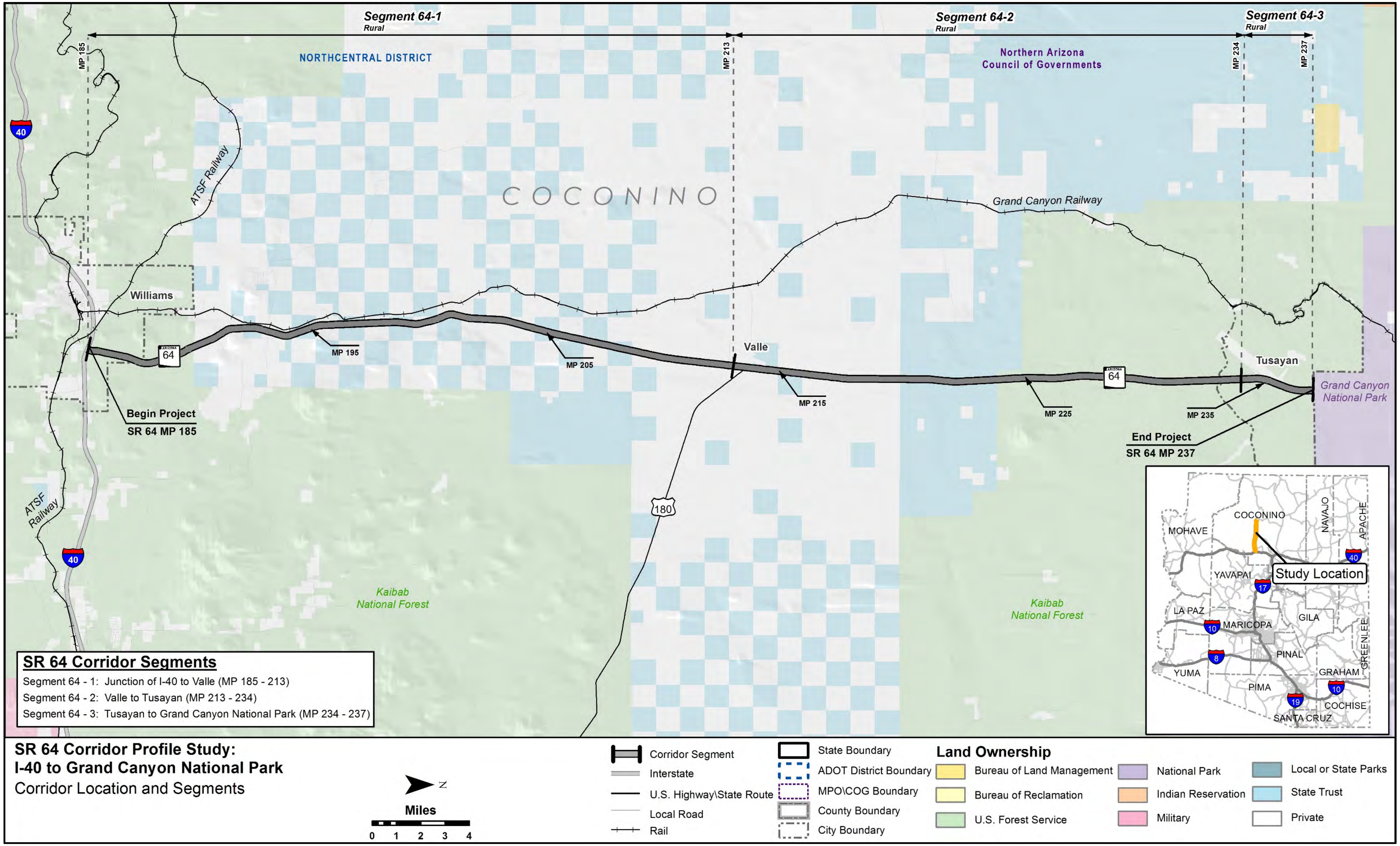
Figure ES-1: Corridor Study Area



Study Location and Corridor Segments

The SR 64 corridor is divided into 3 planning segments for analysis and evaluation. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are shown in **Figure ES-2**.

Figure ES-2: Corridor Location and Segments



CORRIDOR PERFORMANCE

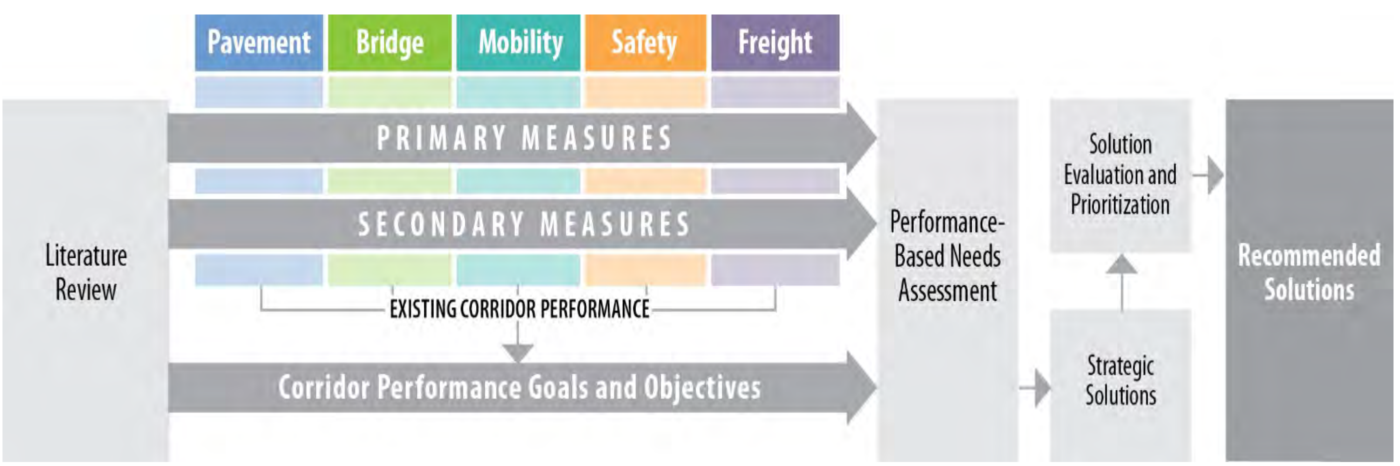
A series of performance measures is used to assess the SR 64 corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure ES-3 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance.

Figure ES-3: Corridor Profile Performance Framework



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance. **Table ES-1** provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table ES-1: Corridor Performance Measures

Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index and cracking	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Functionally Obsolete Bridges • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and incapacitating injury crashes	• Directional Safety Index • Strategic Highway Safety Plan Emphasis Areas • Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck planning time index	• Recurring Delay • Non-Recurring Delay • Closure Duration • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

Each of the primary and secondary performance measures identified in the table above is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above the identified desirable/average range

Fair/Average Performance – Rating is within the identified desirable/average range

Poor/Below Average Performance – Rating is below the identified desirable/average range

The terms "good", "fair", and "poor" apply to the Pavement, Bridge, Mobility, and Freight performance measures, which have defined thresholds. The terms "above average", "average", and "below average" apply to the Safety performance measures, which have thresholds referenced to statewide averages.

Corridor Performance Summary

Table ES-2 shows a summary of corridor performance for all primary measures and secondary measure indicators for the SR 64 corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure as shown in **Table ES-2**.

The corridor is performing in the “good/above average” range for the primary measure weighted corridor average in all performance areas with the exception of the Pavement Index and the Freight Index. A total of 28 miles or 54% of the corridor is performing in the “below average” range for the Pavement Index and a total of 49 miles or 94% of the corridor is performing in the “poor” range for the Freight Index. Other findings include:

- Overall Performance: The Bridge and Safety performance areas show “good” performances; The Mobility performance area shows generally “good” performances with a few “fair” and one “poor” performances; The Pavement performance area shows “fair” performances; The Freight performance area shows a mix of “good,” “fair,” and “poor” performances
- Pavement Performance: The weighted average of the Pavement Index shows “fair” overall performance for the SR 64 corridor; Segment 64-1 shows “poor” performance, and Segments 64-2 and 64-3 show “good” or “fair” performances in all Pavement performance measures
- Bridge Performance: The weighted average of the Bridge Index shows “good” overall performance for the SR 64 corridor; Segment 64-1 is the only segment in the corridor containing bridges and shows “good” performance for all Bridge performance area measures
- Mobility Performance: The weighted average of the Mobility Index shows “good” overall performance for the SR 64 corridor; Segments 64-1 and 64-2 show “poor” or “fair” performances for % Bicycle Accommodation and % Non-Single Occupancy Vehicle (SOV) Trips performance area measures, and they also show “poor” performances Directional PTI measure in the WB direction
- Safety Performance: The weighted average of the Safety Index shows “good” overall performance for the SR 64 corridor; All the segments in SR 64 show “good” in every Safety performance area measure
- Freight Performance: The weighted average of the Freight Index shows “poor” overall performance for the SR 64 corridor; Segments 64-1 and 64-2 show “poor” performances in the Directional TPTI measure in both the EB and WB directions; All the segments show “fair” performances in the Directional TTTI measure in the WB direction, and all the segments show “poor” performances in the Closure Duration measure in the EB direction
- Lowest Performing Segments: Segment 64-1 show “poor/below average” performance for many performance area measures
- Highest Performing Segments: Segment 64-3 shows “good/above average” performance for many performance measures

Table ES-2: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area				Mobility Performance Area											
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			EB	WB								EB	WB	EB	WB	EB	WB	EB	WB		
64-1[^c2]	28	2.88	3.09		38.0%	7.00	84.60	0.0%	7	0.22	0.22	0.21	0.21	0.33	0.03	1.01	1.06	1.27	1.59	5%	13.9%
64-2[^c2]	21	3.60	3.50		0.0%	No Bridges				0.28	0.32	0.28	0.26	0.28	0.01	1.02	1.17	2.03	2.57	4%	16.8%
64-3[*b2]	3	3.69	3.52		0.0%	No Bridges				0.55	0.65	0.35	0.35	0.20	0.07	1.07	1.16	1.00	2.04	95%	10.6%
Weighted Corridor Average		3.22	3.28		20%	7.00	84.60	0%	7.00	0.26	0.29	0.25	0.24	0.30	0.02	1.02	1.11	1.56	2.01	9%	15%
SCALES																					
Performance Level		**Non-Interstate**				**All**				**Urban and Fringe Urban**				**All**		**Uninterrupted**				**All**	
Good/Above Average		> 3.50			< 5%	> 6.5	> 80	< 12%	> 6	< 0.71				< 0.22		< 1.15		< 1.3		> 90%	> 17%
Fair/Average		2.90 - 3.50			5% - 20%	5.0 - 6.5	50 - 80	12% - 40%	5 - 6	0.71 - 0.89				0.22 - 0.62		1.15 - 1.33		1.3 - 1.5		60% - 90%	11% - 17%
Poor/Below Average		< 2.90			> 20%	< 5.0	< 50	> 40%	< 5	> 0.89				> 0.62		> 1.33		> 1.5		< 60%	< 11%
Performance Level										**Rural**						**Interrupted**					
Good/Above Average										< 0.56						< 1.3		< 3.0			
Fair/Average										0.56 - 0.76						1.3 – 2.0		3.0 – 6.0			
Poor/Below Average										> 0.76						> 2.0		> 6.0			

^Uninterrupted Flow Facility
*Interrupted Flow Facility

[a]2 or 3 or 4 Lane Divided Highway
[b]4 or 5 Lane Undivided Highway
[c]2 or 3 Lane Undivided Highway

[1]Urban Operating Environment
[2]Rural Operating Environment

Table ES-2: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area							Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/year/mile)		Bridge Vertical Clearance (feet)
			EB	WB						EB	WB	EB	WB	EB	WB	
64-1[^c2]	28	0.27	0.45	0.09	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.42	1.10	1.19	1.54	3.24	264.89	4.46	No UP
64-2[^c2]	21	0.36	0.08	0.64	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.28	1.14	1.30	2.46	4.60	271.39	1.15	No UP
64-3[*b2]	3	0.08	0.00	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.68	1.03	1.32	1.00	1.96	231.20	8.67	No UP
Weighted Corridor Average		0.30	0.27	0.32	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.38	1.11	1.24	1.88	3.72	265.57	3.37	No UP
SCALES																
Performance Level		**2 or 3 or 4 Lane Divided Highway**							**Uninterrupted**					**All**		
Good/Above Average		< 0.77			< 44%	< 4%	< 16%	< 2%	> 0.77	< 1.15		< 1.3		< 44.18		> 16.5
Fair/Average		0.77 - 1.23			44% - 54%	4% - 7%	16% - 26%	2% - 4%	0.67 - 0.77	1.15 - 1.33		1.3 - 1.5		44.18-124.86		16.0 - 16.5
Poor/Below Average		> 1.23			> 54%	> 7%	> 26%	> 4%	< 0.67	> 1.33		> 1.5		> 124.86		< 16.0
Performance Level		**2 or 3 Lane Undivided Highway**							**Interrupted**							
Good/Above Average		< 0.94			< 51%	< 6%	< 19%	< 5%	> 0.33	< 1.3		< 3.0				
Fair/Average		0.94 - 1.06			51% - 58%	6% - 10%	19% - 27%	5% - 8%	0.17 - 0.33	1.3 - 2.0		3.0 - 6.0				
Poor/Below Average		> 1.06			> 58%	> 10%	> 27%	> 8%	< 0.17	> 2.0		> 6.0				
Performance Level		**4 or 5 Undivided Highway**														
Good/Above Average		< 0.80			< 42%	< 6%	< 6%	< 5%								
Fair/Average		0.80 - 1.20			42% - 51%	6% - 10%	6% - 9%	5% - 8%								
Poor/Below Average		> 1.20			> 51%	> 10%	> 9%	> 8%								

^Uninterrupted Flow Facility
*Interrupted Flow Facility

[a]2 or 3 or 4 Lane Divided Highway
[b]4 or 5 Lane Undivided Highway
[c]2 or 3 Lane Undivided Highway

[1]Urban Operating Environment
[2]Rural Operating Environment

Notes: *"Insufficient Data" indicates there was not enough data available to generate reliable performance ratings*
"No UP" indicates no underpasses are present in the segment

NEEDS ASSESSMENT

Corridor Description

The SR 64 corridor is an important travel corridor in the central/northwestern part of the state. The corridor functions as a route for recreational, tourist, and regional traffic and provides critical connections between the communities it serves and the rest of the regional and interstate network.

Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP) 2010-2035 goals and objectives that were updated in 2017. Statewide performance goals that are relevant to SR 64 performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three “emphasis areas” were identified for the SR 64 corridor: Pavement, Mobility, and Safety.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Needs Assessment Process

The performance-based needs assessment evaluates the difference between the baseline performance and the performance objectives for each of the five performance areas used to characterize the health of the corridor: Pavement, Bridge, Mobility, Safety, and Freight. The performance-based needs assessment process is illustrated in **Figure ES-4**.

The needs assessment compares baseline corridor performance with performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown in **Figure ES-5**.

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. A detailed review of available data helps identify contributing factors to the need and if there is a high level of historical investment.

Figure ES-4: Needs Assessment Process

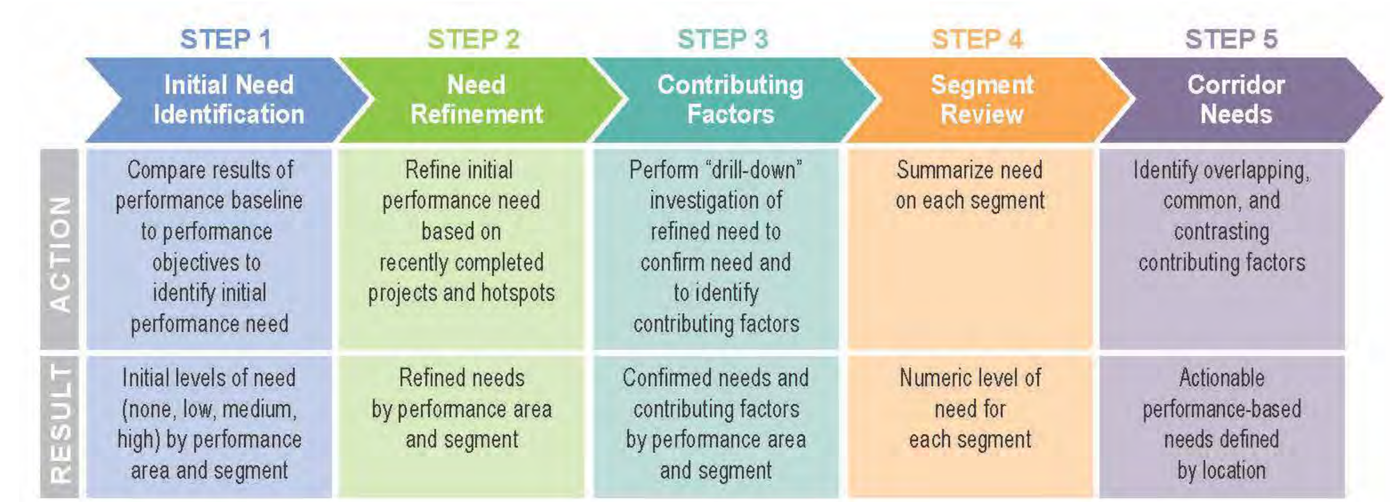


Figure ES-5: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
6.5	Good		
	Fair		
	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
5.0	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

**A segment need rating of ‘None’ does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Summary of Needs

Table ES-3 provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Pavement, Mobility, and Safety for the SR 64 corridor). There is one segment with a Medium average need (64-1) and two segments with a Low average need. More information on the identified final needs in each performance area is provided below.

Pavement Needs

- Segment 64-1 contains several Pavement hot spots
- Segments 64-2 and 64-3 have final needs of None and Segment 64-1 has a High need

Bridge Needs

- Segment 64-1 includes one bridge
- Segments 64-2 and 64-3 do not include any bridges
- There are no final Bridge needs along the corridor

Mobility Needs

- Low Mobility needs exist on Segments 64-1 and 64-2
- Segment 64-2 contains High directional PTI needs in both directions
- Bicycle accommodation needs are High on Segments 64-1 and 64-2 due shoulder width less than 6' for higher speeds

Safety Needs

- There are no final Safety needs along the corridor
- There is insufficient data related to the Safety top 5 emphasis behavior areas

Freight Needs

- High Freight needs exist on Segments 64-1 and 64-2
- Many segments along the corridor contain High directional PTI and closure duration needs
- No freight hot spots exist along the corridor

Overlapping Needs

This section identifies overlapping performance needs on the SR 64 corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- Segment 64-1 has the highest average need score of all the segments of the corridor with elevated Needs in the Pavement and Freight performance areas
- Segment 64-2 contains needs in the Mobility and Freight performance areas

Table ES-3: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)		
	64-1	64-2	64-3
	MP 185-213	MP 213-234	MP 234-237
Pavement[+]	High	None*	None*
Bridge	None*	None*	None*
Mobility[+]	Low	Low	None*
Safety[+]	None*	None*	None*
Freight	High	High	Low
Average Need	**1.38**	**0.69**	**0.15**

[+] *Identified as an emphasis area for the SR 64 corridor.*
** A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Level of Need	Average Need Range
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need as addressing these needs will have the greatest effect on corridor performance. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The SR 64 strategic investment areas (resulting from the elevated needs) are shown in **Figure ES-6**.

Screening Process

In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 64 corridor will be considered along with other candidate projects in the ADOT statewide programming process.

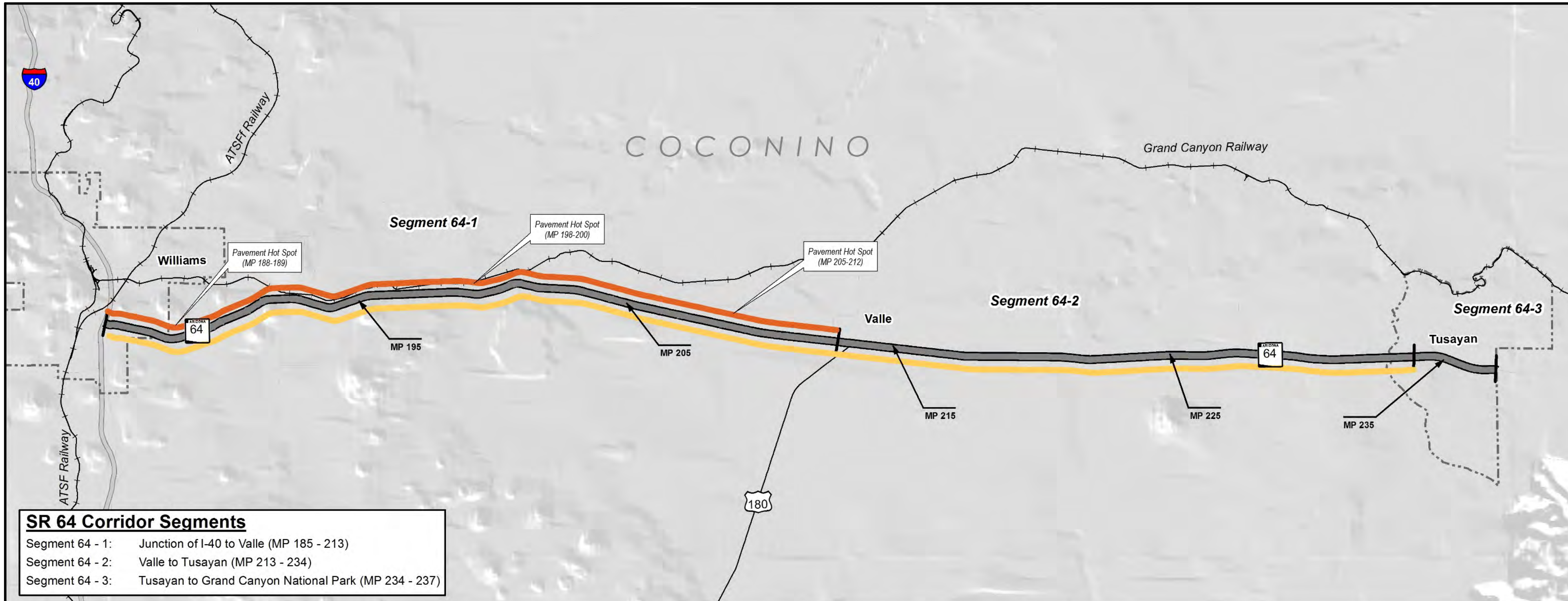
Candidate solutions include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance areas include two options; rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Figure ES-6: Strategic Investment Areas



Performance Area	64-1 MP 185-213	64-2 MP 213-234	64-3 MP 234-237	Performance Area
Pavement+	High	-	-	Pavement+
Bridge	-	-	-	Bridge
Mobility+	-	-	-	Mobility+
Safety+	-	-	-	Safety+
Freight	High	High	-	Freight

+ Identified as emphasis area for SR 64 Corridor

Note: Figure shows strategic investment areas, which are segments with Medium and High levels of need and locations of hotspots. A "-" symbol indicates a segment level of need of Low, None, or N/A, which is not considered strategic

SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Strategic Investment Areas

N
Miles
0 1 2 3 4

Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary

Performance Area Needs
Safety
Pavement
Freight
Mobility
Bridge

Level of Need
Low
Medium
High

SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation is shown in **Figure ES-7** and described more fully below.

Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

All Mobility, Safety, and Freight strategic investment areas that result in multiple independent candidate solutions are advanced directly to the Performance Effectiveness Evaluation.

Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

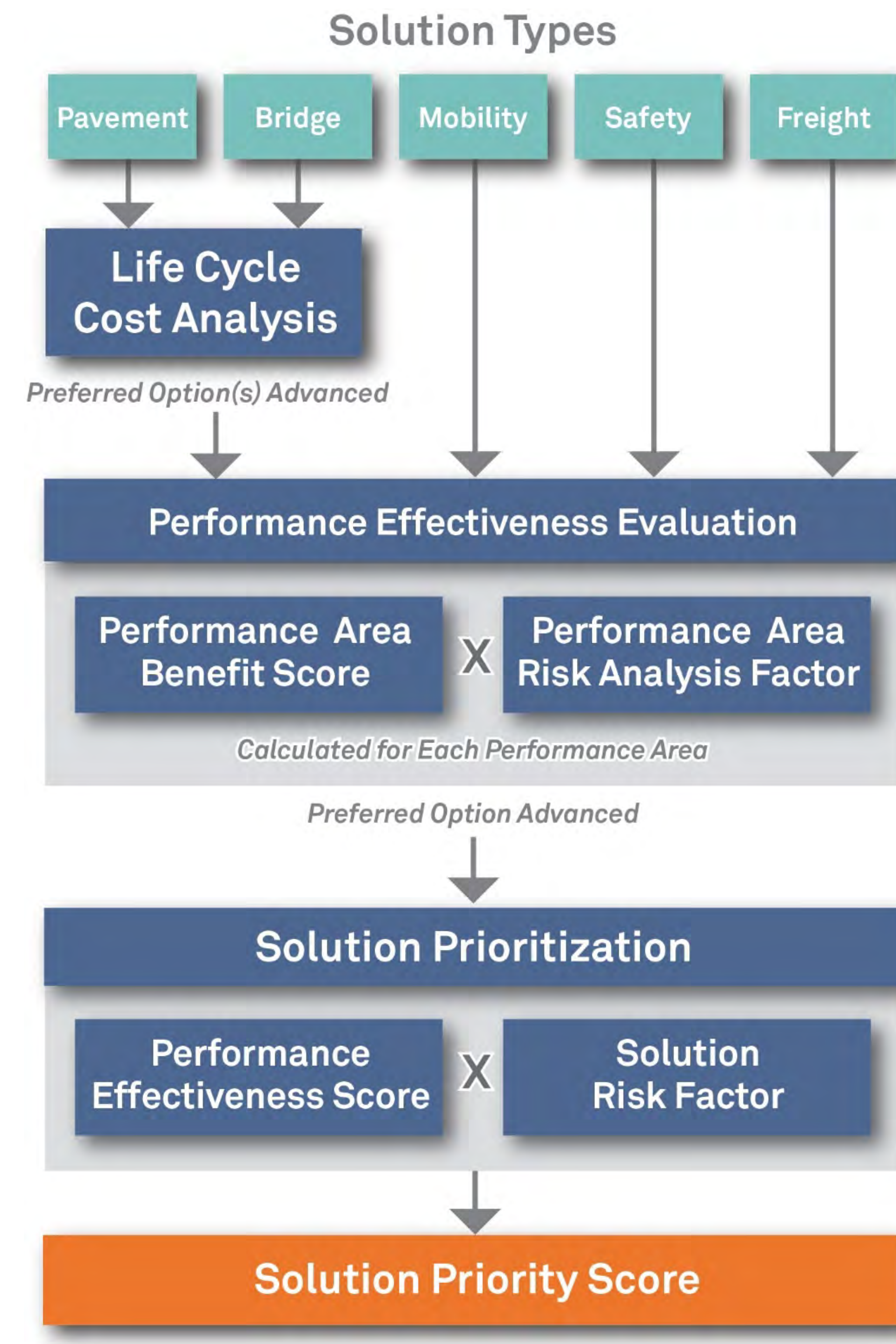
Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure.

Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure ES-7: Candidate Solution Evaluation Process



SUMMARY OF CORRIDOR RECOMMENDATIONS

Prioritized Candidate Solution Recommendations

Table ES-4 and **Figure ES-8** show the prioritized candidate solutions recommended for the SR 64 corridor. Implementation of these solutions is anticipated to improve performance of the SR 64 corridor, primarily in the Pavement, Mobility, and Safety performance areas. The following observations were noted about the prioritized solutions:

- Most of the anticipated improvements in performance are in the Freight performance areas
- The highest priority solutions address needs in the Williams to Valle Area (MP 185-205) along SR 64.

Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor specific recommendations that are not related to construction or policy. The following list identifies other corridor recommendations for the SR 64 corridor:

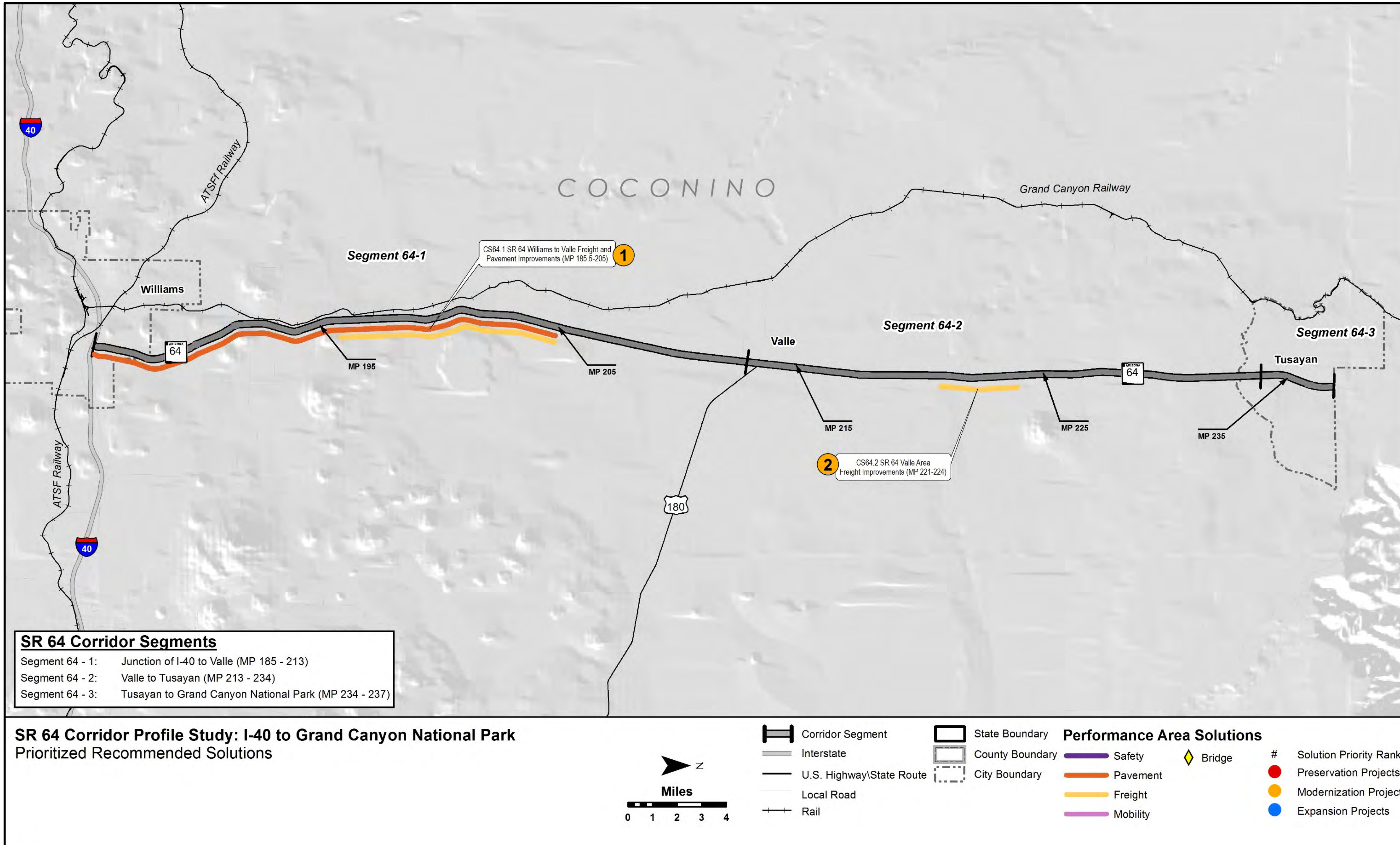
- Project P9100 07P, proposed in an ADOT Scoping Letter in January 2017, is a pavement preservation project on the SR 64 Corridor with proposed project limits beginning at MP 185.46 and ending at MP 205. This proposed project added the pavement preservation item from MP 185.5-205 to the scope of CS64.1.
- Conduct future wildlife mitigation studies to address and reduce the high number of animal crashes on the SR 64 Corridor. According to data used for this study, animal-vehicle collisions (not resulting in fatal or incapacitating crashes) are concentrated in the following locations:
  - o Eastbound: MP 186-196, MP 204-210, MP 211-213, MP 218-237
  - o Westbound: MP 186-194, MP 196-199, MP 219, MP 222-223, MP 224-237

Table ES-4: Prioritized Recommended Solutions

Rank	Candidate Solution #	Option	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS64.1	-	Williams to Valle Freight and Pavement Improvements (SR 64 MP 185.5-205)	• Construct EB climbing lanes, MP 196-198 and MP 203-205 • Construct WB climbing lane, MP 200-202 • Pavement Preservation EB and WB, MP 185.5 - 205	$34.8	P, M	**19**
2	CS64.2	-	Valle Area Freight Improvements (SR 64 MP 221-224)	• Construct EB climbing lane, MP 223-224 • Construct WB climbing lane, MP 221-222	$7.5	M	**6**

* '-': Indicates only one solution is being proposed and no options are being considered

Figure ES-8: Prioritized Recommended Solutions



Policy and Initiative Recommendations

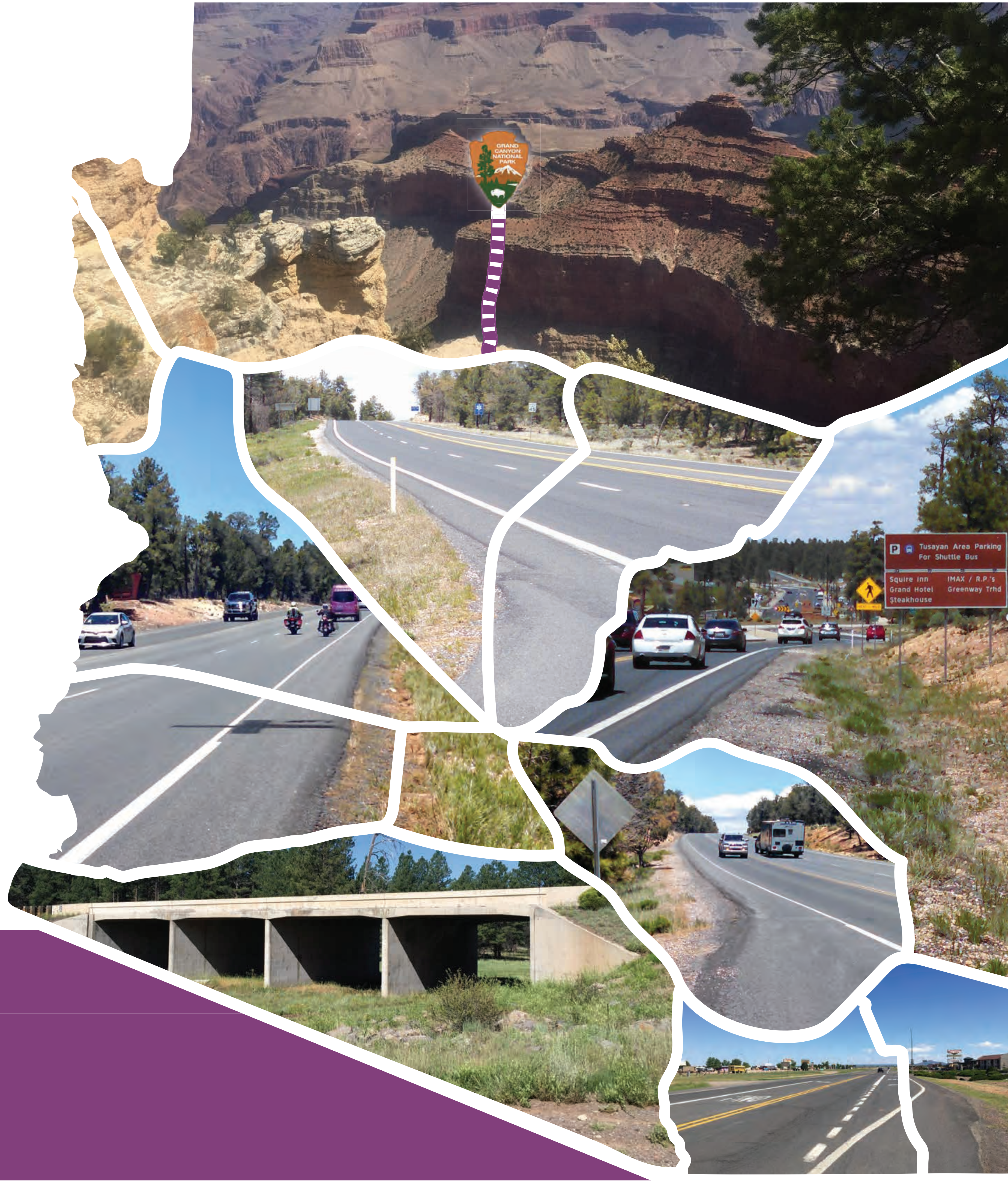
In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through the CPS process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the SR 64 corridor, but across the entire state highway system where conditions are applicable. The following list, which is in no particular order of priority, was derived from the four CPS rounds:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic message signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is required to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network
- At traffic interchanges with existing communication connectivity to the ADOT TOC, consideration should be given to adding thermal detection cameras for vehicle detection with the capability for wrong way vehicle detection
- Improved vehicle detection systems, as recommended by ADOT Systems Technology group, should be deployed at traffic interchanges for improved traffic control

Next Steps

Candidate solutions developed for the SR 64 corridor will be considered along with other candidate projects in the ADOT statewide programming process. It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

Upon completion of all four CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.



Final Report

Final Report

1.0 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 64 (SR 64) between Junction Interstate 40 (I-40) and Grand Canyon National Park. The study examines key performance measures relative to the SR 64 corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT has completed 21 CPS within four separate groupings or rounds.

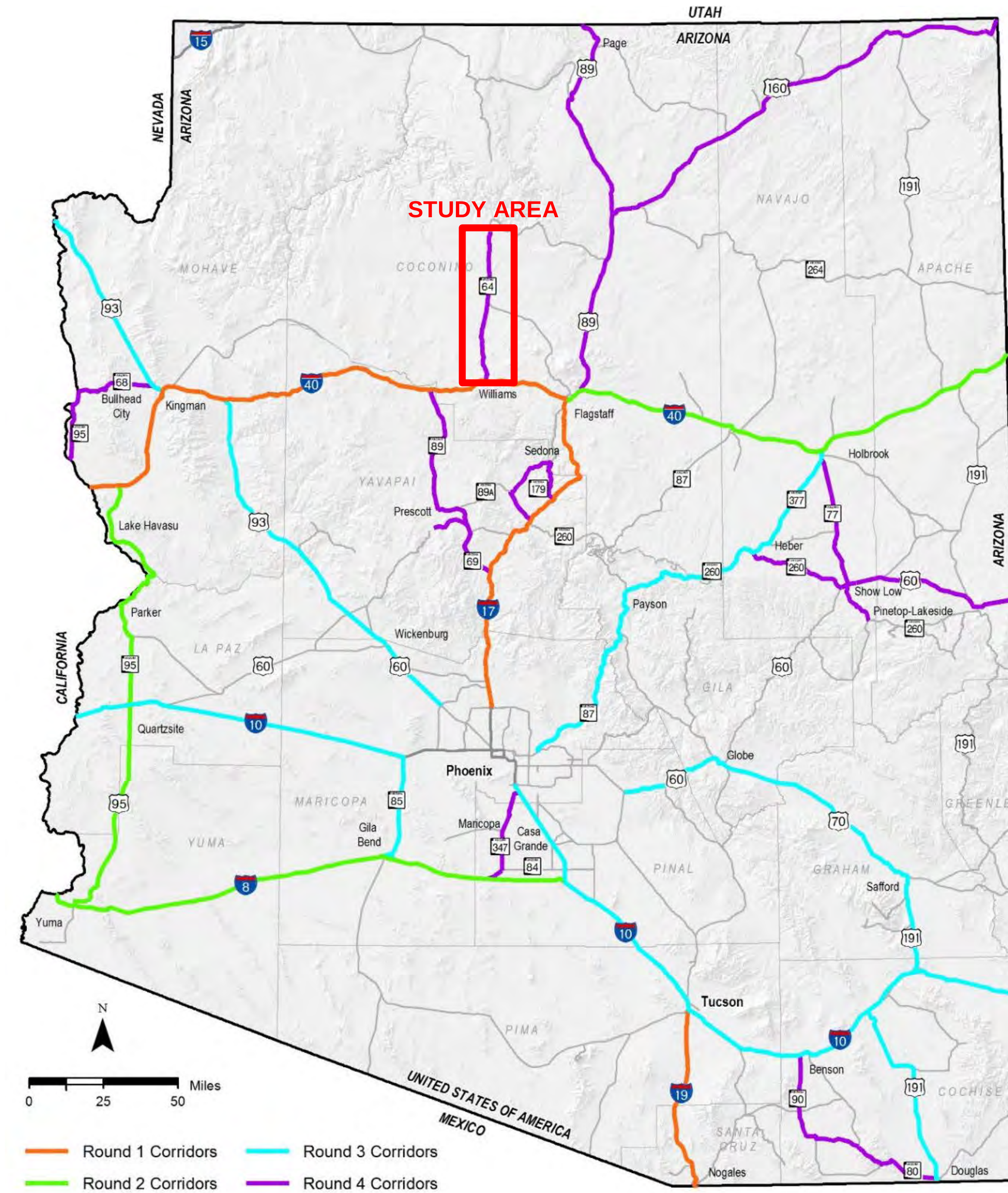
The fourth round (Round 4) of studies began in Spring 2017, and includes:

- SR 64: I-40 to Grand Canyon National Park
- SR 68: SR 95 North to US 93 and SR 95 North: California State Line to Nevada State Line
- SR 69: I-17 to SR 89; Fain Rd: SR 69 to SR 89A; SR 89A: Fain Rd to SR 89; SR 89: SR 89A to I-40
- SR 77: US 60 to SR 377
- US 89: Flagstaff to Utah State Line
- SR 90: I-10 to SR 80 and SR 80: SR 90 to US 191
- US 160: US 89 to New Mexico State Line
- SR 179: I-17 to SR 89A; SR 89A: SR 179 to SR 260; and SR 260: SR 89A to I-17
- SR 260: SR 277 to SR 73 and US 60: SR 260 to New Mexico State Line
- SR 347: I-10 to SR 84 and SR 84: SR 347 to I-8

The studies under this program assess the overall health, or performance, of the state's strategic highways. The CPS will identify candidate solutions for consideration in the Multimodal Planning Division's (MPD) P2P project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

The SR 64 corridor, depicted in **Figure 1** along with other previously completed or underway CPS**,** is one of the strategic statewide corridors identified and the subject of this Round 4 CPS.

Figure 1: Corridor Study Area



1.1 Corridor Study Purpose

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

1.2 Study Goals and Objectives

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The SR 64 CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance. Corridor benefits can be categorized by the following three investment types:

- Preservation: Activities that protect transportation infrastructure by sustaining asset condition or extending asset service life
- Modernization: Highway improvements that upgrade efficiency, functionality, and safety without adding capacity
- Expansion: Improvements that add transportation capacity through the addition of new facilities and/or services

This study identifies potential actions to improve the performance of the SR 64 corridor. Proposed actions are compared based on their likelihood of achieving desired performance levels, life-cycle costs, cost-effectiveness, and risk analysis to produce a prioritized list of solutions that help achieve corridor goals.

The following goals are identified as the desired outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

1.3 Corridor Overview and Location

SR 64 serves as the entrance road to the South Rim of Grand Canyon National Park. It connects the Canyon South Rim with the City of Williams on I-40, 60 miles to the south. The mostly two-lane road travels in a north-south direction through a scenic landscape of rolling hills, grasslands and forest. While the road serves a few smaller communities along the route (e.g., Valle and Tusayan), the primary purpose of the road is to provide access to Grand Canyon National Park. Since the South Rim of the Grand Canyon attracts over 5 million visitors each year and is by far is the most visited side of the Canyon, SR 64 carries a very high volume of recreational traffic. The Grand Canyon is also one of the most accessible National Parks with a wide variety of amenities that draw visitors throughout the year. That accessibility places heavy demands on SR 64, particularly during the summer months.

There are few alternatives to SR 64 for most visitors to the National Park, hence maintaining the roadway in good condition at all times regardless of weather or travel demand is required. The sensitive environment places significant limits on the prospect of any widening of the road in many places as does the South Rim visitor capacity.

Initially constructed as Arizona Forest Highway 2 in the late 1920s and early 1930s as an 18-foot roadway, the facility was taken into the State Highway System as SR 64 in 1932. It was reconstructed to its current alignment and basic 34-foot roadway width in the 1950s and 1960s. Climbing lanes, minor widening and intersection improvements have occurred as well as reconstruction and widening in the Tusayan area.

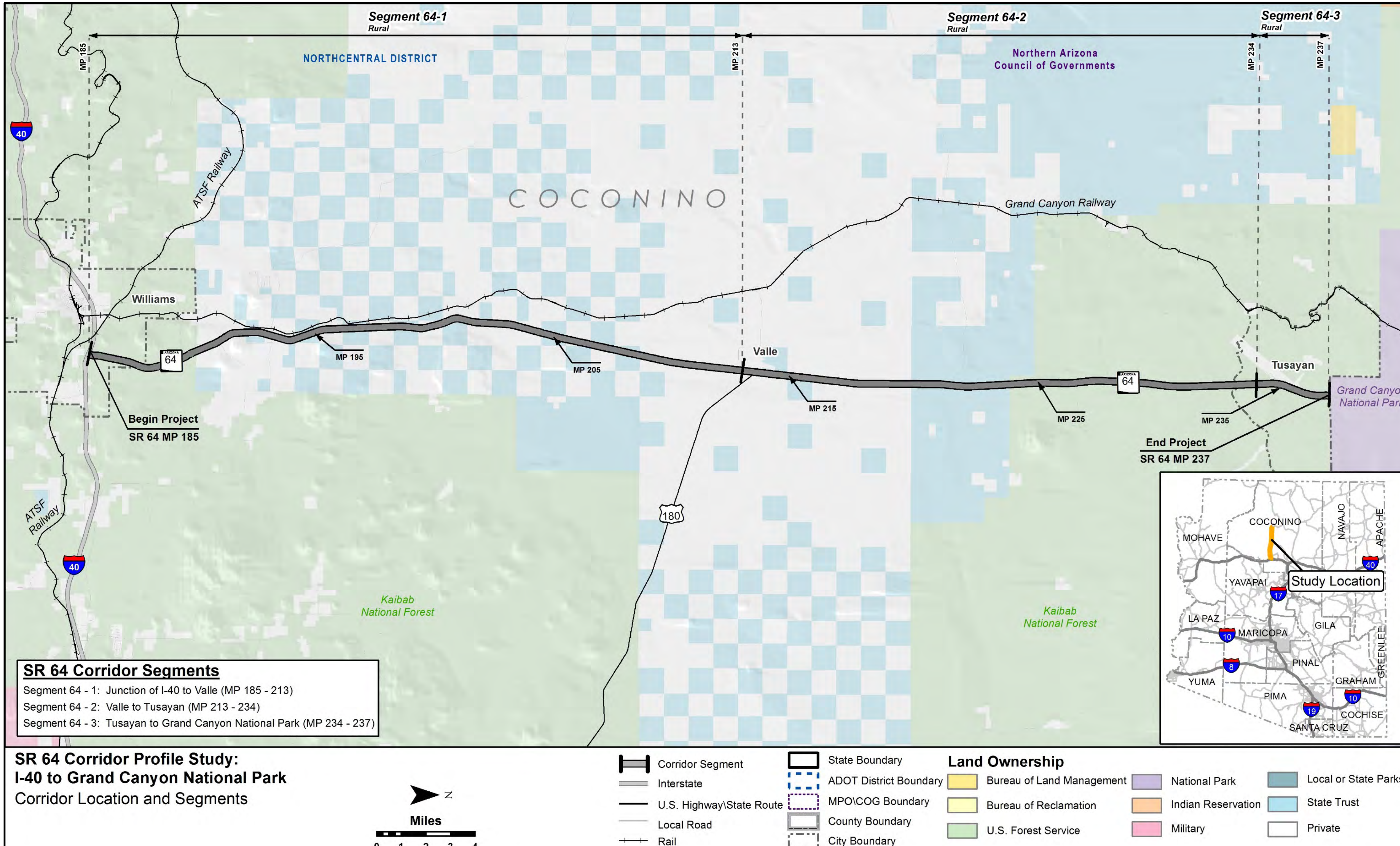
1.4 Corridor Segments

The SR 64 corridor is divided into 3 planning segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are described in **Table 1** and shown in **Figure 2**.

Table 1: SR 64 Corridor Segments

Segment #	Route	Begin	End	Approx. Begin Milepost	Approx. End Milepost	Approx. Length (miles)	Typical Through Lanes (EB, WB)	2015/2035 Average Annual Daily Traffic Volume (vpd)	Character Description
64-1	SR 64	Junction of I-40	Valle	185	213	28	1,1	7,000 / 9,000	This rural highway road with uninterrupted flow has rolling topography and consistent traffic volumes.
64-2	SR 64	Valle	Tusayan	213	234	21	1,1	6,000 / 8,000	Segment 2 has uninterrupted flow characteristics in a rural setting. Notable is the junction with US 180 at the beginning of the segment that connects to Flagstaff.
64-3	SR 64	Tusayan	Grand Canyon National Park	234	237	3	2,2	7,000 / 10,000	The short, mostly four-lane segment passes through the town of Tusayan before arriving at the entrance of Grand Canyon National Park. It has an interrupted flow due to the town's two roundabouts.

Figure 2: Corridor Location and Segments



1.5 Corridor Characteristics

The SR 64 corridor is an important travel corridor in the central/northeastern part of the state. The corridor functions as a route for recreational, tourist, and regional traffic and provides critical connections between the communities it serves and the rest of the regional and interstate network.

National Context
The SR 64 corridor provides access to the Grand Canyon National Park from I-40 and SR 180.

Regional Connectivity
The SR 64 corridor between I-40 and the Grand Canyon National Park provides movement for freight, tourism, and recreation needs within Arizona. The corridor is located in the North Central ADOT District; the Northern Arizona Council of Governments (NACOG); and in Coconino County. Within the corridor study limits, SR 64 offers connections to several major roadways, including I-40 and SR 180. This corridor serves Arizona cities and towns including Williams, Valle, Tusayan, and Grand Canyon Village.

Commercial Truck Traffic
Communities along the SR 64 corridor are dependent on the corridor to access the state economy through freight deliveries and travel to other locations. Freight traffic (trucks) comprise from 13.8% to 16.5% of the total traffic flow on the corridor, with the higher truck percentages between Valle and Grand Canyon Airport Road.

Commuter Traffic
A majority of the commuter traffic along the SR 64 corridor occurs within the urbanized areas of Williams, Valle and Tusayan. Staff necessary to run and support the commercial development within Tusayan, Grand Canyon National Park, and Kaibab National Forest must commute along SR 64 due to the limited supply of nearby residential housing. These areas are economic centers along what is considered mostly a rural combination of local roads and Forest Service routes. According to the most recent traffic volume data maintained by ADOT, traffic volumes range from approximately 4,400 vehicles per day between Spring Valley Road and Valle to approximately 7,400 vehicles per day near the Grand Canyon Airport and entrance to the Grand Canyon.

According to the 2015 American Community Survey data from the US Census Bureau, 74% of the workforce in areas along the corridor relies on a private vehicle to get to work.

Recreation and Tourism
SR 64 provides access to many Arizona attractions such as Grand Canyon National Park, Kaibab National Forest, and other recreational activities. Other recreational destinations accessible from the SR 64 corridor include Kaibab Lake Campground (via FR 47), Ten-X Campground (2 miles south of Tusayan), Red Butte Trail (via FR 305/320), and Beal Wagon Road Historic Trail (via FR 141 and 84), among others.

Multimodal Uses

Freight Rail
The BNSF Railway, one of the top transporters of intermodal freight in North America, crosses through the City of Williams. The BNSF "Transcon Corridor" connects Los Angeles with Chicago and passes through northern Arizona, paralleling I-40. The BNSF Transcon Corridor typically carries up to about 120 trains per day. The Williams and SR 64 Junction is also the northern point of service for the Arizona Central Railroad/Verde Canyon Railroad, and the BNSF Railway North-South Corridor which ends in Phoenix[1]. Unique to SR 64 is the Grand Canyon Railway, which is a passenger train providing scenic recreational riding packages from Williams to the South Rim of the Grand Canyon National Park.

Passenger Rail
Amtrak's Southwest Chief Chicago to Los Angeles route primarily serves long-distance tourist travel, with daily service. The Southwest Chief shares track on the BNSF Transcon Corridor and is subject to delays caused by freight traffic. It travels at an average speed of 63 miles per hour across the State. There is a passenger station in Williams Junction. The Thruway Bus connects Amtrak passengers to the Grand Canyon Railway Station.

Bicycles/Pedestrians
Opportunities for bicycle and pedestrian travel are limited on SR 64. Bicycle traffic is permitted on the mainline outside shoulder; however, outside effective shoulder widths are less than the preferred 4-foot minimum width and include rumble strips in some areas. The summary of previous corridor projects includes recommendations to improve/widen shoulders along the SR 64 corridor and include the corridor as a part the U.S. Bike Route 79.

Bus/Transit
Bus/transit services along the SR 64 corridor cater mostly to customers visiting the Grand Canyon National Park. In Tusayan, visitors can utilize the Park and Ride and take the Purple Route shuttle bus service to the park and back. The shuttle bus has 4 additional routes (Blue, Orange, Red, and Hiker Express) that provide services into the park. There are no other transit services offered within the corridor, although there are a range of private operators providing private tourist bus service.

Aviation
There are three general aviation facilities in proximity to the SR 64 corridor. These include the Grand Canyon National Park Airport, the H.A. Clark Memorial Airport, and the Valle Airport, which is privately owned and operated.

[1] Source: Arizona Multimodal Freight Analysis Study (2009), Appendix A

Land Ownership, Land Uses and Jurisdictions

As shown previously in **Figure 2**, the SR 64 corridor traverses multiple jurisdictions and land owned or managed by various entities within Coconino County. The southern section of the corridor traverses the Kaibab National Forest. A majority of the corridor (from approximately MP 190 to MP 225) traverses interspersed sections of private and county/city/state park land. The northern section of the corridor traverses through the northern portion of Kaibab National Forest.

Population Centers

Population centers of various sizes exist along the SR 64 corridor. **Table 2** provides a summary of the populations for communities along the corridor. Low to moderate population growth is projected between 2010 and 2040 in the major population centers along the corridor according to the Arizona State Demographer's Office.

Table 2: Current and Future Population

Community	2010 Population	2015 Population	2040 Population	% Change 2010-2040	Total Growth
Coconino County	134,679	141,602	167,897	25%	33,218
Williams	3,023	3,185	3,370	11%	347
Valle	832	858	930	12%	98
Tusayan	558	589	600	8%	42

Source: U.S. Census, Arizona Department of Administration – Employment and Population Statistics

Major Traffic Generators

The Grand Canyon National Park is the major traffic generator for the SR 64 corridor.

Tribes

There are no tribal reservations within the SR 64 corridor.

Wildlife Linkages

The Arizona State Wildlife Action Plan (SWAP) provides a 10-year vision for the entire state, identifying wildlife and habitats in need of conservation, insight regarding the stressors to those resources, and actions that can be taken to alleviate those stressors. Using the Habimap Tool that creates an interactive database of information included in the SWAP, the following were identified in relation to the SR 64 corridor:

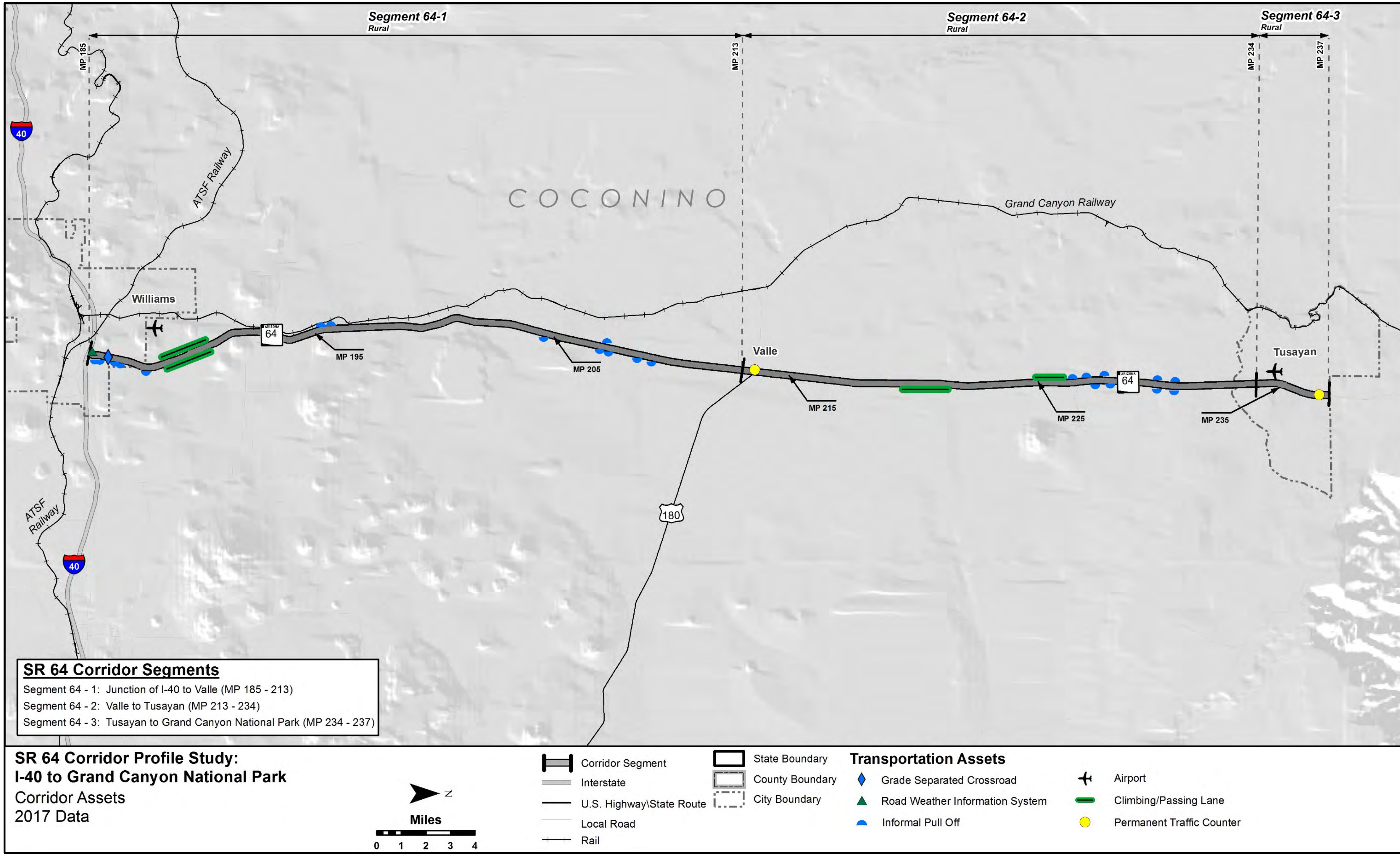
- Arizona Game and Fish Department (AGFD) Wildlife Waters are scattered near the corridor, specifically in the areas near Tusayan
- Arizona Important Bird Areas: The northern point of the corridor is near the Grand Canyon NP-Lipan and Yaki Raptor Migration Points Important Bird Area
- The corridor travels through allotments controlled by the Arizona State Land Department (ASLD) and United States Forest Service
- A moderate Riparian area is located near the southern point of the corridor
- Arizona Wildlife Linkages: No missing linkages are noted, but there are potential Arizona Wildlife Linkage Zones along SR 64 from MP 190 to MP 224
- According to the Species and Habitat Conservation Guide (SHCG), sensitive habitats that have moderate to high conservation potential exist along the corridor; these areas are located near the Town of Tusayan in the north and near the Williams and SR 64 Junction in the south
- Areas where Species of Greatest Conservation Need (SGCN) are high or moderately vulnerable are located along the entire SR 64 corridor
- Identified areas of moderate or high levels of Species of Economic and Recreational Importance (SERI) are in the vicinity south of the Town of Valle, and north of MP 224 leading into the Town of Tusayan and the park

Corridor Assets

Corridor transportation assets are summarized in **Figure 3**. Four passing lanes exist on the corridor between MP 185 and MP 226. The corridor includes one grade-separated traffic interchange (TI) at the I-40 Junction.

Other assets include a Road Weather Information System (RWIS) located at MP 185 and closed-circuit television (CCTV) cameras are located at MP 213.9. The corridor also includes approximately 30 informal pull-offs located along the route.

Figure 3: Corridor Assets



1.6 Corridor Stakeholders and Input Process

A Technical Advisory Committee (TAC) was created comprised of representatives from key stakeholders. TAC meetings were held at key milestones to present results and obtain feedback. In addition, several meetings were conducted with key stakeholders between July 2017 and December 2017 to present the results and obtain feedback.

Key stakeholders identified for this study included:

- ADOT North Central District
- ADOT Technical Groups
- NACOG
- AGFD
- ASLD
- Federal Highway Administration (FHWA)

Several chapter deliverables were developed during the course of the Corridor Profile Study. The chapters were provided to the TAC for review and comment.

1.7 Prior Studies and Recommendations

Studies, plans, and programs pertinent to the SR 64 corridor were reviewed to understand the full context of future planning and design efforts within and around the study area. These studies are organized below into four categories: Framework and Statewide Studies, Regional Planning Studies, Planning Assistance for Rural Areas (PARAs) and Small Area Transportation Studies (SATS), and Design Concept Reports (DCRs) and Project Assessments (PAs).

Framework and Statewide Studies

- ADOT Bicycle and Pedestrian Plan Update (2013)
- ADOT Pedestrian Safety Action Plan (2017)
- ADOT Five-Year Transportation Facilities Construction Program (2018 – 2022)
- ADOT Climbing and Passing Lane Prioritization Study (2015)
- ADOT Arizona Key Commerce Corridors (2014)
- ADOT Arizona Multimodal Freight Analysis Study (2009)
- ADOT Arizona Ports of Entry Study (2013)
- ADOT Arizona State Airport Systems Plan (2008)
- ADOT Arizona State Freight Plan (2016)
- ADOT Arizona State Rail Plan (2011)
- AGFD Arizona State Wildlife Action Plan (2012) / Arizona Wildlife Linkages Assessment
- ADOT Arizona Statewide Dynamic Message Sign Master Plan (2011)
- ADOT Arizona Statewide Rail Framework Study (2010)
- ADOT Arizona Statewide Rest Area Study (2011)
- ADOT Arizona Statewide Shoulders Study (2015)
- ADOT Arizona Strategic Highway Safety Plan (2014)
- ADOT Arizona Roadway Departure Safety Implementation Plan (RDSIP) (2014)
- ADOT AASHTO U.S. Bicycle Route System (2015)
- ADOT Low Volume State Routes Study (2017)
- ADOT Statewide Transportation Planning Framework - Building a Quality Arizona (BQAZ) (2010)
- ADOT Eastern Arizona Framework Study (2009)
- ADOT What Moves You Arizona? Long-Range Transportation Plan (2010-2035)

Regional Planning Studies

- City of Williams General Plan 2013 Update (2013)
- Coconino County Comprehensive Plan (2003)
- Final Feasibility Report SR 64: I-40 to Moqui (2006)
- NACOG, Regional Transportation Improvement Program (2017)
- Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)

Design Concept Reports and Project Assessments

- SR 64: I-40 to Bureau Camp – Project Assessment (2007)
- SR 64: Valle – Project Assessment (2009)
- SR 64: Williams – Materials Design Review (2010)

Summary of Prior Recommendations

Various studies and plans, including several DCRs and PAs, have recommended improvements to the SR 64 corridor as shown in **Table 3** and **Figure 4**. They include, but are not limited to:

- Widening the roadway along the corridor
- Safety shoulder improvements at the following locations
  - MP 196 – 204 Tier 1 Priority
  - MP 212 – 214 Tier 1 Priority
  - MP 216 – 232 Tier 1 Priority
  - MP 204 – 212, 214 – 216 Tier 2 Priority
- Climbing and passing lanes have been recommended throughout the SR 64 corridor based on the Climbing and Passing Lane Prioritization Study
- New underpasses and overpasses have been recommended throughout the SR 64 corridor based on the Wildlife Accident Reduction Study and Monitoring

Table 3: Corridor Recommendations from Previous Studies

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
1	185	237	52.0	Roadway Widening (MP 185-237); (MP 212.45-214.39) from 2 to 5 lanes; curb/gutter replacement; new roadway markings depressed curb and concrete apron at driveways; concrete median north and south of US 180 intersection, south of Highgrove Road intersection and south of Airport Entrance. New street lights at SR 64/US180 intersection		√		2030	N/A	N	Building and Quality Arizona (BQAZ) (2010)
2	185	237	52.0	Designate SR 64 as a part of U.S. Bicycle Route 79		√		-	N/A	N	ADOT AASHTO U.S. Bicycle Route System (2015)
3	185	236	51.0	Potential rest area between Tusayan and Williams (marked as spot between MP 185 and MP 236)		√		-	N/A	N	Arizona Statewide Rest Area Study (2011)
4	186	198.2	12.2	8-foot ungulate-proof (wildlife) fencing along ROW		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012) State Route 64: I-40 to Moqui Feasibility Report (2006) SR 64: Jct I-40 to Bureau Camp Right of Way Fence – PA (2006)
5	187.3	187.3	0.0	Retrofitting Cataract Canyon Bridge as an underpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
6	187.80	225.7	37.9	Passing/Climbing Lanes: • EB Passing/Climbing (MP 196 -198) - Tier 2 • WB Climbing Lane (MP 199 -197) – Tier 2 • EB/WB Passing (MP 204 - 201) -Tier 2 • EB Passing (224.4-225.7) - Tier 2 • EB Passing (MP 211-218)-Tier 3;			√	-	~~N/A~~	N	State Route 64: I-40 to Moqui Feasibility Report (2006) ADOT Climbing and Passing Lane Prioritization Study (2015)

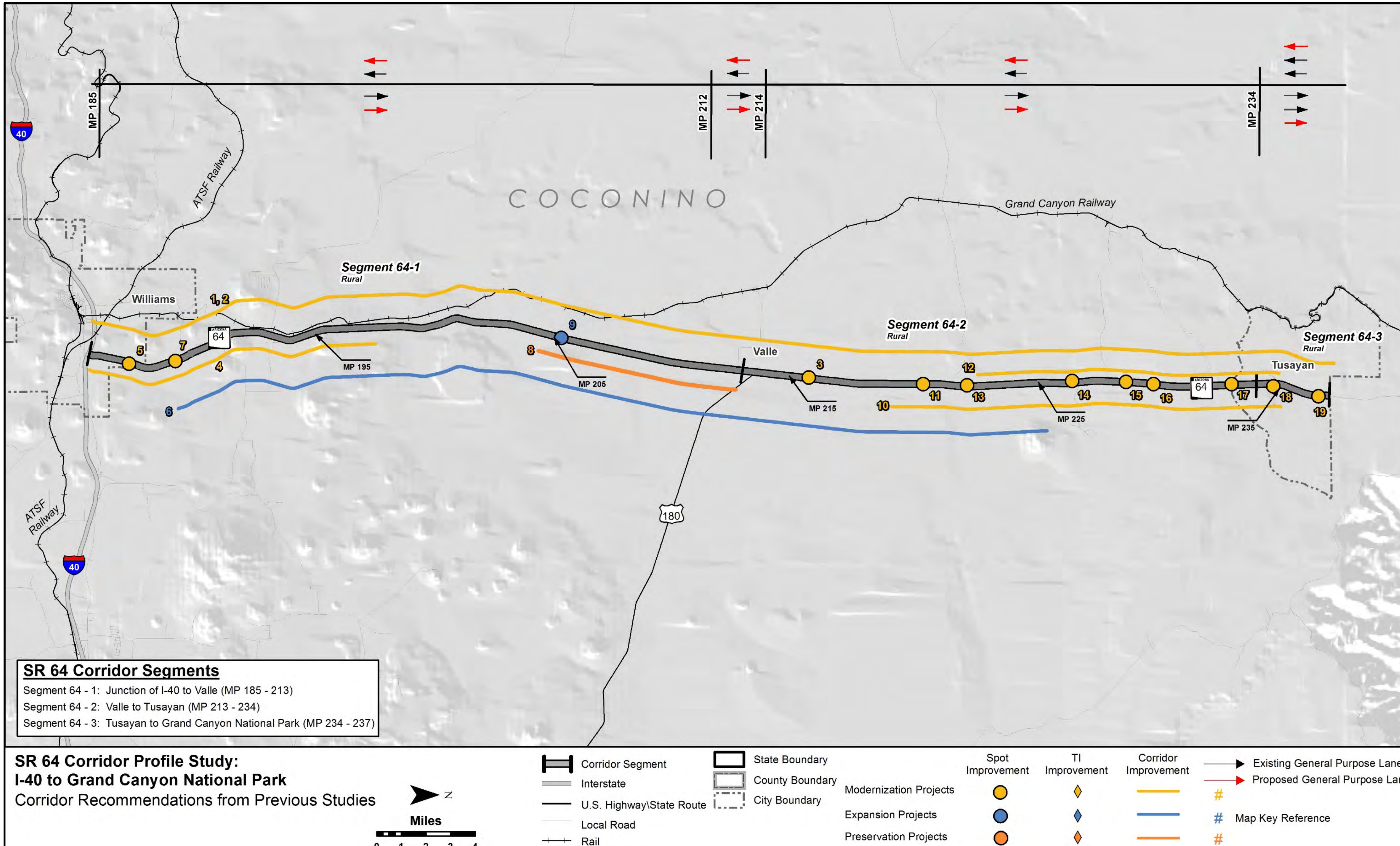
Table 3: Corridor Recommendations from Previous Studies (continued)

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
7	189.2	189.2	0.0	New Overpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
8	205	213	8.0	Pavement Preservation: Pipeline Rd-Airpark	√			2021	N/A	N	ADOT Five-Year Transportation Facilities Construction Program ~~2018~~ – 2022
9	205.0	205.5	0.5	New Overpass			√	-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
10	219	235	16.0	Grand Canyon National Park – Construct Right of Way Fence		√		2018	N/A	N	ADOT Five-Year Transportation Facilities Construction Program ~~2018~~ – 2022
11	220.0	220.59	0.6	New Overpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
12	222.3	234.4	12.1	8-foot ungulate-proof (wildlife) fencing		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
13	222.3	222.3	0.0	New Overpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
14	226.6	226.6	0.0	New Underpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
15	228.8	228.8	0.0	New Underpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
16	229.7	229.7	0.0	New Underpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)

Table 3: Corridor Recommendations from Previous Studies (continued)

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
17	233.0	233.0	0.0	New Underpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
18	235.5	235.5	0.0	Electrified barrier across highway		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)
19	236.8	236.8	0.0	New Underpass		√		-	N/A	N	Wildlife Accident Reduction Study and Monitoring: SR 64 (2012)

Figure 4: Corridor Recommendations from Previous Studies



2.0 CORRIDOR PERFORMANCE

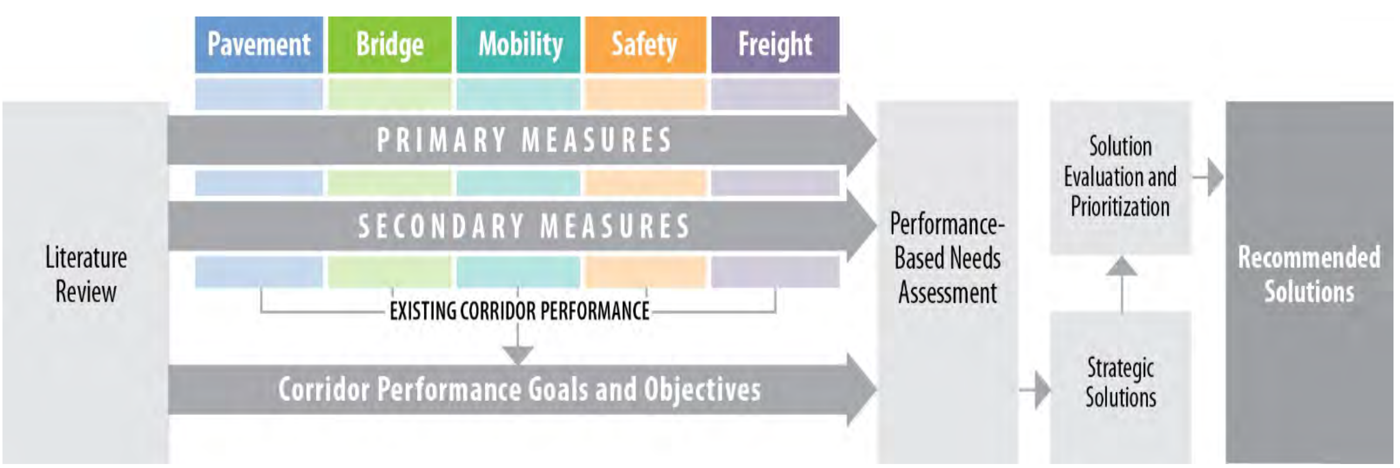
This chapter describes the evaluation of the existing performance of the SR 64 corridor. A series of performance measures is used to assess the corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

2.1 Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure 5 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance. The primary measures in each of five performance areas are used to define the overall health of the corridor, while the secondary measures identify locations that warrant further diagnostic investigation to delineate needs. Needs are defined as the difference between baseline corridor performance and established performance objectives.

Figure 5: Corridor Profile Performance Framework



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

These performance areas reflect national performance goals stated in *Moving Ahead for Progress in the 21st Century* (MAP-21):

- Safety: To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
- Infrastructure Condition: To maintain the highway infrastructure asset system in a state of good repair
- Congestion Reduction: To achieve a significant reduction in congestion on the National Highway System
- System Reliability: To improve the efficiency of the surface transportation system
- Freight Movement and Economic Vitality: To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
- Environmental Sustainability: To enhance the performance of the transportation system while protecting and enhancing the natural environment
- Reduced Project Delivery Delays: To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion

The MAP-21 performance goals were considered in the development of ADOT's P2P process, which integrates transportation planning with capital improvement programming and project delivery. Because the P2P program requires the preparation of annual transportation system performance reports using the five performance areas adopted for the CPS, consistency is achieved in the performance measures used for various ADOT analysis processes.

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance.

Each of the primary and secondary performance measures is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance	– Rating is above the identified desirable/average range
Fair/Average Performance	– Rating is within the identified desirable/average range
Poor/Below Average Performance	– Rating is below the identified desirable/average range

Table 4 provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table 4: Corridor Performance Measures

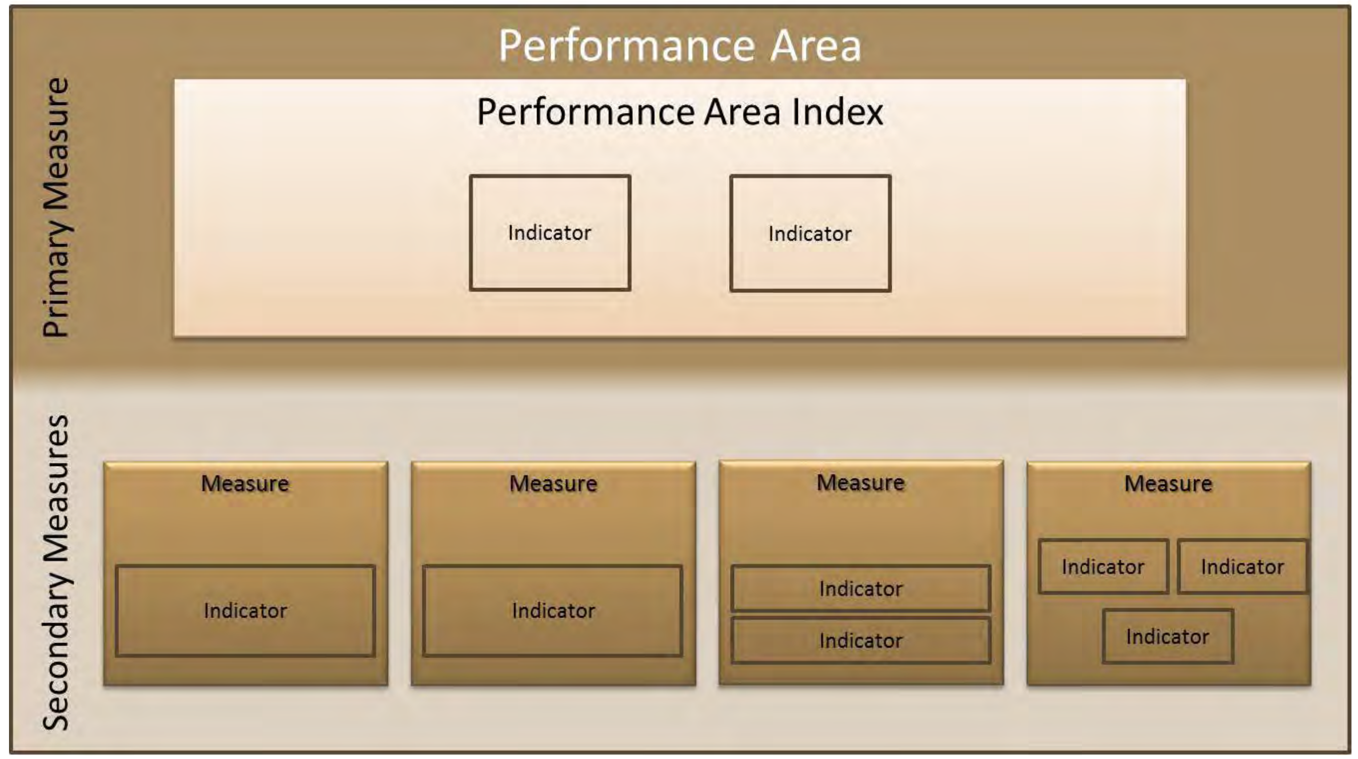
Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index and cracking	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Functionally Obsolete Bridges • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and incapacitating injury crashes	• Directional Safety Index • Strategic Highway Safety Plan Emphasis Areas • Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck planning time index	• Recurring Delay • Non-Recurring Delay • Closure Duration • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

The general template for each performance area is illustrated in **Figure 6**.

The guidelines for performance measure development are:

- Indicators and performance measures for each performance area should be developed for relatively homogeneous corridor segments
- Performance measures for each performance area should be tiered, consisting of primary measure(s) and secondary measure(s)
- Primary and secondary measures should assist in identifying those corridor segments that warrant in-depth diagnostic analyses to identify performance-based needs and a range of corrective actions known as solution sets
- One or more primary performance measures should be used to develop a Performance Index to communicate the overall health of a corridor and its segments for each performance area; the Performance Index should be a single numerical index that is quantifiable, repeatable, scalable, and capable of being mapped; primary performance measures should be transformed into a Performance Index using mathematical or statistical methods to combine one or more data fields from an available ADOT database
- One or more secondary performance measure indicators should be used to provide additional details to define corridor locations that warrant further diagnostic analysis; secondary performance measures may include the individual indicators used to calculate the Performance Index and/or "hot spot" features

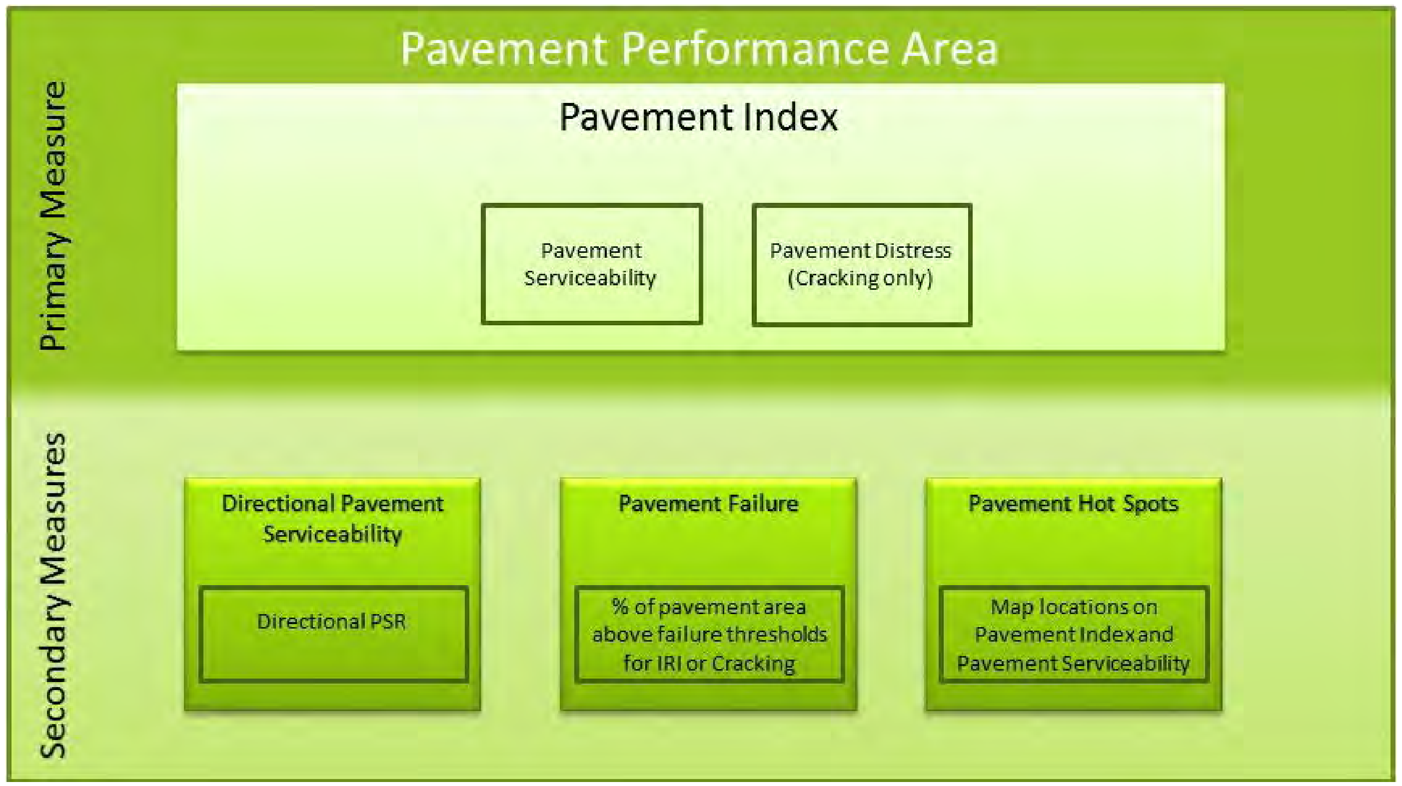
Figure 6: Performance Area Template



2.2 Pavement Performance Area

The Pavement performance area consists of a primary measure (Pavement Index) and three secondary measures, as shown in **Figure 7**. These measures assess the condition of the existing pavement along the SR 64 corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 7: Pavement Performance Measures



<u>*Primary Pavement Index*</u>

The Pavement Index is calculated using two pavement condition ratings: the Pavement Serviceability Rating (PSR) and the Pavement Distress Index (PDI).

The PSR is extracted from the International Roughness Index (IRI), a measurement of pavement roughness based on field-measured longitudinal roadway profiles. The PDI is extracted from the Cracking Rating (CR), a field-measured sample from each mile of highway.

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than the condition of a section with fewer travel lanes.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Pavement performance area, the relevant operating environments are designated as interstate and non-interstate segments. For the SR 64 corridor, the following operating environment was identified:

- Non-interstate: all segments

<u>*Secondary Pavement Measures*</u>

Three secondary measures provide an in-depth evaluation of the different characteristics of pavement performance.

Directional Pavement Serviceability

- Weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel

Pavement Failure

- Percentage of pavement area rated above failure thresholds for IRI or Cracking

Pavement Hot Spots

- A Pavement "hot spot" exists where a given one-mile section of roadway rates as being in "poor" condition
- Highlights problem areas that may be under-represented in a segment average; this measure is recorded and mapped, but not included in the Pavement performance area rating calculations

<u>*Pavement Performance Results*</u>

The Pavement Index provides a high-level assessment of the pavement condition for the corridor and for each segment. The three secondary measures provide more detailed information to assess pavement performance.

Based on the results of this analysis, the following observations were made:

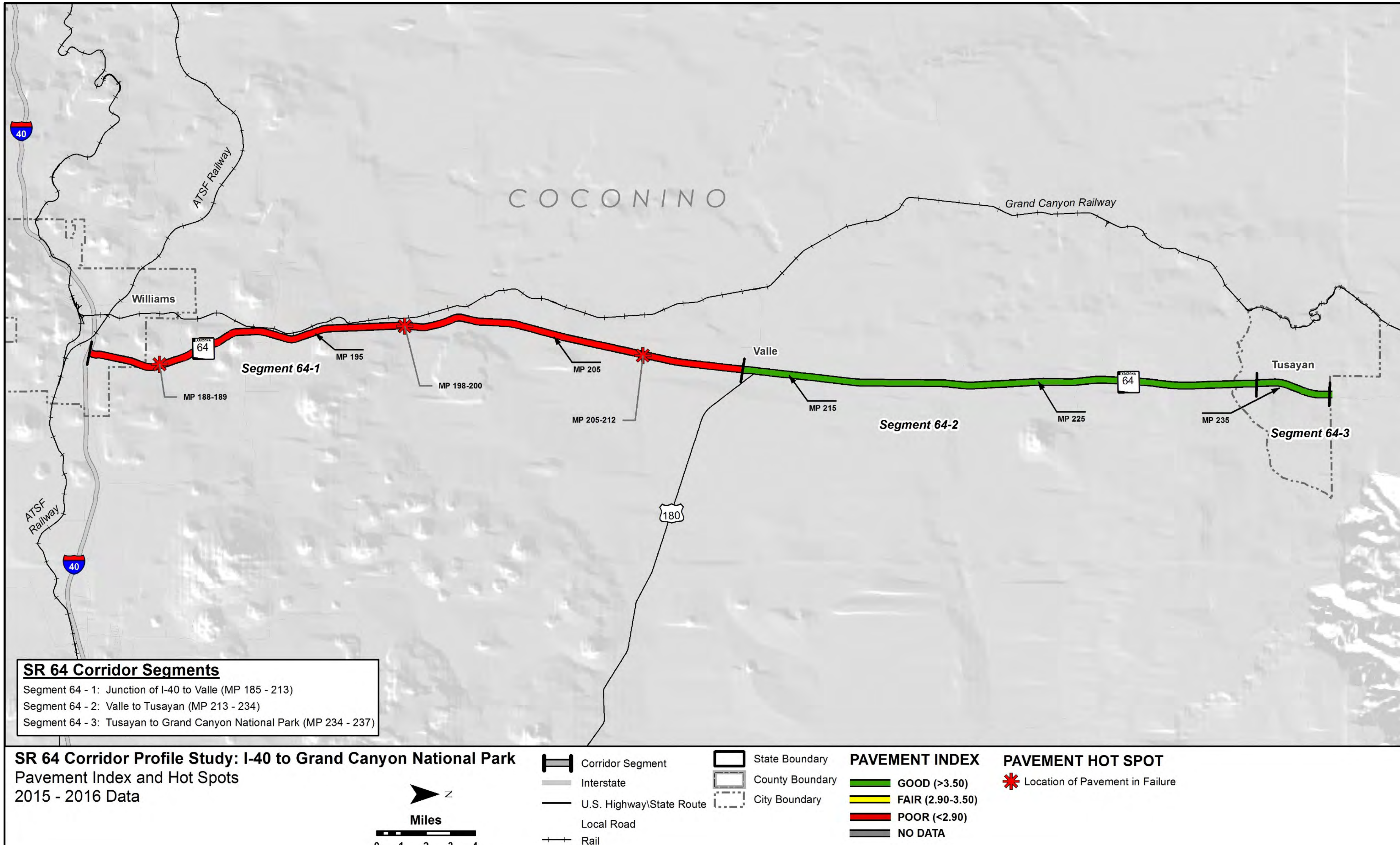
- The weighted average of the Pavement Index shows "fair" overall performance for the SR 64 corridor
- According to the Pavement Index, Segment 64-1 is in "poor" condition and Segments 64-2 and 64-3 are in "good" condition
- Segment 64-1 has "poor" % Pavement Area Failure ratings
- Pavement hot spots along the corridor include:
  - Segment 64-1 MP 188-189, 198-200, 205-212

Table 5 summarizes the Pavement performance results for the SR 64 corridor. **Figure 8** illustrates the primary Pavement Index performance and locations of Pavement hot spots along the SR 64 corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 5: Pavement Performance

Segment #	Segment Length (miles)	Pavement Index	Directional PSR		% Area Failure
			EB	WB	
64-1	28	2.88	3.09		38.0%
64-2	21	3.60	3.50		0.0%
64-3	3	3.69	3.52		0.0%
Weighted Corridor Average		3.22	3.28		20%
SCALES					
Performance Level		**Non-Interstate**			
Good		> 3.50			< 5%
Fair		2.90 - 3.50			5% - 20%
Poor		< 2.90			> 20%

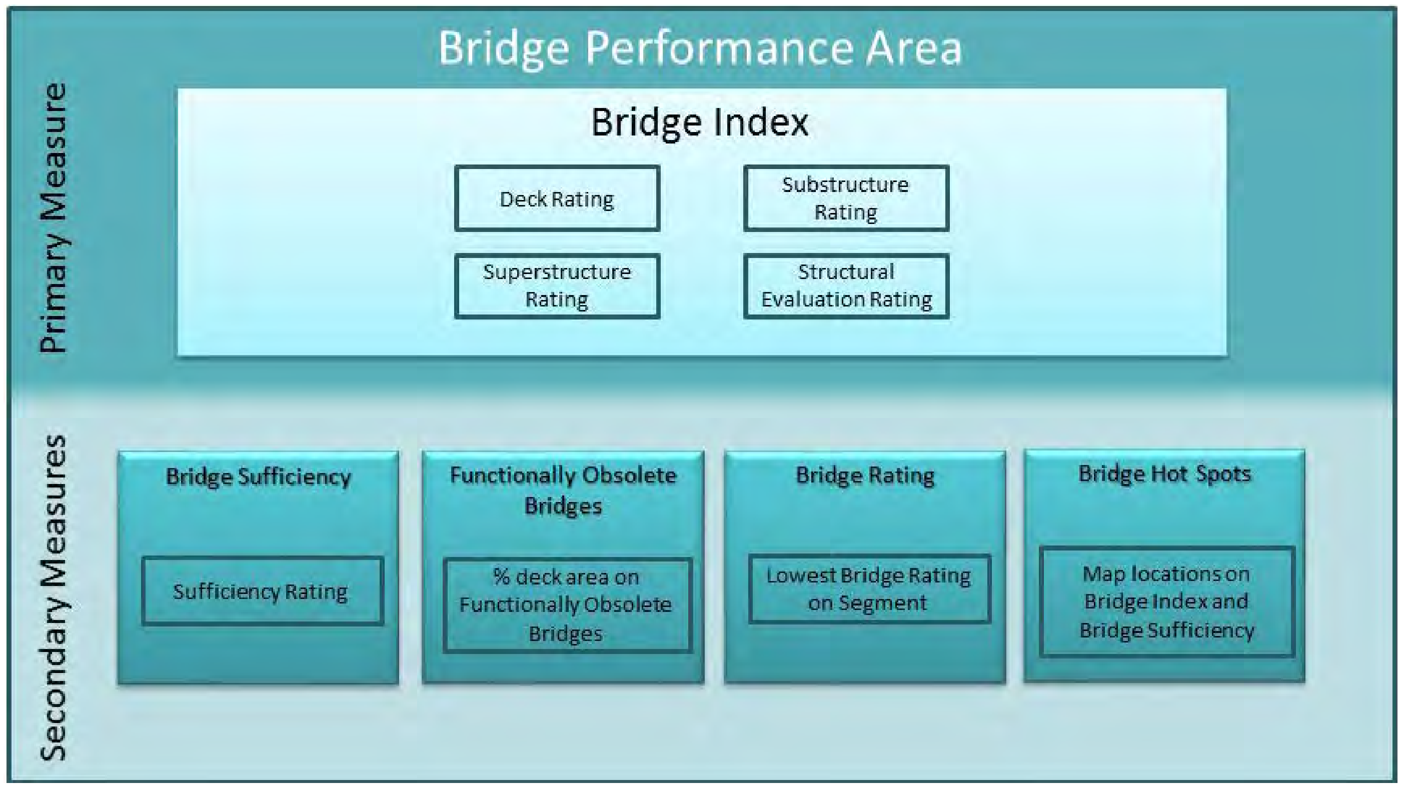
Figure 8: Pavement Performance



2.3 Bridge Performance Area

The Bridge performance area consists of a primary measure (Bridge Index) and four secondary measures, as shown in **Figure 9**. These measures assess the condition of the existing bridges along the SR 64 corridor. Only bridges that carry mainline traffic or bridges that cross the mainline are included in the calculation. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 9: Bridge Performance Measures



Primary Bridge Index

The Bridge Index is calculated based on the use of four different bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. These ratings are based on inspection reports and establish the structural adequacy of each bridge. The performance of each individual bridge is established by using the lowest of these four ratings. The use of these ratings, and the use of the lowest rating, is consistent with the approach used by the ADOT Bridge Group to assess the need for bridge rehabilitation. The Bridge Index is calculated as a weighted average for each segment based on deck area.

Secondary Bridge Measures

Four secondary measures provide an in-depth evaluation of the characteristics of each bridge:

Bridge Sufficiency

- Multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour
- Rates the structural and functional sufficiency of each bridge on a 100-point scale

Functionally Obsolete Bridges

- Percentage of total deck area in a segment that is on functionally obsolete bridges
- Identifies bridges that no longer meet standards for current traffic volumes, lane width, shoulder width, or bridge rails
- A bridge that is functionally obsolete may still be structurally sound

Bridge Rating

- The lowest rating of the four bridge condition ratings (substructure, superstructure, deck, and structural evaluation) on each segment
- Identifies lowest performing evaluation factor on each bridge

Bridge Hot Spots

- A Bridge "hot spot" is identified where a given bridge has a bridge rating of 4 or lower or multiple ratings of 5 between the deck, superstructure, and substructure ratings
- Identifies particularly low-performing bridges or those that may decline to low performance in the immediate future

Bridge Performance Results

The Bridge Index provides a high-level assessment of the structural condition of bridges for the corridor and for each segment. The four secondary measures provide more detailed information to assess bridge performance.

Based on the results of this analysis, the following observations were made:

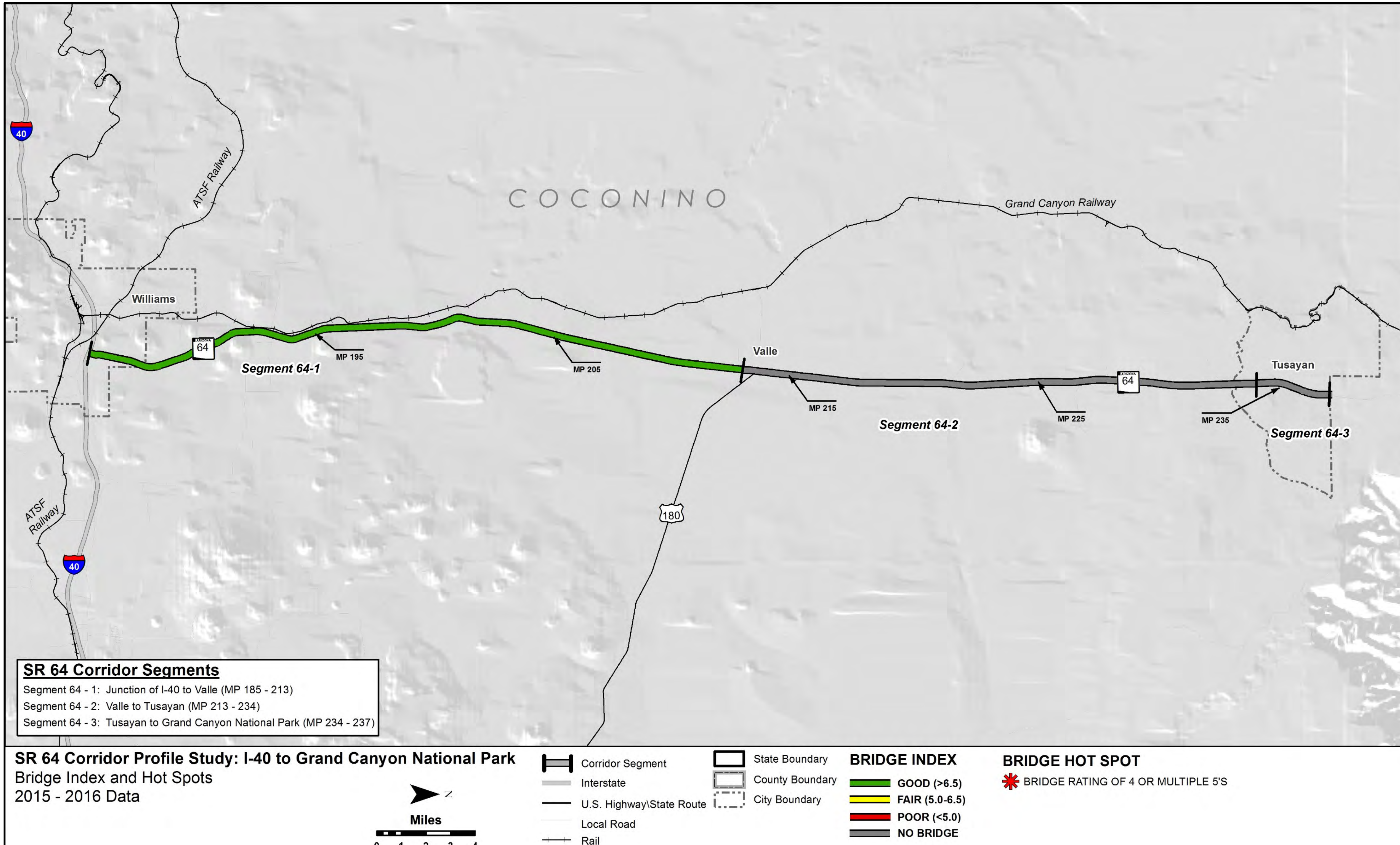
- The weighted average of the Bridge Index shows "good" overall performance for the SR 64 corridor
- Segment 64-1 is the only segment with a bridge and has a "good" Bridge Index rating, a "good" Sufficiency Rating, and a "good" Lowest Bridge Rating
- There are no functionally obsolete bridges or bridge hot spots on the corridor

Table 6 summarizes the Bridge performance results for the SR 64 corridor. **Figure 10** illustrates the primary Bridge Index performance and locations of Bridge hot spots along the SR 64 corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 6: Bridge Performance

Segment #	Segment Length (miles)	# of Bridges	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating
64-1	28	1	7.00	84.60	0.0%	7
64-2	21	0	No Bridges			
64-3	3	0	No Bridges			
Weighted Corridor Average			7.00	84.60	0%	7
SCALES						
Performance Level			**All**			
Good			> 6.5	> 80	< 12%	> 6
Fair			5.0 - 6.5	50 - 80	12% - 40%	5 - 6
Poor			< 5.0	< 50	> 40 %	< 5

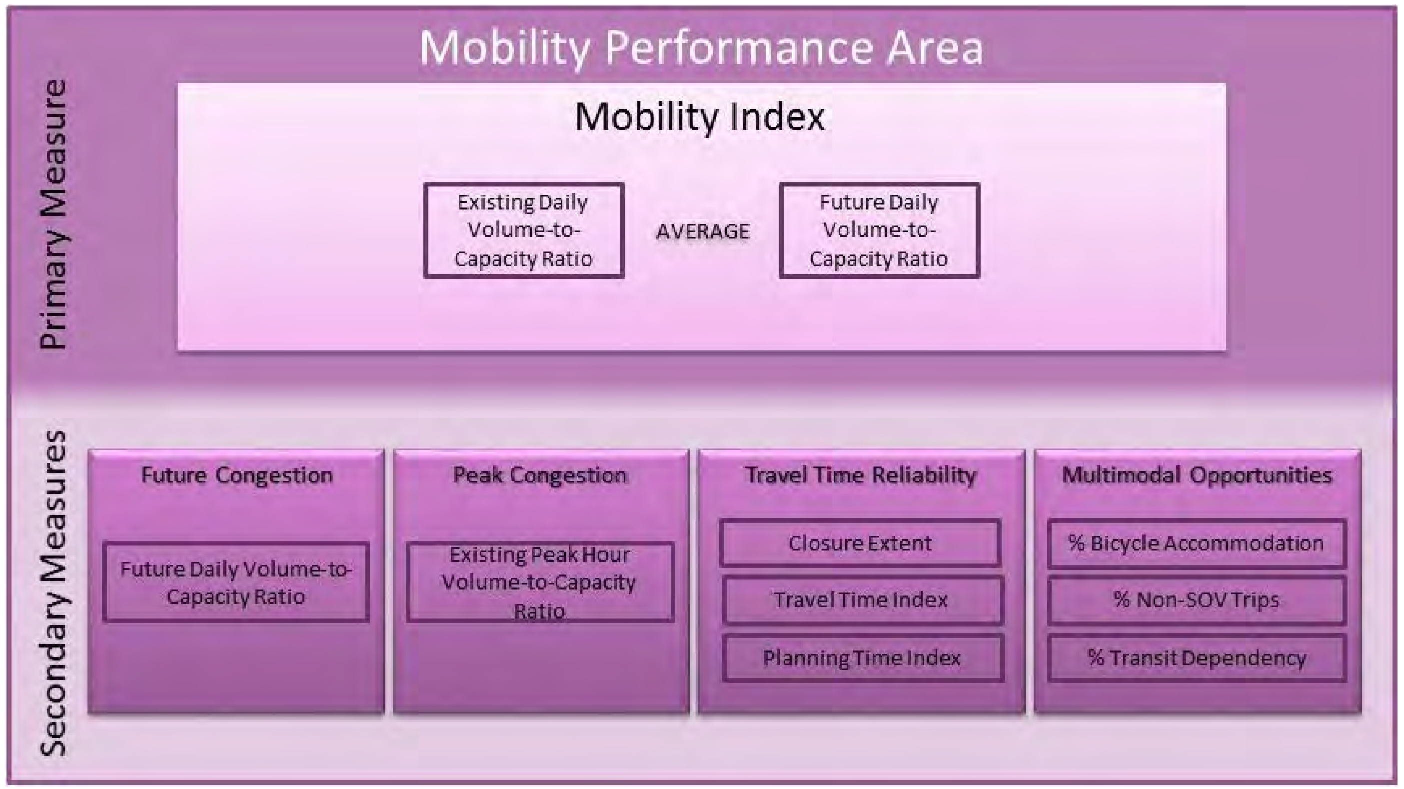
Figure 10: Bridge Performance



2.4 Mobility Performance Area

The Mobility performance area consists of a primary measure (Mobility Index) and four secondary measures, as shown in **Figure 11**. These measures assess the condition of existing mobility along the SR 64 corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 11: Mobility Performance Measures



Primary Mobility Index

The Mobility Index is an average of the existing (2014) daily volume-to-capacity (V/C) ratio and the future (2035 AZTDM) daily V/C ratio for each segment of the corridor. The V/C ratio is an indicator of the level of congestion. This measure compares the average annual daily traffic (AADT) volume to the capacity of the corridor segment as defined by the service volume for level of service (LOS) E. By using the average of the existing and future year daily volumes, this index measures the level of daily congestion projected to occur in approximately ten years (2025) if no capacity improvements are made to the corridor.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Mobility performance area, the relevant operating environments are urban vs. rural setting and interrupted flow (e.g., signalized at-grade intersections are present) vs. uninterrupted flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway). For the SR 64 corridor, the following operating environments were identified:

- Rural Uninterrupted Flow: Segments 64-1 and 64-2
- Rural Interrupted Flow: Segment 64-3

Secondary Mobility Measures

Four secondary measures provide an in-depth evaluation of operational characteristics of the corridor:

Future Congestion – Future Daily V/C

- The future (2035 AZTDM) daily V/C ratio; this measure is the same value used in the calculation of the Mobility Index
- Provides a measure of future congestion if no capacity improvements are made to the corridor

Peak Congestion – Existing Peak Hour V/C

- The peak hour V/C ratio for each direction of travel
- Provides a measure of existing peak hour congestion during typical weekdays

Travel Time Reliability– Three separate travel time reliability indicators together provide a comprehensive picture of how much time may be required to travel within the corridor:

- Closure Extent:
  - The average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average was applied to each closure that takes into account the distance over which the closure occurs
  - Closures related to crashes, weather, or other incidents are a significant contributor to non-recurring delays; construction-related closures were excluded from the analysis
- Directional Travel Time Index (TTI):
  - The ratio of the average peak period travel time to the free-flow travel time (based on the posted speed limit) in a given direction
  - The TTI recognizes the delay potential from recurring congestion during peak periods; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics
- Directional Planning Time Index (PTI):
  - The ratio of the 95^{th} percentile travel time to the free-flow travel time (based on the posted speed limit) in a given direction
  - The PTI recognizes the delay potential from non-recurring delays such as traffic crashes, weather, or other incidents; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics

- The PTI indicates the amount of time in addition to the typical travel time that should be allocated to make an on-time trip 95% of the time in a given direction

Multimodal Opportunities – Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to the single occupancy vehicle (SOV) for trips along the corridor:

- % Bicycle Accommodation:
  - Percentage of the segment that accommodates bicycle travel; bicycle accommodation on the roadway or on shoulders varies depending on traffic volumes, speed limits, and surface type
  - Encouraging bicycle travel has the potential to reduce automobile travel, especially on non-interstate highways
- % Non-SOV Trips:
  - The percentage of trips (less than 50 miles in length) by non-SOVs
  - The percentage of non-SOV trips in a corridor gives an indication of travel patterns along a section of roadway that could benefit from additional multimodal options
- % Transit Dependency:
  - The percentage of households that have zero or one automobile and households where the total income level is below the federally defined poverty level
  - Used to track the level of need among those who are considered transit dependent and more likely to utilize transit if it is available

Mobility Performance Results

The Mobility Index provides a high-level assessment of mobility conditions for the corridor and for each segment. The four secondary measures provide more detailed information to assess mobility performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Mobility Index shows “good” overall performance for the SR 64 corridor
- During the existing peak hour, traffic operations are “good” for all segments
- All segments are anticipated to have “good” performance in the future, according to the Future Daily V/C performance indicator
- Segments 64-1 and 64-2 have “fair” performance in the Closure Extent performance indicator for EB travel; all other segments have “good” performance
- The TTI performance indicator shows that all segments on the SR 64 corridor performance at “fair” or “good” performance levels
- The PTI performance indicator shows many of the SR 64 segments, both EB and WB, have “fair” or “poor” performance in terms of reliability
- All segments of SR 64 show “poor” or “fair” performance for non-SOV trips, indicating single occupant trips are more common
- Segments 64-1 and 64-2 show “poor” performance in % Bicycle Accommodation, indicating narrow shoulders, with “good” performance for Segment 64-3

Table 7 summarizes the Mobility performance results for the SR 64 corridor. **Figure 12** illustrates the primary Mobility Index performance along the SR 64 corridor. Maps for each secondary measure can be found in **Appendix**

Table 7: Mobility Performance

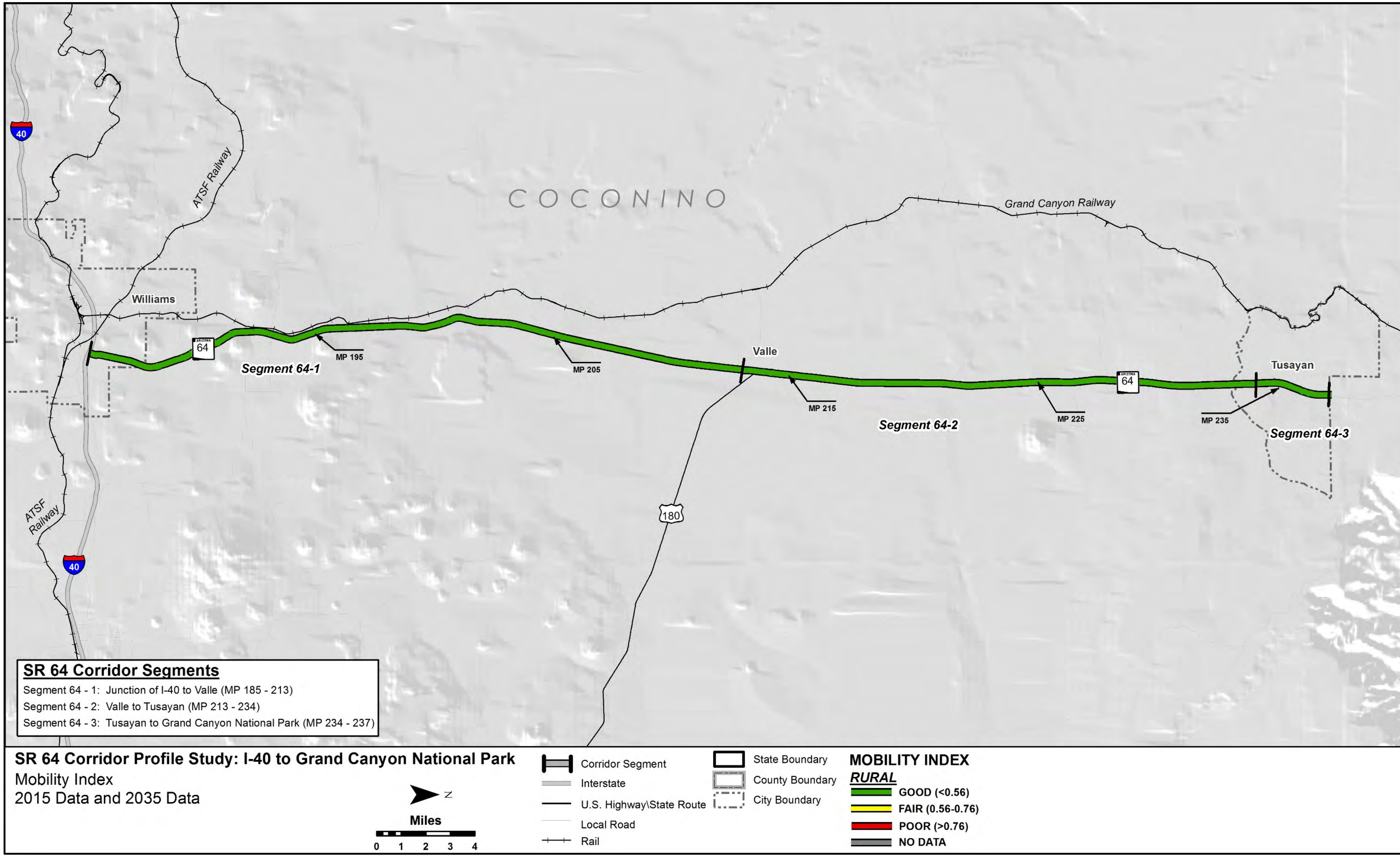
Segment #	Segment Length (miles)	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
				EB	WB	EB	WB	EB	WB	EB	WB		
64-1[2]^	28	0.22	0.22	0.21	0.21	0.33	0.03	1.01	1.06	1.27	1.59	5%	13.9%
64-2[2]^	21	0.28	0.32	0.28	0.26	0.28	0.01	1.02	1.17	2.03	2.57	4%	16.8%
64-3[2]*	3	0.55	0.65	0.35	0.35	0.20	0.07	1.07	1.16	1.00	2.04	95%	10.6%
Weighted Corridor Average		0.26	0.29	0.25	0.24	0.30	0.02	1.02	1.11	1.56	2.01	9%	15%

SCALES

Performance Level	Urban Rural	All	Uninterrupted Interrupted		All	
Good	< 0.71[1] < 0.56[2]	< 0.22	< 1.15^ < 1.30*	< 1.30^ < 3.00*	> 90%	> 17%
Fair	0.71 - 0.89[1] 0.56 - 0.76[2]	0.22 – 0.62	1.15 - 1.33^ 1.30 - 2.00*	1.30 - 1.50^ 3.00 - 6.00*	60% - 90%	11% - 17%
Poor	> 0.89[1] > 0.76[2]	> 0.62	> 1.33^ > 2.00*	> 1.50^ > 6.00*	< 60%	< 11%

[1]Urban Operating Environment
[2]Rural Operating Environment
^Uninterrupted Flow Facility
*Interrupted Flow Facility

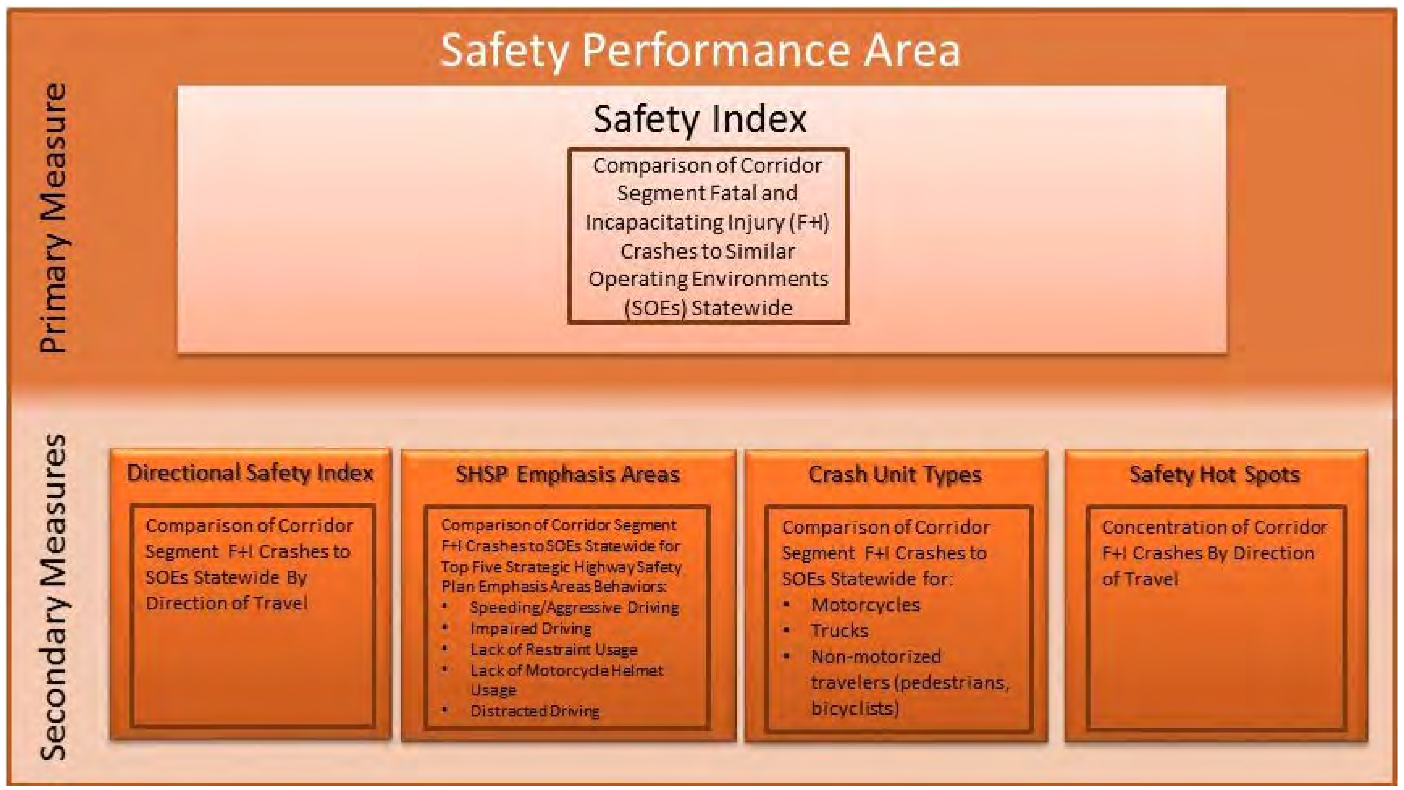
Figure 12: Mobility Performance



2.5 Safety Performance Area

The Safety performance area consists of a primary measure (Safety Index) and four secondary measures, as illustrated in **Figure 13**. All measures relate to crashes that result in fatal and incapacitating injuries, as these types of crashes are the emphasis of the ADOT Strategic Highway Safety Plan (SHSP), FHWA, and MAP-21. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C.**

Figure 13: Safety Performance Measures



Primary Safety Index

The Safety Index is based on the bi-directional frequency and rate of fatal and incapacitating injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT's 2010 Highway Safety Improvement Program Manual, fatal crashes have an estimated cost that is 14.5 times the estimated cost of incapacitating injury crashes ($5.8 million compared to $400,000).

Each corridor segment is rated on a scale by comparing the segment score with the average statewide score for similar operating environments. Because crash frequencies and rates vary depending on the operating environment of a particular roadway, statewide values were developed for similar operating environments defined by functional classification, urban vs. rural setting, number of travel lanes, and traffic volumes. For the SR 64 corridor, the following operating environments were identified:

- 2 or 3 lane Undivided Highway: Segments 64-1 and 64-2
- 4 or 5 Lane Undivided Highway: Segment 64-3

Secondary Safety Measures

Four secondary measures provide an in-depth evaluation of the different characteristics of safety performance:

Directional Safety Index

- This measure is based on the directional frequency and rate of fatal and incapacitating injury crashes

SHSP Emphasis Areas

ADOT's 2014 SHSP identified several emphasis areas for reducing fatal and incapacitating injury crashes. This measure compared rates of crashes in the top five SHSP emphasis areas to other corridors with a similar operating environment. The top five SHSP emphasis areas related to the following driver behaviors:

- Speeding and aggressive driving
- Impaired driving
- Lack of restraint usage
- Lack of motorcycle helmet usage
- Distracted driving

Crash Unit Types

- The percentage of total fatal and incapacitating injury crashes that involves crash unit types of motorcycles, trucks, or non-motorized travelers is compared to the statewide average on roads with similar operating environments

Safety Hot Spots

- The hot spot analysis identifies abnormally high concentrations of fatal and incapacitating injury crashes along the study corridor by direction of travel

For the Safety Index and the secondary safety measures, any segment that has too small of a sample size to generate statistically reliable performance ratings for a particular performance measure is considered to have "insufficient data" and is excluded from the safety performance evaluation for that particular performance measure.

Safety Performance Results

The Safety Index provides a high-level assessment of safety performance for the corridor and for each segment. The four secondary measures provide more detailed information to assess safety performance.

Based on the results of this analysis, the following observations were made:

- The crash unit type performance measures for crashes involving trucks, motorcycles, and non-motorized travelers as well as for behaviors associated with the SHSP Top 5 Emphasis Areas had insufficient data to generate reliable performance ratings for the SR 64 corridor
- A total of 11 fatal and incapacitating injury crashes occurred along the SR 64 corridor in 2011-2015; of these crashes, 2 were fatal and 9 involved incapacitating injuries
- The weighted average of the Safety Index shows "above average" performance for the SR 64 corridor compared to other segments statewide that have similar operating environments, meaning the corridor generally performs well as it relates to safety
- The Directional Safety Index value for all segments is "above average"

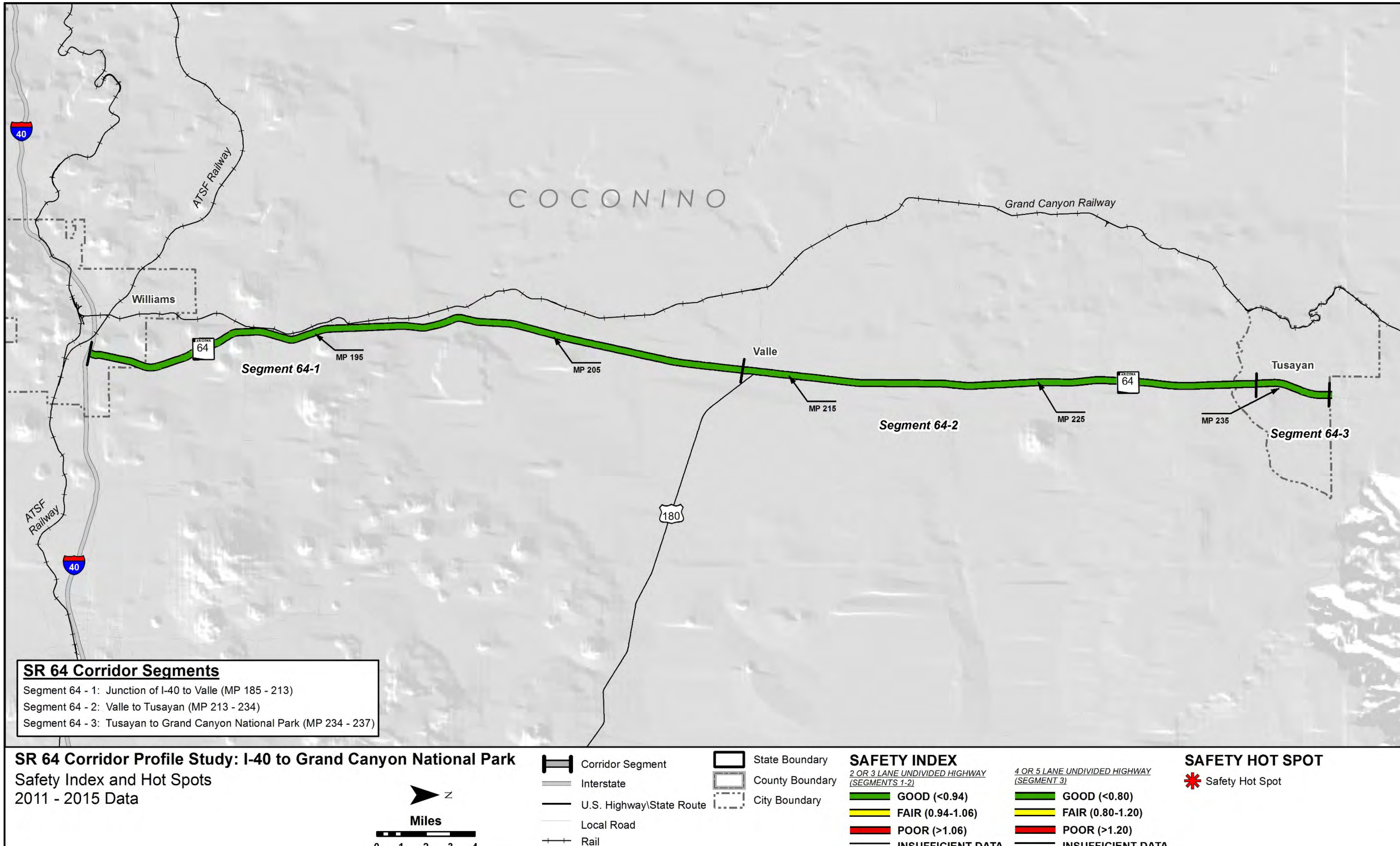
Table 8 summarizes the Safety performance results for the SR 64 corridor. **Figure 14** illustrates the primary Safety Index performance and locations of Safety hot spots along the SR 64 corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 8: Safety Performance

Segment #	Segment Length (miles)	Total Fatal & Incapacitating Injury Crashes (F/I)	Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers
				EB	WB				
64-1[c]	28	1/4	0.27	0.45	0.09	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
64-2[c]	21	1/4	0.36	0.08	0.64	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
64-3[b]	3	0/1	0.08	0.00	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
Weighted Corridor Average			0.30	0.27	0.32	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
SCALES									
Performance Level			**2 or 3 or 4 Lane Divided Highway**						
Above Average			< 0.77			< 44%	< 4%	< 16%	< 2%
Average			0.77 – 1.23			44% - 54%	4% - 7%	16% - 26%	2% - 4%
Below Average			> 1.23			> 54%	> 7%	> 26%	> 4%
Performance Level			**4 or 5 Lane Undivided Highway**						
Above Average			< 0.80			< 42%	< 6%	< 6%	< 5%
Average			0.80 – 1.20			42% - 51%	6% - 10%	6% - 9%	5% - 8%
Below Average			> 1.20			> 51%	> 10%	> 9%	> 8%
Performance Level			**2 or 3 Lane Undivided Highway**						
Above Average			< 0.94			< 51%	< 6%	< 19%	< 5%
Average			0.94 – 1.06			51% - 58%	6% - 10%	19% - 27%	5% - 8%
Below Average			> 1.06			> 58%	> 10%	> 27%	> 8%

[a]2 or 3 or 4 Lane Divided Highway
[b]4 or 5 Lane Undivided Highway
[c]2 or 3 Lane Undivided Highway
Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings.

Figure 14: Safety Performance



2.6 Freight Performance Area

The Freight performance area consists of a single primary measure (Freight Index) and five secondary measures, as illustrated in **Figure 15**. All measures related to the reliability of truck travel as measured by observed truck travel time speed and delays to truck travel from freeway closures or physical restrictions to truck travel. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 15: Freight Performance Measures

Primary Freight Index

The Freight Index is a reliability performance measure based on the PTI for truck travel. The Truck Planning Time Index (TPTI) is the ratio of the 95th percentile truck travel time to the free-flow truck travel time. The TPTI reflects the extra buffer time needed for on-time delivery while accounting for non-recurring delay. Non-recurring delay refers to unexpected or abnormal delay due to closures or restrictions resulting from circumstances such as crashes, inclement weather, and construction activities.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Freight performance area, the relevant operating environments are interrupted flow (e.g., signalized at-grade intersections are present) and uninterrupted flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway).

For the SR 64 corridor, the following operating environments were identified:

- Uninterrupted Flow: Segments 64-1 and 64-2
- Interrupted Flow: Segment 64-3

Secondary Freight Measures

The Freight performance area includes five secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

Recurring Delay (Directional Truck Travel Time Index [TTTI])

- The ratio of the average peak period truck travel time to the free-flow truck travel time (based on the posted speed limit up to a maximum of 65 miles per hour) in a given direction
- The TTTI recognizes the delay potential from recurring congestion during peak periods; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics

Non-Recurring Delay (Directional TPTI)

- The ratio of the 95th percentile truck travel time to the free-flow truck travel time (based on the posted speed limit up to a maximum of 65 miles per hour) in a given direction
- The TPTI recognizes the delay potential from non-recurring delays such as traffic crashes, weather, or other incidents; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics
- The TPTI indicates the amount of time in addition to the typical travel time that should be allocated to make an on-time trip 95% of the time in a given direction

Closure Duration

- The average time (in minutes) a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average is applied to each closure that takes into account the distance over which the closure occurs

Bridge Vertical Clearance

- The minimum vertical clearance (in feet) over the travel lanes for underpass structures on each segment

Bridge Vertical Clearance Hot Spots

- A Bridge vertical clearance "hot spot" exists where the underpass vertical clearance over the mainline travel lanes is less than 16.25 feet and no exit/entrance ramps exist to allow vehicles to bypass the low clearance location
- If a location with a vertical clearance less than 16.25 feet can be avoided by using immediately adjacent exit/entrance ramps rather than the mainline, it is not considered a hot spot

Freight Performance Results

The Freight Index provides a high-level assessment of freight mobility for the corridor and for each segment. The five secondary measures provide more detailed information to assess freight performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Freight Index shows "poor" overall performance for the SR 64 corridor
- A majority of the segments show either "poor" or "fair" performance for directional TPTI measures, meaning the corridor has "poor" or "fair" travel time reliability in the EB and WB direction due to non-recurring congestion
- All of the segments show "poor" performance in the EB direction and "good" performance in the WB direction in the closure duration performance measure
- No bridge vertical clearance hot spots exist along the SR 64 corridor

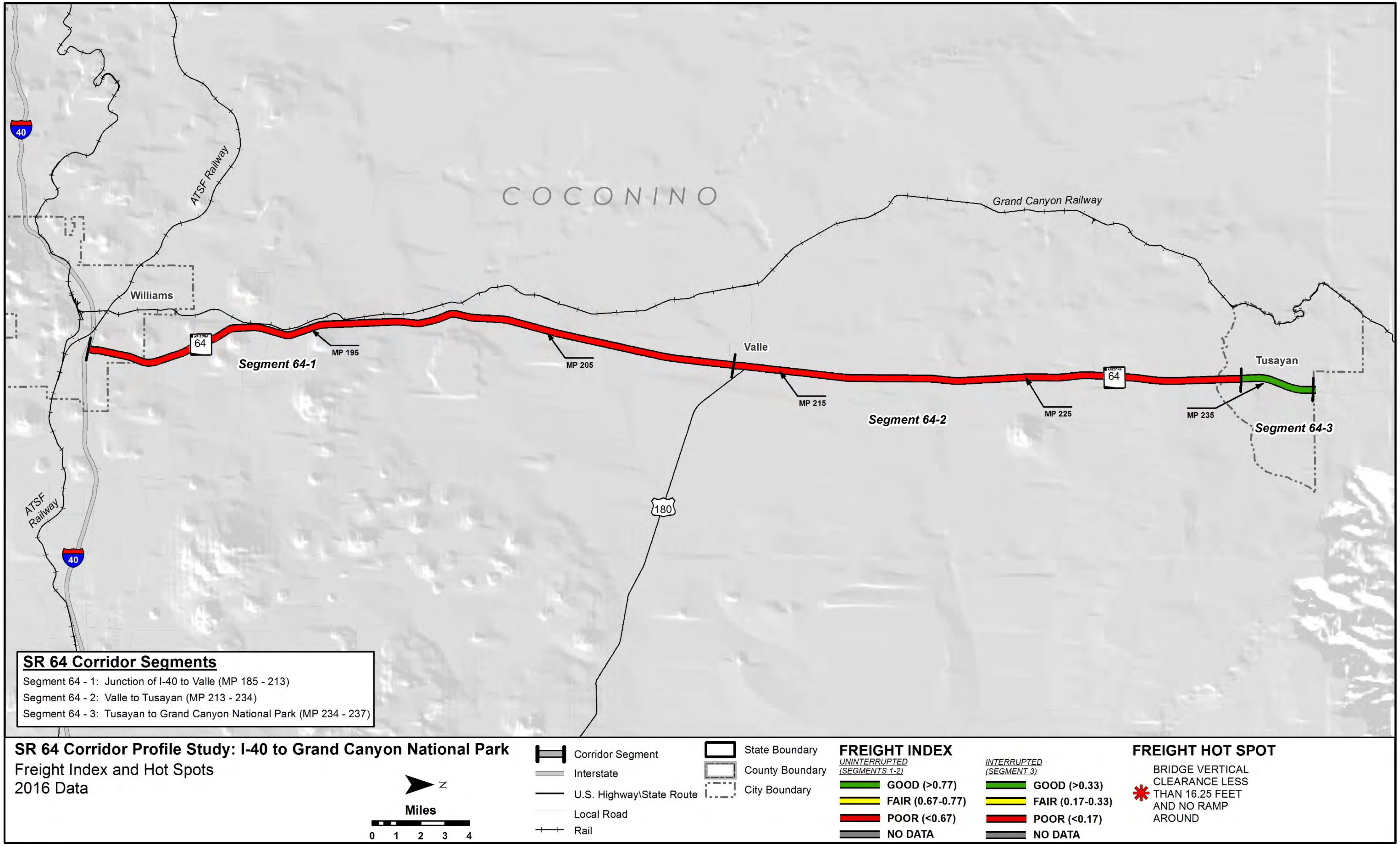
Table 9 summarizes the Freight performance results for the SR 64 corridor. **Figure 16** illustrates the primary Freight Index performance and locations of freight hot spots along the SR 64 corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 9: Freight Performance

Segment #	Segment Length (miles)	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/ year/mile)		Bridge Vertical Clearance (feet)
			EB	WB	EB	WB	EB	WB	
64-1[2^]	28	0.42	1.10	1.19	1.54	3.24	264.89	4.46	No UP
64-2[2^]	21	0.28	1.14	1.30	2.46	4.60	271.39	1.15	No UP
64-3[2*]	3	0.68	1.03	1.32	1.00	1.96	231.20	8.67	No UP
Weighted Corridor Average		0.38	1.11	1.24	1.88	3.72	265.57	3.37	No UP
SCALES									
Performance Level		Uninterrupted Interrupted					All		
Good	> 0.77^ > 0.33*		< 1.15^ < 1.30*		< 1.30^ < 3.00*		< 44.18		> 16.5
Fair	0.67 - 0.77^ 0.17 - 0.33*		1.15 -1.33^ 1.30 - 2.00*		1.30 - 1.50^ 3.00-6.00*		44.18 -124.86		16.0 - 16.5
Poor	< 0.67^ < 0.17*		> 1.33^ > 2.00*		> 1.50^ > 6.00*		> 124.86		< 16.0

[1]Urban Operating Environment
[2]Rural Operating Environment
^Uninterrupted Flow Facility
*Interrupted Flow Facility

Figure 16: Freight Performance



2.7 Corridor Performance Summary

Based on the results presented in the preceding sections, the following general observations were made related to the performance of the SR 64 corridor:

- Overall Performance: The Bridge and Safety performance areas show "good" performances; The Mobility performance area shows generally "good" performances with a few "fair" and one "poor" performances; The Pavement performance area shows "fair" performances; The Freight performance area shows a mix of "good," "fair," and "poor" performances
- Pavement Performance: The weighted average of the Pavement Index shows "fair" overall performance for the SR 64 corridor; Segment 64-1 shows "poor" performance, and Segments 64-2 and 64-3 show "good" or "fair" performances in all Pavement performance measures
- Bridge Performance: The weighted average of the Bridge Index shows "good" overall performance for the SR 64 corridor; Segment 64-1 is the only segment in the corridor containing bridges and shows "good" performance for all Bridge performance area measures
- Mobility Performance: The weighted average of the Mobility Index shows "good" overall performance for the SR 64 corridor; Segments 64-1 and 64-2 show "poor" or "fair" performances for % Bicycle Accommodation and % Non-Single Occupancy Vehicle (SOV) Trips performance area measures, and they also show "poor" performances Directional PTI measure in the WB direction
- Safety Performance: The weighted average of the Safety Index shows "good" overall performance for the SR 64 corridor; All the segments in SR 64 show "good" in every Safety performance area measure
- Freight Performance: The weighted average of the Freight Index shows "poor" overall performance for the SR 64 corridor; Segments 64-1 and 64-2 show "poor" performances in the Directional TPTI measure in both the EB and WB directions; All the segments show "fair" performances in the Directional TTTI measure in the WB direction, and all the segments show "poor" performances in the Closure Duration measure in the EB direction
- Lowest Performing Segments: Segment 64-1 shows "poor/below average" performance for many performance area measures
- Highest Performing Segments: Segment 64-3 shows "good/above average" performance for many performance area measures

Figure 17 shows the percentage of the SR 64 corridor that rates either "good/above average" performance, "fair/average" performance, or "poor/below average" performance for each primary measure. On the SR 64 corridor, Freight is the lowest performing area with 94% of the corridor in "poor" condition as it relates to the primary measure. Bridge, Mobility and Safety are the highest performing areas along the SR 64 corridor with 100% of the corridor in "good" condition as it relates to the primary measures.

Table 10 shows a summary of corridor performance for all primary measures and secondary measure indicators for the SR 64 corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure. The weighted average ratings are summarized in **Figure 18** which also provides a brief description of each performance measure. **Figure 18** represents the average for the entire corridor and any given segment or location could have a higher or lower rating than the corridor average.

Figure 17: Performance Summary by Primary Measure

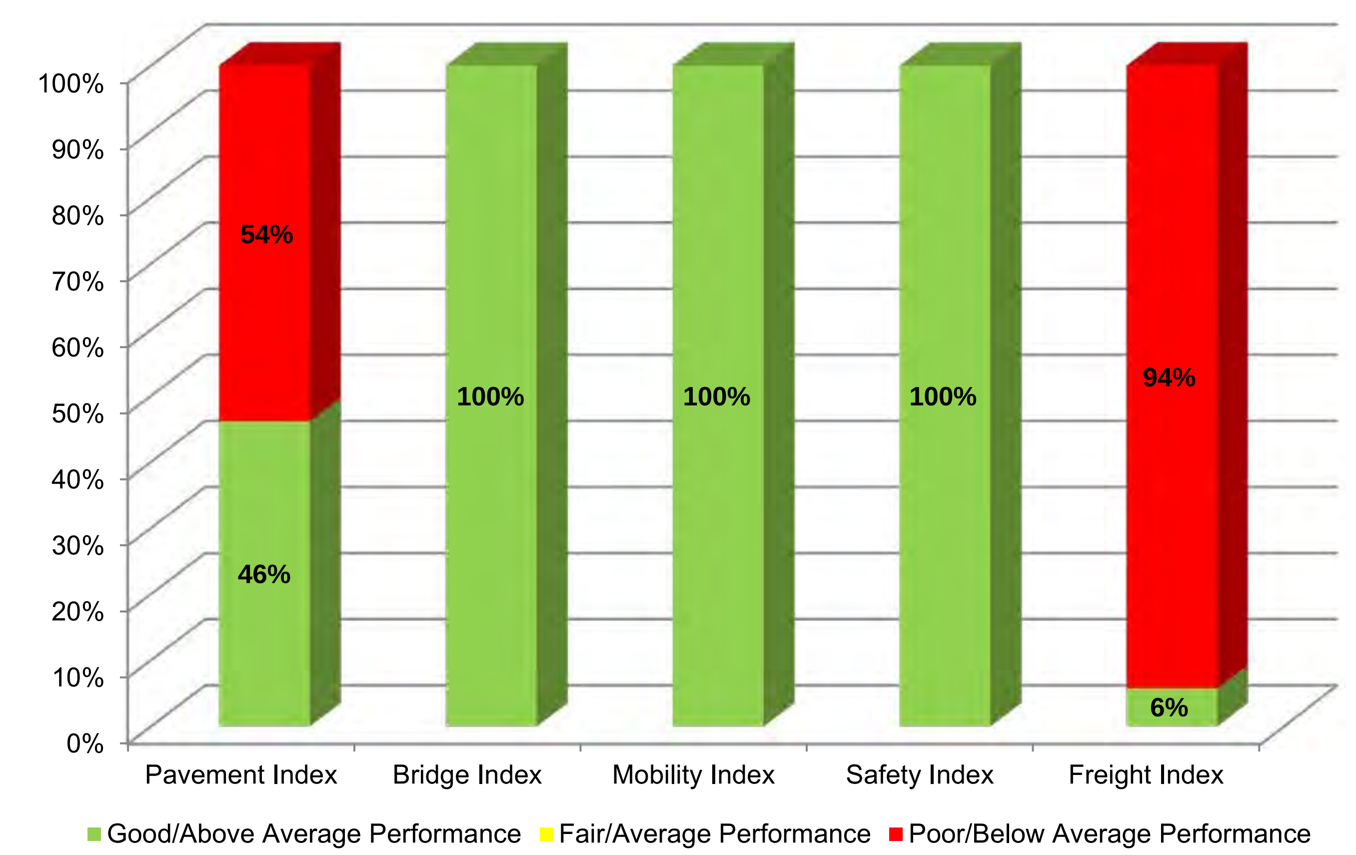


Figure 18: Corridor Performance Summary by Performance Measure

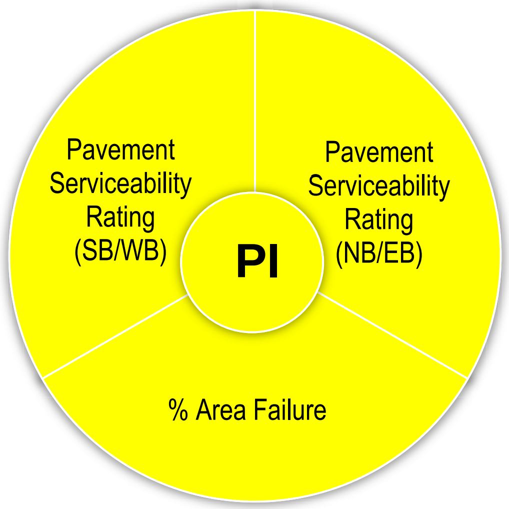
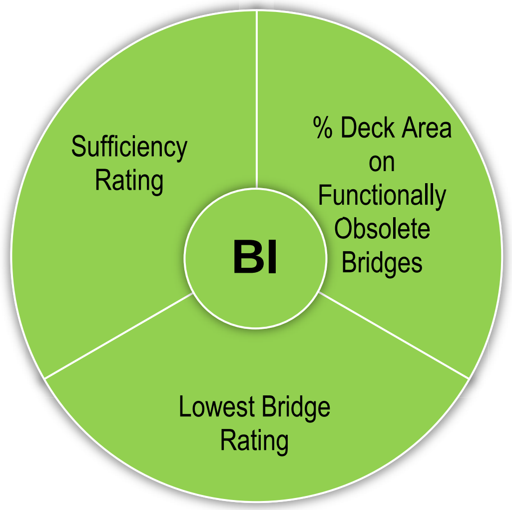
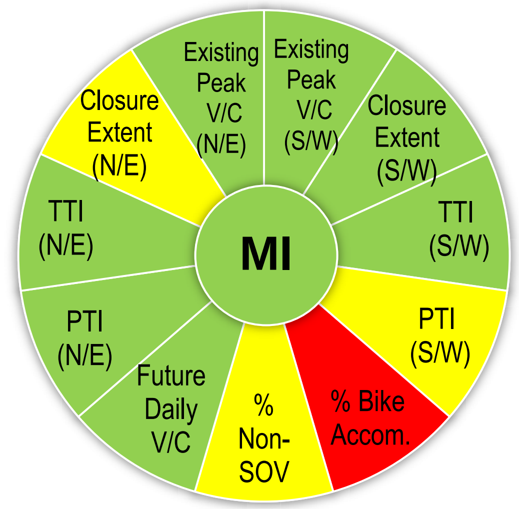
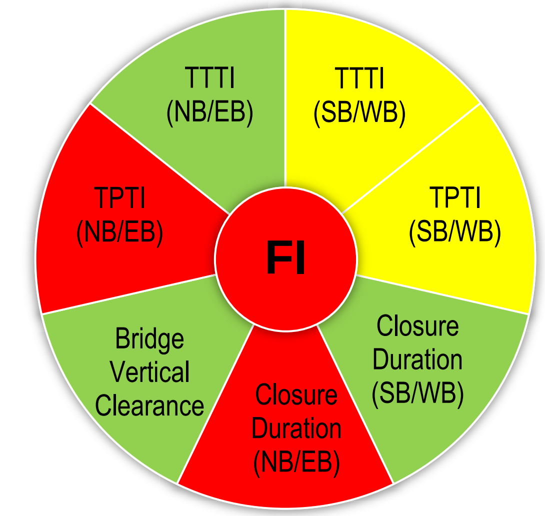
Pavement	Bridge	Mobility	Safety	Freight
				
Pavement Index (PI): based on two pavement condition ratings from the ADOT Pavement Database; the two ratings are the International Roughness Index (IRI) and the Cracking Rating	**Bridge Index (BI):** based on four bridge condition ratings from the ADOT Bridge Database; the four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating	**Mobility Index (MI):** an average of the existing daily volume-to-capacity (V/C) ratio and the projected 2035 daily V/C ratio	**Safety Index (SI):** combines the bi-directional frequency and rate of fatal and incapacitating injury crashes, compared to crash occurrences on similar roadways in Arizona	**Freight Index (FI):** a reliability performance measure based on the bi-directional planning time index for truck travel
➢ **Directional Pavement Serviceability Rating (PSR)** – the weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel ➢ **% Area Failure** – the percentage of pavement area rated above failure thresholds for IRI or Cracking	➢ **Sufficiency Rating**– multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour ➢ **% of Deck Area on Functionally Obsolete Bridges**– the percentage of deck area in a segment that is on functionally obsolete bridges; identifies bridges that no longer meet standards for current traffic volumes, lane width, shoulder width, or bridge rails; a bridge that is functionally obsolete may still be structurally sound ➢ **Lowest Bridge Rating** –the lowest rating of the four bridge condition ratings on each segment	➢ **Future Daily V/C** – the future 2035 V/C ratio provides a measure of future congestion if no capacity improvements are made to the corridor ➢ **Existing Peak Hour V/C** – the existing peak hour V/C ratio for each direction of travel provides a measure of existing peak hour congestion during typical weekdays ➢ **Closure Extent** – the average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel ➢ **Directional Travel Time Index (TTI)** – the ratio of the average peak period travel time to the free-flow travel time; the TTI represents recurring delay along the corridor ➢ **Directional Planning Time Index (PTI)** – the ratio of the 95th percentile travel time to the free-flow travel time; the PTI represents non-recurring delay along the corridor ➢ **% Bicycle Accommodation** – the percentage of a segment that accommodates bicycle travel ➢ **% Non-single Occupancy Vehicle (Non-SOV) Trips** –the percentage of trips that are taken by vehicles carrying more than one occupant	➢ **Directional Safety Index** – the combination of the directional frequency and rate of fatal and incapacitating injury crashes, compared to crash occurrences on similar roadways in Arizona ➢ **% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors** – the percentage of fatal and incapacitating crashes that involve at least one of the five Strategic Highway Safety Plan (SHSP) emphasis areas on a given segment compared to the statewide average percentage on roads with similar operating environments ➢ **% of Fatal + Incapacitating Crashes Involving SHSP Crash Unit Types** – the percentage of total fatal and incapacitating injury crashes that involves a given crash unit type (motorcycle, truck, non-motorized traveler) compared to the statewide average percentage on roads with similar operating environments	➢ **Directional Truck Travel Time Index (TTTI)** – the ratio of the average peak period truck travel time to the free-flow truck travel time; the TTTI represents recurring delay along the corridor ➢ **Directional Truck Planning Time Index (TPTI)** – the ratio the 95th percentile truck travel time to the free-flow truck travel time; the TPTI represents non-recurring delay along the corridor ➢ **Closure Duration** – the average time a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel ➢ **Bridge Vertical Clearance** – the minimum vertical clearance over the travel lanes for underpass structures on each segment

Table 10: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area				Mobility Performance Area											
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			EB	WB								EB	WB	EB	WB	EB	WB	EB	WB		
64-1[^c2]	28	2.88	3.09		38.0%	7.00	84.60	0.0%	7	0.22	0.22	0.21	0.21	0.33	0.03	1.01	1.06	1.27	1.59	5%	13.9%
64-2[^c2]	21	3.60	3.50		0.0%	No Bridges				0.28	0.32	0.28	0.26	0.28	0.01	1.02	1.17	2.03	2.57	4%	16.8%
64-3[*b2]	3	3.69	3.52		0.0%	No Bridges				0.55	0.65	0.35	0.35	0.20	0.07	1.07	1.16	1.00	2.04	95%	10.6%
Weighted Corridor Average		3.22	3.28		20%	7.00	84.60	0%	7.00	0.26	0.29	0.25	0.24	0.30	0.02	1.02	1.11	1.56	2.01	9%	15%
SCALES																					
Performance Level		Non-Interstate				All				Urban and Fringe Urban				All		Uninterrupted				All	
Good/Above Average		> 3.50			< 5%	> 6.5	> 80	< 12%	> 6	< 0.71				< 0.22		< 1.15		< 1.3		> 90%	> 17%
Fair/Average		2.90 - 3.50			5% - 20%	5.0 - 6.5	50 - 80	12% - 40%	5 - 6	0.71 - 0.89				0.22 - 0.62		1.15 - 1.33		1.3 - 1.5		60% - 90%	11% - 17%
Poor/Below Average		< 2.90			> 20%	< 5.0	< 50	> 40%	< 5	> 0.89				> 0.62		> 1.33		> 1.5		< 60%	< 11%
Performance Level										Rural						Interrupted					
Good/Above Average										< 0.56						< 1.3		< 3.0			
Fair/Average										0.56 - 0.76						1.3 – 2.0		3.0 – 6.0			
Poor/Below Average										> 0.76						> 2.0		> 6.0			

^Uninterrupted Flow Facility
*Interrupted Flow Facility
[a]2 or 3 or 4 Lane Divided Highway
[b]4 or 5 Lane Undivided Highway
[c]2 or 3 Lane Undivided Highway
[1]Urban Operating Environment
[2]Rural Operating Environment

Table 10: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area							Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/year/mile)		Bridge Vertical Clearance (feet)
			EB	WB						EB	WB	EB	WB	EB	WB	
64-1[^c2]	28	0.27	0.45	0.09	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.42	1.10	1.19	1.54	3.24	264.89	4.46	No UP
64-2[^c2]	21	0.36	0.08	0.64	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.28	1.14	1.30	2.46	4.60	271.39	1.15	No UP
64-3[*b2]	3	0.08	0.00	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.68	1.03	1.32	1.00	1.96	231.20	8.67	No UP
Weighted Corridor Average		0.30	0.27	0.32	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.38	1.11	1.24	1.88	3.72	265.57	3.37	No UP

SCALES

Performance Level	Safety Index / Directional Safety Index	% SHSP Top 5 Emphasis Areas	% Trucks	% Motorcycles	% Non-Motorized	Freight Index	Directional TTTI	Directional TPTI	Closure Duration	Bridge Vertical Clearance
Performance Level	**2 or 3 or 4 Lane Divided Highway**					**Uninterrupted**			**All**	
Good/Above Average	< 0.77	< 44%	< 4%	< 16%	< 2%	> 0.77	< 1.15	< 1.3	< 44.18	> 16.5
Fair/Average	0.77 - 1.23	44% - 54%	4% - 7%	16% - 26%	2% - 4%	0.67 - 0.77	1.15 - 1.33	1.3 - 1.5	44.18-124.86	16.0 - 16.5
Poor/Below Average	> 1.23	> 54%	> 7%	> 26%	> 4%	< 0.67	> 1.33	> 1.5	> 124.86	< 16.0
Performance Level	**2 or 3 Lane Undivided Highway**					**Interrupted**				
Good/Above Average	< 0.94	< 51%	< 6%	< 19%	< 5%	> 0.33	< 1.3	< 3.0		
Fair/Average	0.94 - 1.06	51% - 58%	6% - 10%	19% - 27%	5% - 8%	0.17 - 0.33	1.3 - 2.0	3.0 - 6.0		
Poor/Below Average	> 1.06	> 58%	> 10%	> 27%	> 8%	< 0.17	> 2.0	> 6.0		
Performance Level	**4 or 5 Undivided Highway**									
Good/Above Average	< 0.80	< 42%	< 6%	< 6%	< 5%					
Fair/Average	0.80 - 1.20	42% - 51%	6% - 10%	6% - 9%	5% - 8%					
Poor/Below Average	> 1.20	> 51%	> 10%	> 9%	> 8%					

^Uninterrupted Flow Facility
*Interrupted Flow Facility
[a]2 or 3 or 4 Lane Divided Highway
[b]4 or 5 Lane Undivided Highway
[c]2 or 3 Lane Undivided Highway
[1]Urban Operating Environment
[2]Rural Operating Environment

Notes: *"Insufficient Data" indicates there was not enough data available to generate reliable performance ratings*
"No UP" indicates no underpasses are present in the segment

3.0 NEEDS ASSESSMENT

3.1 Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP) 2010-2035 goals and objectives that were updated in 2017. Statewide performance goals that are relevant to SR 64 performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three “emphasis areas” were identified for the SR 64 corridor: Pavement, Mobility, and Safety.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas. **Table 11** shows the SR 64 corridor goals, corridor objectives, and performance objectives, and how they align with the statewide goals.

It is not reasonable within a financially constrained environment to expect that every performance measure will always be at the highest levels on every corridor segment. Therefore, individual corridor segment objectives have been set as “fair/average” or better and should not fall below that standard.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Addressing current and future congestion, thereby improving mobility on congested segments, will also help the corridor fulfill its potential as a significant contributor to the region’s economy.

Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Goal achievement will improve or reduce current and future congestion, increase travel time reliability, and reduce fatalities and incapacitating injuries resulting from vehicle crashes. Where performance is currently rated “good”, the goal is always to maintain that standard, regardless of whether or not the performance is in an emphasis area.

Table 11: Corridor Performance Goals and Objectives

ADOT Statewide LRTP Goals	SR 64 Corridor Goals	SR 64 Corridor Objectives	Performance Area	Primary Measure / Secondary Measure Indicators	Performance Objective: Corridor Average	Performance Objective: Segment
Improve Mobility, Reliability, and Accessibility **Make Cost Effective Investment Decisions and Support Economic Vitality**	Provide a safe and reliable route for recreational and tourist travel Provide safe, reliable and efficient connection to all communities along the corridor to permit efficient regional travel	Reduce current and future congestion and delay in the urbanized areas Improve access management and provide guidance for future connections within the corridor Reduce delays from non-recurring events and incidents to improve reliability Improve bicycle and pedestrian accommodations Utilize technology to optimize existing system capacity and performance	Mobility (*Emphasis Area*)	Mobility Index	Good	Fair or better
				Future Daily V/C		
				Existing Peak Hour V/C		
				Closure Extent		
				Directional Travel Time Index		
				Directional Planning Time Index		
				% Bicycle Accommodation		
				% Non-SOV Trips		
	Provide a safe, reliable and efficient freight route	Reduce delays and restrictions to freight movement to improve reliability Improve travel time reliability (including impacts to motorists due to freight traffic)	Freight	Freight Index	Fair or better	Fair or better
				Directional Truck Travel Time Index		
				Directional Truck Planning Time Index		
				Closure Duration		
				Bridge Vertical Clearance		
Preserve and Maintain the System	Preserve and modernize highway infrastructure	Maintain structural integrity of bridges	Bridge	Bridge Index	Fair or better	Fair or better
				Sufficiency Rating		
				% of Deck Area on Functionally Obsolete Bridges		
				Lowest Bridge Rating		
		Improve pavement ride quality for all corridor users	Pavement (*Emphasis Area*)	Pavement Index	Good	Fair or better
				Directional Pavement Serviceability Rating		
				% Area Failure		
Enhance Safety	Provide a safe, reliable, and efficient connection for the communities along the corridor Promote safety by implementing appropriate countermeasures	Reduce fatal and incapacitating injury crashes Reduce wildlife-related crashes	Safety (*Emphasis Area*)	Safety Index	Above Average	Average or better
				Directional Safety Index		
				% of Crashes Involving SHSP Top 5 Emphasis Areas Behaviors		
				% of Crashes Involving Crash Unit Types		

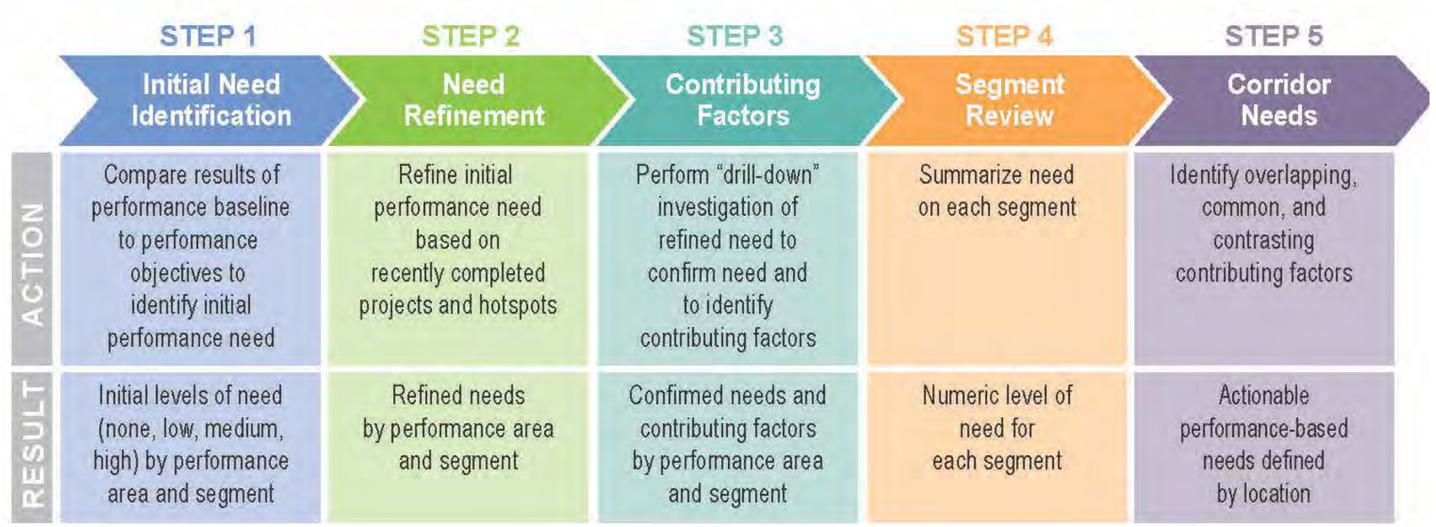
3.2 Needs Assessment Process

The following guiding principles were used as an initial step in developing a framework for the performance-based needs assessment process:

- Corridor needs are defined as the difference between the corridor performance and the performance objectives
- The needs assessment process should be systematic, progressive, and repeatable, but also allow for engineering judgment where needed
- The process should consider all primary and secondary performance measures developed for the study
- The process should develop multiple need levels including programmatic needs for the entire length of the corridor, performance area-specific needs, segment-specific needs, and location-specific needs (defined by MP limits)
- The process should produce actionable needs that can be addressed through strategic investments in corridor preservation, modernization, and expansion

The performance-based needs assessment process is illustrated in **Figure 19** and described in the following sections.

Figure 19: Needs Assessment Process



Step 1: Initial Needs Identification

The first step in the needs assessment process links baseline (existing) corridor performance with performance objectives. In this step, the baseline corridor performance is compared to the performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown below in **Figure 20**.

Figure 20: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
5.0	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. Values of 0, 1, 2, and 3 are assigned to the initial need levels of None, Low, Medium, and High, respectively. A weight of 1.0 is applied to the Performance Index need and equal weights of 0.20 are applied to each need for each secondary performance measure. For directional secondary performance measures, each direction of travel receives a weight of 0.10.

Step 2: Need Refinement

In Step 2, the initial level of need for each segment is refined using the following information and engineering judgment:

- For segments with an initial need of None that contain hot spots, the level of need should be increased from None to Low
- For segments with an initial level of need where recently completed projects or projects under construction are anticipated to partially or fully address the identified need, the level of need should be reduced or eliminated as appropriate
- Programmed projects that are expected to partially or fully address an identified need are not justification to lower the initial need because the programmed projects may not be implemented as planned; in addition, further investigations may suggest that changes in the scope of a programmed project may be warranted

The resulting final needs are carried forward for further evaluation in Step 3.

Step 3: Contributing Factors

In Step 3, a more detailed review of the condition and performance data available from ADOT is conducted to identify contributing factors to the need. Typically, the same databases used to develop the baseline performance serve as the principal sources for the more detailed analysis. However, other supplemental databases may also be useful sources of information. The databases used for diagnostic analysis are listed below:

Pavement Performance Area

- Pavement Rating Database

Bridge Performance Area

- ABISS

Mobility Performance Area

- Highway Performance Monitoring System (HPMS) Database
- AZTDM
- Real-time traffic conditions data produced by American Digital Cartography Inc. (HERE) Database
- Highway Conditions Reporting System (HCRS) Database

Safety Performance Area

- Crash Database

Freight Performance Area

- HERE Database
- HCRS Database

In addition, other sources considered helpful in identifying contributing factors are:

- Maintenance history (from ADOT PeCoS database for pavement), the level of past investments, or trends in historical data that provide context for pavement and bridge history
- Field observations from ADOT district personnel can be used to provide additional information regarding a need that has been identified
- Previous studies can provide additional information regarding a need that has been identified

Step 3 results in the identification of performance-based needs and contributing factors by segment (and MP locations, if appropriate) that can be addressed through investments in preservation, modernization, and expansion projects to improve corridor performance. See **Appendix D** for more information.

Step 4: Segment Review

In this step, the needs identified in Step 2 and refined in Step 3 are quantified for each segment to numerically estimate the level of need for each segment. Values of 0 to 3 are assigned to the final need levels (from Step 3) of None, Low, Medium, and High, respectively. A weighting factor is applied to the performance areas identified as emphasis areas and a weighted average need is calculated for each segment. The resulting average need score can be used to compare levels of need between segments within a corridor and between segments in different corridors.

Step 5: Corridor Needs

In this step, the needs and contributing factors for each performance area are reviewed on a segment-by-segment basis to identify actionable needs and to facilitate the formation of solution sets that address multiple performance areas and contributing factors. The intent of this process is to identify overlapping, common, and contrasting needs to help develop strategic solutions. This step results in the identification of corridor needs by specific location.

3.3 Corridor Needs Assessment

This section documents the results of the needs assessment process described in the prior section. The needs in each performance area were classified as either None, Low, Medium, or High based on how well each segment performed in the existing performance analysis. The needs for each segment were numerically combined to estimate the average level of need for each segment of the corridor

The final needs assessments for each performance measure, along with the scales used in analysis, are shown in **Table 12** through **Table 16**.

Pavement Needs Refinement and Contributing Factors

- Recently completed projects in the corridor did not result in an adjustment to level of need
  See **Appendix D** for detailed information on contributing factors

Table 12: Final Pavement Needs

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Pavement Index	Directional PSR		% Area Failure				
		EB	WB					
64-1	2.88	3.09	3.09	38%	3.00	MP 188-189 MP 198-200 MP 205-212	None	High
64-2	3.60	3.50	3.50	0%	0.00	None	None	None*
64-3	3.69	3.52	3.52	0%	0.00	None	None	None*

Level of Need (Score)	Performance Score Need Scale		Segment Level Need Scale
None* (0)	> 3.30	< 10%	0
Low (1)	3.10 - 3.30	10% - 15%	< 1.5
Medium (2)	2.70 - 3.10	15% - 25%	1.5 - 2.5
High (3)	< 2.90	> 25%	> 2.5

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Bridge Needs Refinement and Contributing Factors

- The only bridge within the corridor does not exhibit potential historical investment issues
- No recently completed bridge projects have occurred on the corridor
- See **Appendix D** for detailed information on contributing factors

Table 13: Final Bridge Needs

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Bridge Index	Sufficiency Rating	% of Deck on Functionally Obsolete Bridges	Lowest Bridge Rating				
64-1	7.00	84.60	0.00%	7.00	0.0	None	None	None*
64-2	No Bridges				None	None	None	None*
64-3	No Bridges				None	None	None	None*

Level of Need (Score)	Performance Score Need Scale				Segment Level Need Scale
None (0)	≥ 6.0	≥ 70	≤ 21.0%	> 5.0	0.0
Low (1)	5.5 - 6.0	60 - 70	21.0% - 31.0%	5.0	< 1.5
Medium (2)	4.5 - 5.5	40 - 60	31.0% - 49.0%	4.0	1.5 - 2.5
High (3)	≤ 4.5	≤ 40	≥ 49.0%	< 4.0	> 2.5

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Mobility Needs Refinement and Contributing Factors

- The Low level of need was adjusted to None due to recently completed mobility projects within Segment 64-3
- See **Appendix D** for detailed information on contributing factors

Table 14: Final Mobility Needs

Segment #	Performance Score and Level of Need											Initial Segment Need	Recently Completed Projects	Final Segment Need
	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent		Directional TTI		Directional PTI		% Bicycle Accommodation			
			EB	WB	EB	WB	EB	WB	EB	WB				
64-1	0.22	0.22	0.21	0.21	0.33	0.03	1.01	1.06	1.27	1.59	5%	0.9	None	Low
64-2	0.28	0.32	0.28	0.26	0.28	0.01	1.02	1.17	2.03	2.57	4%	1.2	None	Low
64-3	0.55	0.65	0.35	0.35	0.20	0.07	1.07	1.16	1.00	2.04	95%	0.2	FY16 H7832: TUSAYAN STREETS PH-II, New Sidewalks, Landscape (MP 235.15-236.10) FY16 H8258: Grand Canyon Airport/FS Road 328, Construct Shoulder Widening (MP 234.24-237.05)	None*

Level of Need (Score)	Performance Score Need Scale					Segment Level Need Scale
None* (0)	≤ 0.77 (Urban) ≤ 0.63 (Rural)	< 0.35	< 1.21[a] < 1.53[b]	< 1.37[a] < 4.00[b]	> 80%	0.0
Low (1)	0.77 - 0.83 (Urban) 0.63 - 0.69 (Rural)	0.35 - 0.49	1.21 - 1.27[a] 1.53 - 1.77[b]	1.37 - 1.43[a] 4.00 - 5.00[b]	70% - 80%	< 1.5
Medium (2)	0.83 - 0.95 (Urban) 0.69 - 0.83 (Rural)	0.49 - 0.75	1.27 - 1.39[a] 1.77 - 2.23[b]	1.43 - 1.57[a] 5.00 - 7.00[b]	50% - 70%	1.5 - 2.5
High (3)	≥ 0.95 (Urban) ≥ 0.83 (Rural)	> 0.75	> 1.39[a] > 2.23[b]	> 1.57[a] > 7.00[b]	< 50%	> 2.5

a: Uninterrupted
b: Interrupted

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Safety Needs Refinements and Contributing Factors

- No adjustments were made between the initial and final needs of safety
- See **Appendix D** for detailed information on contributing factors

Table 15: Final Safety Needs

Segment #	Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Area Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Performance Score and Level of Need	EB	WB								
64-1	0.27	0.45	0.09	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	None	None	None*
64-2	0.36	0.08	0.64	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	None	None	None*
64-3	0.08	0.00	0.16	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	None	FY16 H7832: TUSAYAN STREETS PH-II, New Sidewalks, Landscape (MP 235.15-236.10) FY16 H8258: Grand Canyon Airport/FS Road 328, Construct Shoulder Widening (MP 234.24-237.05)	None*

Level of Need (Score)		Performance Score Needs Scale					Segment Level Need Scale
None* (0)	a	≤ 0.92	≤ 47%	≤ 5%	≤ 19%	≤ 3%	0
	b	≤ 0.93	≤ 45%	≤ 7%	≤ 7%	≤ 6%	
	c	≤ 0.98	≤ 53%	≤ 6%	≤ 22%	≤ 3%	
Low (1)	a	0.92 - 1.07	47% - 50%	5% - 6%	19% - 22%	3% - 4%	≤ 1.5
	b	0.93 - 1.06	45% - 48%	7% - 8%	7% - 8%	6% - 7%	
	c	0.98 - 1.02	53% - 55%	6% - 7%	22% - 25%	3% - 4%	
Medium (2)	a	1.07 - 1.38	50% - 57%	6% - 8%	22% - 29%	4% - 5%	1.5 - 2.5
	b	1.06 - 1.33	48% - 54%	8% - 11%	8% - 10%	7% - 9%	
	c	1.02 - 1.10	55% - 59%	7% - 8%	25% - 30%	4% - 5%	
High (3)	a	≥ 1.38	≥ 57%	≥ 8%	≥ 29%	≥ 5%	≥ 2.5
	b	≥ 1.33	≥ 54%	≥ 11%	≥ 10%	≥ 9%	
	c	≥ 1.10	≥ 59%	≥ 8%	≥ 30%	≥ 5%	

a: 2 or 3 or 4 Lane Divided Highway
b: 4 or 5 Lane Undivided Highway
c: 2 or 3 Lane Undivided Highway

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

#N/A indicates insufficient or no data available to determine level of need

Freight Needs Refinements and Contributing Factors

- No recently completed projects have resulted in an adjusted freight need
- See **Appendix D** for detailed information on contributing factors

Table 16: Final Freight Needs

Segment #	Performance Score and Level of Need								Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Freight Index	Directional TTTI		Directional TPTI		Closure Duration		Bridge Vertical Clearance				
		EB	WB	EB	WB	EB	WB					
64-1	0.42	1.10	1.19	1.54	3.24	264.89	4.46	No UP	3.8	None	None	High
64-2	0.28	1.14	1.30	2.46	4.60	271.39	1.15	No UP	4.1	None	None	High
64-3	0.68	1.03	1.32	1.00	1.96	231.20	8.67	No UP	0.3	None	FY16 H7832: TUSAYAN STREETS PH-II, New Sidewalks, Landscape (MP 235.15-236.10) FY16 H8258: Grand Canyon Airport/FS Road 328, Construct Shoulder Widening (MP 234.24-237.05)	Low

Level of Need (Score)		Performance Score Need Scale					Segment Level Need Scale
None* (0)	a b	≥ 0.74 ≥ 0.28	≤ 1.21 ≤ 1.53	≤ 1.37 ≤ 4.00	≤ 71.07	≥ 16.33	0
Low (1)	a b	0.70 - 0.74 0.22 – 0.28	1.21 - 1.27 1.53 - 1.77	1.37 - 1.43 4.00 - 5.00	71.07 - 97.97	16.17 - 16.33	≤ 1.5
Medium (2)	a b	0.64 - 0.70 0.12 – 0.22	1.27 - 1.39 1.77 - 2.23	1.43 - 1.57 5.00 - 7.00	97.97 - 151.75	15.83 - 16.17	1.5 - 2.5
High (3)	a b	≤ 0.64 ≤ 0.12	≥ 1.39 ≥ 2.23	≥ 1.57 ≥ 7.00	≥ 151.75	≤ 15.83	≥ 2.5

a: Uninterrupted Flow
b: Interrupted Flow

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Segment Review

The needs for each segment were combined to numerically estimate the average level of need for each segment of the corridor. **Table 17** provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Pavement, Mobility, and Safety for the SR 64 corridor). There is one segment with a Medium average need and two segments with a Low average need.

Table 17: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)		
	64-1	64-2	64-3
	MP 185-213	MP 213-234	MP 234-237
Pavement+	High	None*	None*
Bridge	None*	None*	None*
Mobility+	Low	Low	None*
Safety+	None*	None*	None*
Freight	High	High	Low
Average Need	**1.38**	**0.69**	**0.15**

+ Identified as an emphasis area for the SR 64 corridor.

** A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Level of Need	Average Need Range
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

Summary of Corridor

The needs in each performance area are shown in **Figure 21** and summarized below:

Pavement Needs

- Segment 64-1 contains several Pavement hot spots
- Segments 64-2 and 64-3 have final needs of None and Segment 64-1 has a High need

Bridge Needs

- Segment 64-1 includes one bridge
- Segments 64-2 and 64-3 do not include any bridges
- There are no final Bridge needs along the corridor

Mobility Needs

- Low Mobility needs exist on Segments 64-1 and 64-2
- Segment 64-2 contains High directional PTI needs in both directions
- Bicycle accommodation needs are High on Segments 64-1 and 64-2 due shoulder width less than 6' for higher speeds

Safety Needs

- There are no final Safety needs along the corridor
- There is insufficient data related to the Safety top 5 emphasis behavior areas

Freight Needs

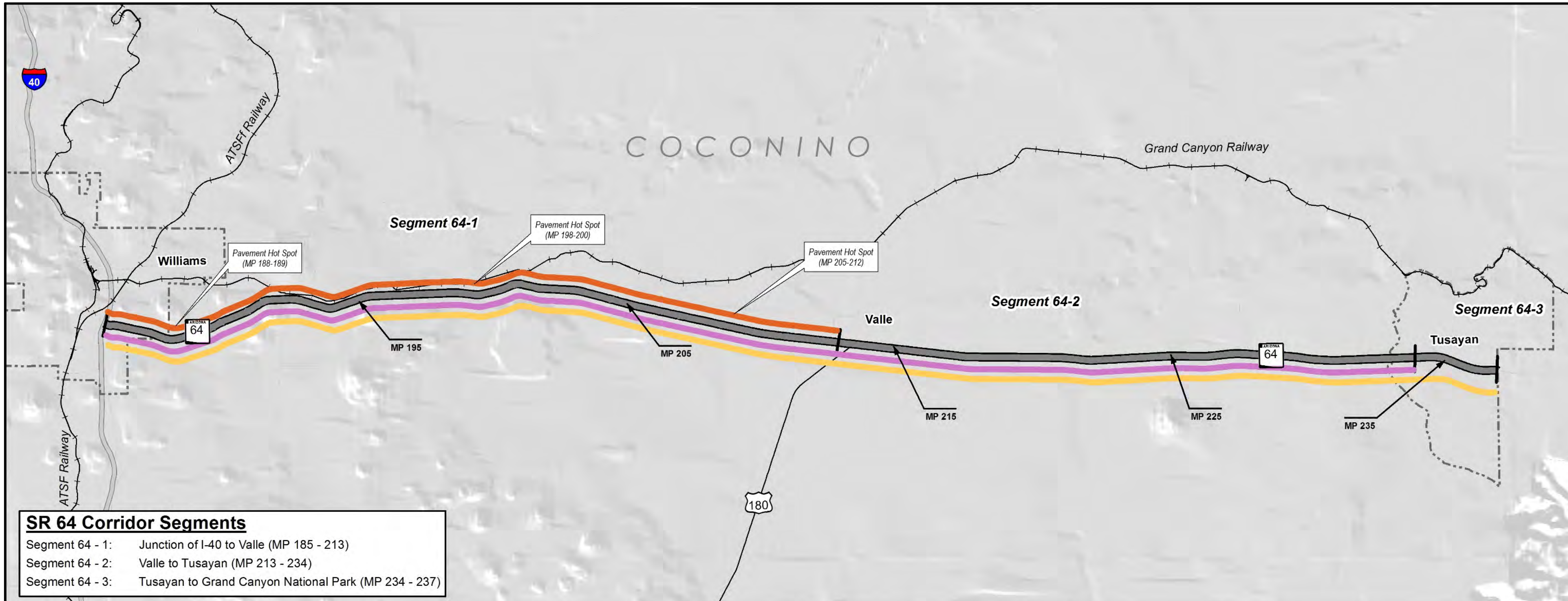
- High Freight needs exist on Segments 64-1 and 64-2
- Many segments along the corridor contain High directional PTI and closure duration needs
- No freight hot spots exist along the corridor

Overlapping Needs

This section identifies overlapping performance needs on the SR 64 corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- Segment 64-1 has the highest average need score of all the segments of the corridor with elevated Needs in the Pavement and Freight performance areas
- Segment 64-2 contains needs in the Mobility and Freight performance areas

Figure 21: Corridor Needs Summary



Performance Area	64-1 MP 185-213	64-2 MP 213-234	64-3 MP 234-237	Performance Area
Pavement+	High	None*	None*	Pavement+
Bridge	None*	None*	None*	Bridge
Mobility+	Low	Low	None*	Mobility+
Safety+	None*	None*	None*	Safety+
Freight	High	High	Low	Freight
Average Need	1.38	0.69	0.15	Average Need

+ *Identified as emphasis area for SR 64 Corridor*

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Corridor Needs Summary

N

Miles
0 1 2 3 4

Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail

State Boundary
County Boundary
City Boundary

Performance Area Needs
Safety
Pavement
Freight
Mobility
Bridge

Level of Need	Average Need Range
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

4.0 STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need (i.e., Medium or High). Addressing areas of Medium or High need will have the greatest effect on corridor performance and are the focus of the strategic solutions. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The SR 64 strategic investment areas (resulting from the elevated needs) are shown in **Figure 22**.

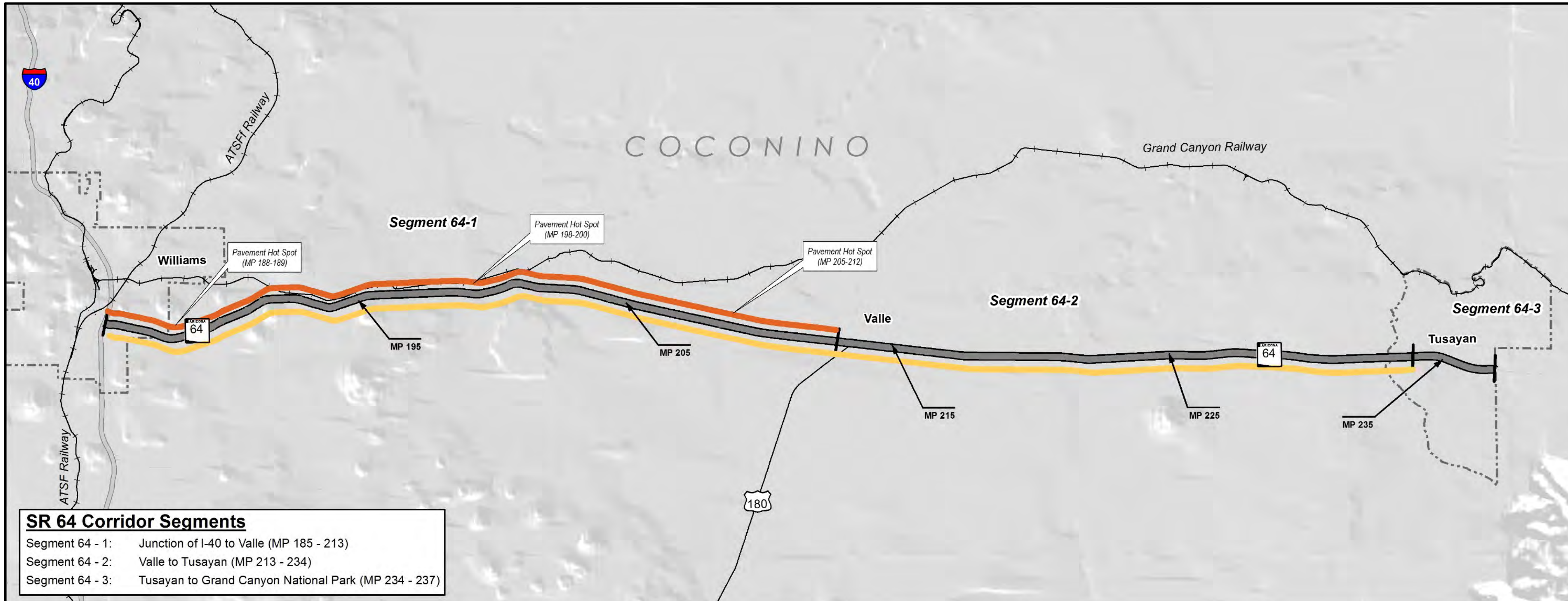
4.1 Screening Process

This section examines qualifying strategic needs and determines if the needs in those locations require action. In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures, including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment or rating issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Table 18 notes if each potential strategic need advanced to solution development, and if not, the reason for screening the potential strategic need out of the process. Locations advancing to solutions development are marked with Yes (Y); locations not advancing are marked with No (N) and highlighted. This screening table provides specific information about the needs in each segment that will be considered for strategic investment. The table identifies the level of need – either Medium or High segment needs, or segments without Medium or High level of need that have a hot spot. Each area of need is assigned a location number in the screening table to help document and track locations considered for strategic investment.

Figure 22: Strategic Investment Areas



Performance Area	64-1	64-2	64-3	Performance Area
	MP 185-213	MP 213-234	MP 234-237	
Pavement+	High	-	-	Pavement+
Bridge	-	-	-	Bridge
Mobility+	-	-	-	Mobility+
Safety+	-	-	-	Safety+
Freight	High	High	-	Freight

+ Identified as emphasis area for SR 64 Corridor

Note: Figure shows strategic investment areas, which are segments with Medium and High levels of need and locations of hotspots. A "-" symbol indicates a segment level of need of Low, None, or N/A, which is not considered strategic

SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park

Strategic Investment Areas

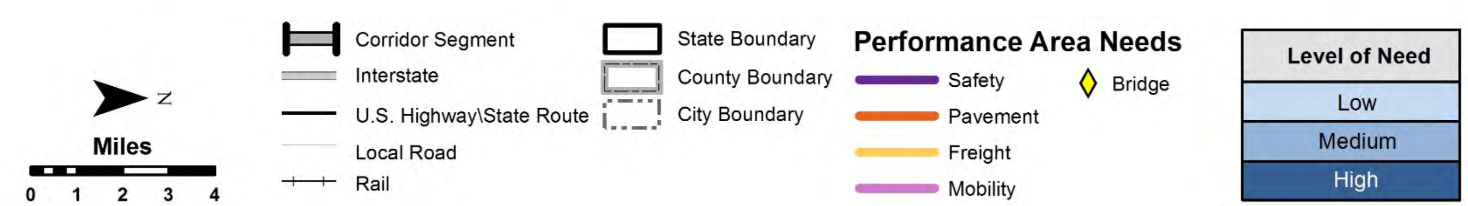


Table 18: Strategic Investment Area Screening

Segment # and MP	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
64-1 (MP 185-213)	High	-	-	-	High	L1	Pavement	Hot spots in both directions at MP 188-189, MP 198-200, and MP 205-212 (High IRI and Excessive Cracking)	N	A low level of historical investment has occurred on Segment 64-1 according to PeCOS data and recent preservation projects. There is one pavement preservation project currently programmed for a portion of this segment from MP 205-213. A pavement preservation project from MP 185.46-MP 205 has been scoped but not yet programmed.
						L2	Freight	Congestion/delay related to trucks, with high PTI in both directions, combined with a few very long closure durations	Y	No programmed projects to address freight need.
64-2 (MP 213-234)	-	-	-	-	High	L3	Freight	Congestion/delay related to trucks, with high PTI in both directions, combined with a few very long closure durations	Y	No programmed projects to address freight need.
64-3 (MP 234-237)	-	-	-	-	-	No Strategic Needs Identified				

Legend: [shaded] Strategic investment area screened out from further consideration

4.2 Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 64 corridor will be considered along with other candidate projects in the ADOT statewide programming process.

Characteristics of Strategic Solutions
Candidate solutions should include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate Solutions
A set of 2 candidate solutions are proposed to address the identified needs on the SR 64 corridor.

Table 19 identifies each strategic location that has been assigned a candidate solution with a number (e.g., CS64.1 and CS64.2). Each candidate solution is comprised of one or more components to address the identified needs. The assigned candidate solution numbers are linked to the location number and provide tracking capability through the rest of the process. The locations of proposed solutions are shown on the map in **Figure 23**.

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance area will include two options: rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

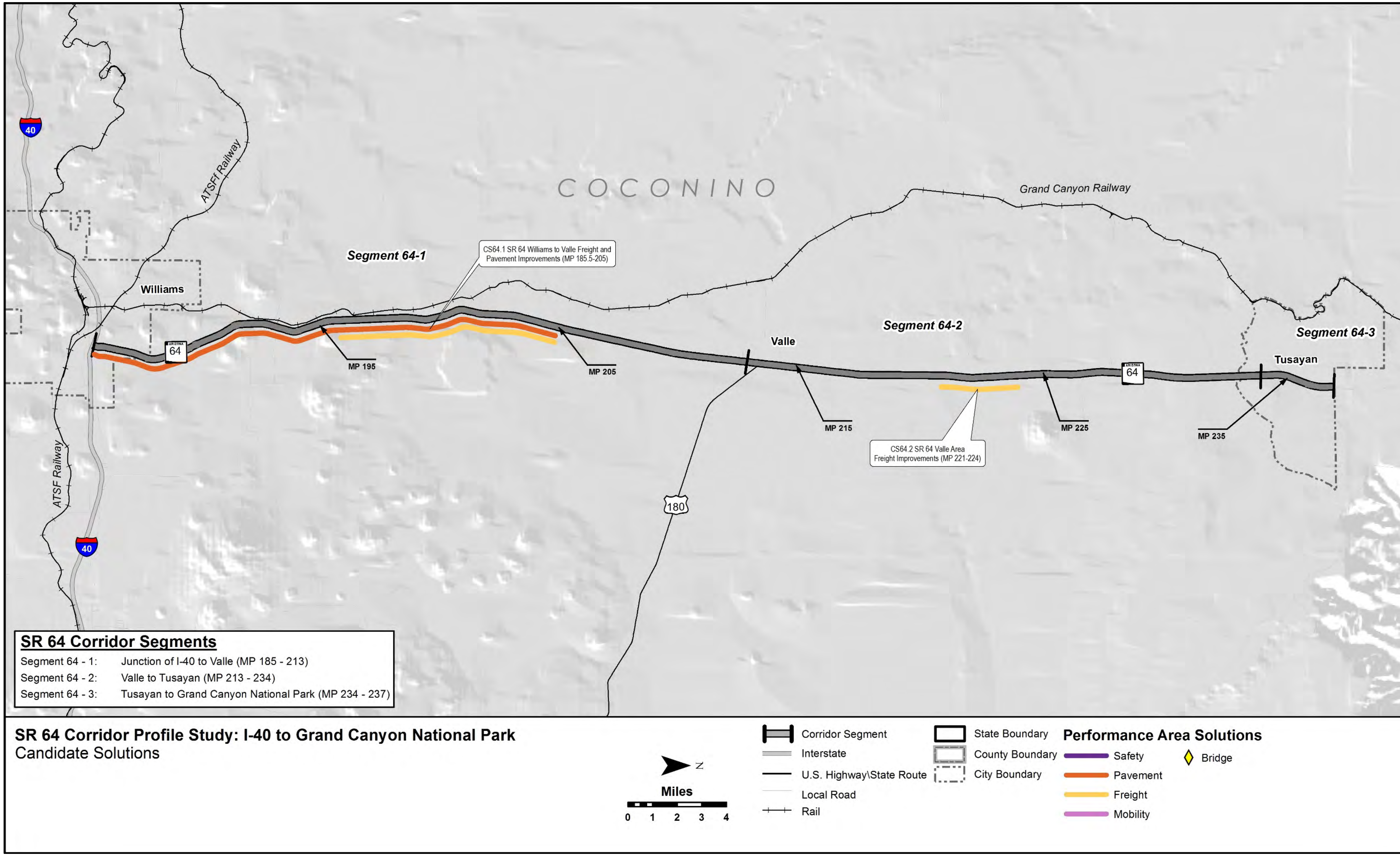
Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Table 19: Candidate Solutions

Candidate Solution #	Segment #	Location #	Beginning Milepost	Ending Milepost	Candidate Solution Name	Option*	Candidate Solution Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS64.1	64-1	L2	185.5	205	Williams to Valle Freight and Pavement Improvements	-	• Construct EB climbing lanes, MP 196-198 and MP 203-205 • Construct WB climbing lane, MP 200-202 • Pavement Preservation EB and WB, MP 185.5 - 205	P, M
CS64.2	64-2	L3	221	224	Valle Area Freight Improvements	-	• Construct EB climbing lane, MP 223-224 • Construct WB climbing lane, MP 221-222	M

* '-': Indicates only one solution is being proposed and no options are being considered

Figure 23: Candidate Solutions



5.0 SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation are shown in **Figure 24** and described more fully below.

Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

When multiple independent candidate solutions are developed for Mobility, Safety, or Freight strategic investment areas, these candidate solution options advance directly to the Performance Effectiveness Evaluation without an LCCA.

Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

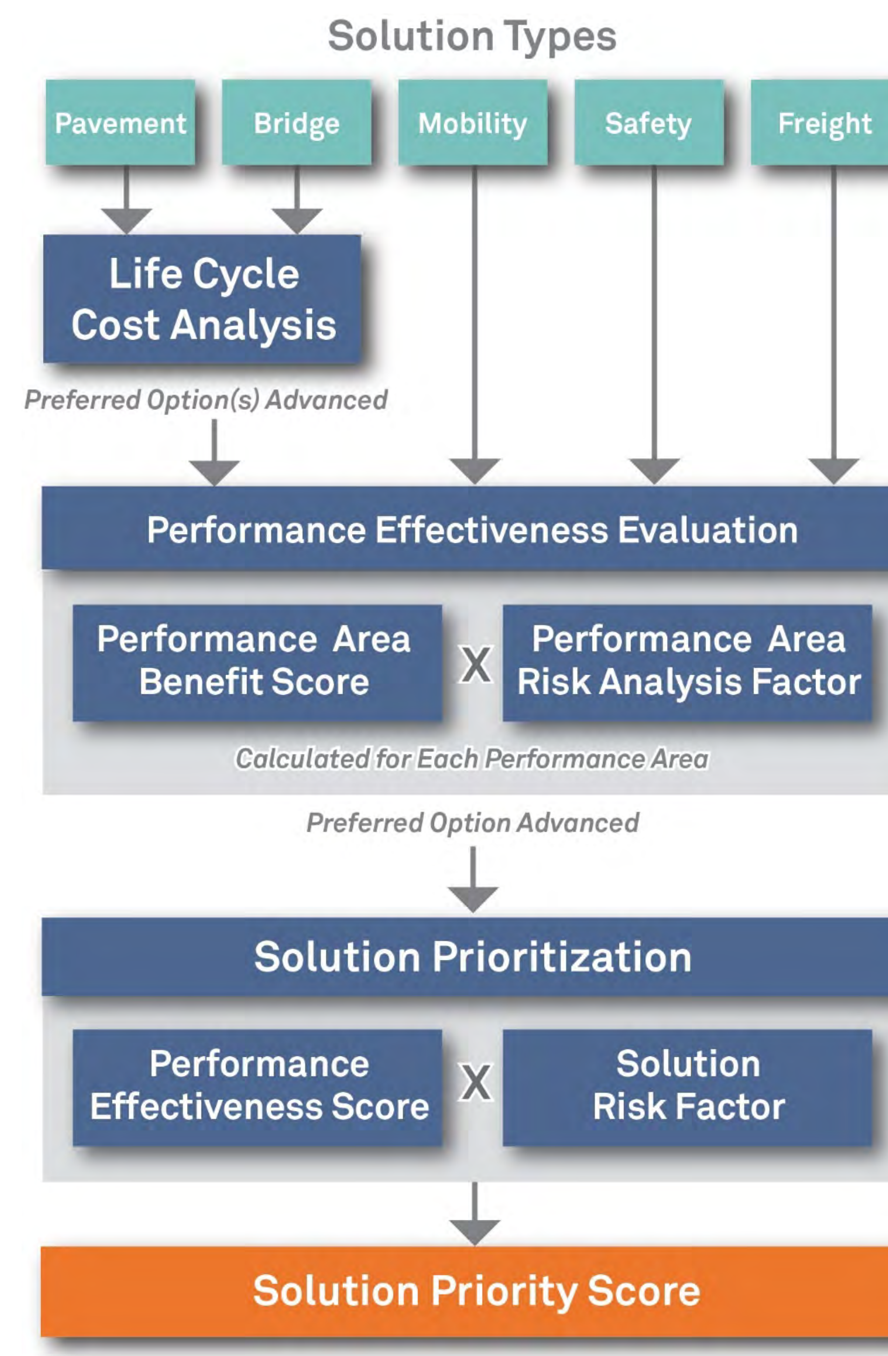
Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure.

Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure 24: Candidate Solution Evaluation Process



5.1 Life-Cycle Cost Analysis

LCCA is conducted for any candidate solution that is developed as a result of a need in the Pavement or Bridge performance area. The intent of the LCCA is to determine which options warrant further investigation and eliminate options that would not be considered strategic.

LCCA is an economic analysis that compares cost streams over time and presents the results in a common measure, the present value of all future costs. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For both bridge and pavement LCCA, the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping the bridge or pavement serviceable over a long period of time.

LCCA is performed to provide a more complete holistic perspective on asset performance and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short-term costs, which often dominate the considerations in transportation investment decision making and programming.

Bridge LCCA

For the bridge LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected bridges, as described below:

- Bridge replacement (large upfront cost but small ongoing costs afterwards)
- Bridge rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- On-going repairs until replacement (low upfront and ongoing costs until replacement)

The bridge LCCA model developed for the CPS reviews the characteristics of the candidate bridges including bridge ratings and deterioration rates to develop the three improvement strategies (full replacement, rehabilitation until replacement, and repair until replacement). Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length-to-span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance. The following assumptions are included in the bridge LCCA model:

- The bridge LCCA only addresses the structural condition of the bridge and does not address other issues or costs
- The bridge will require replacement at the end of its 75-year service life regardless of current condition
- The bridge elevation, pier height, skew angle, and length-to-span ratio can affect the replacement and rehabilitation costs
- The current and historical ratings are used to estimate a rate of deterioration for each candidate bridge
- Following bridge replacement, repairs will be needed every 20 years
- Different bridge repair and rehabilitation strategies have different costs, expected service life, and benefit to the bridge rating
- The net present value of future costs is discounted at 3% and all dollar amounts are in 2015 dollars
- If the LCCA evaluation recommends rehabilitation or repair, the solution is not considered strategic and the rehabilitation or repair will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% should be considered equally; in such a case, the solution should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 19**, LCCA was not conducted for any bridges on the SR 64 Corridor. This is reflected in **Table 20**. Additional information regarding the bridge LCCA is included in **Appendix E**.

Pavement LCCA

The LCCA approach to pavement is very similar to the process used for bridges. For the pavement LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected pavement, as described below:

- Pavement replacement (large upfront cost but small ongoing costs afterwards – could be replacement with asphalt or concrete pavement)
- Pavement major rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- Pavement minor rehabilitation until replacement (low upfront and ongoing costs until replacement)

The pavement LCCA model developed for the CPS reviews the characteristics of the candidate paving locations including the historical rehabilitation frequency to develop potential improvement strategies (full replacement, major rehabilitation until replacement, and minor rehabilitation until replacement, for either concrete or asphalt, as applicable). Each strategy consists of a set of corrective actions that contribute to keeping the pavement serviceable over the analysis period. The following assumptions are included in the pavement LCCA model:

- The pavement LCCA only addresses the condition of the pavement and does not address other issues or costs
- The historical pavement rehabilitation frequencies at each location are used to estimate future rehabilitation frequencies
- Different pavement replacement and rehabilitation strategies have different costs and expected service life

- The net present value of future costs is discounted at 3% and all dollar amounts are in 2015 dollars
- If the LCCA evaluation recommends rehabilitation or repair, the solution is not considered strategic and the rehabilitation will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% should be considered equally; in such a case, the solution should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 19**, LCCA was not conducted for any pavement solutions on the SR 64 Corridor. This is reflected in **Table 21**. Additional information regarding the pavement LCCA is contained in **Appendix E**.

Table 20: Bridge Life-Cycle Cost Analysis Results

Candidate Solution	Present Value at 3% Discount Rate ($)			Ratio of Present Value Compared to Lowest Present Value			Other Needs	Results
	Replace	Rehab	Repair	Replace	Rehab	Repair		
No LCCA conducted for any bridge candidate solutions on the SR 64 Corridor.								

Table 21: Pavement Life-Cycle Cost Analysis Results

Candidate Solution	Present Value at 3% Discount Rate ($)				Ratio of Present Value Compared to Lowest Present Value				Other Needs	Results
	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation		
No LCCA conducted for any pavement candidate solutions on the SR 64 Corridor.										

5.2 Performance Effectiveness Evaluation

The results of the Performance Effectiveness Evaluation are combined with the results of a Performance Area Risk Analysis to determine a Performance Effectiveness Score (PES). The objectives of the Performance Effectiveness Evaluation include:

- Measure the benefit to the performance system versus the cost of the solution
- Include risk factors to help differentiate between similar solutions
- Apply to each performance area that is affected by the candidate solution
- Account for emphasis areas identified for the corridor

The Performance Effectiveness Evaluation includes the following steps:

- Estimate the post-solution performance for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight)
- Use the post-solution performance scores to calculate a post-solution level of need for each of the five performance areas
- Compare the pre-solution level of need to the post-solution level of need to determine the reduction in level of need (potential solution benefit) for each of the five performance areas
- Calculate performance area risk weighting factors for each of the five performance areas
- Use the reduction in level of need (benefit) and risk weighting factors to calculate the PES

Post-Solution Performance Estimation

For each performance area, a slightly different approach is used to estimate the post-solution performance. This process is based on the following assumptions:

- Pavement:
  - The IRI rating would decrease (to 30 for replacement or 45 for rehabilitation)
  - The Cracking rating would decrease (to 0 for replacement or rehabilitation)
- Bridge:
  - The structural ratings would increase (+1 for repair, +2 for rehabilitation, or increase to 8 for replacement)
  - The Sufficiency Rating would increase (+10 for repair, +20 for rehabilitation, or increase to 98 for replacement)
- Mobility:
  - Additional lanes would increase the capacity and therefore affect the Mobility Index and associated secondary measures
  - Other improvements (e.g., ramp metering, parallel ramps, variable speed limits) would also increase the capacity (to a lesser extent than additional lanes) and therefore would affect the Mobility Index and associated secondary measures
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the TTI secondary measure
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the PTI secondary measure
  - Changes in the Safety Index (due to crash reductions) would have a direct effect on the Closure Extent secondary measure
- Safety:
  - Crash modification factors were developed that would be applied to estimate the reduction in crashes (for additional information see **Appendix F**)
- Freight:
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the Freight Index and the TPTI secondary measure
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the TTTI secondary measure
  - Changes in the Safety Index (due to crash reductions) would have a direct effect on the Closure Duration secondary measure

Performance Area Risk Analysis

The Performance Area Risk Analysis is intended to develop a numeric risk weighting factor for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight). This risk analysis addresses other considerations for each performance area that are not directly included in the performance system. A risk weighting factor is calculated for each candidate solution based on the specific characteristics at the solution location. For example, the Pavement Risk Factor is based on factors such as the elevation, daily traffic volumes, and amount of truck traffic. Additional information regarding the Performance Area Risk Factors is included in **Appendix G**.

Following the calculation of the reduction in level of need (benefit) and the Performance Area Risk Factors, these values are used to calculate the PES. In addition, the reduction in level of need in each emphasis area is also included in the PES.

Net Present Value Factor

The benefit (reduction in need) is measured as a one-time benefit. However, different types of solutions will have varying service lives during which the benefits will be obtained. For example, a preservation solution would likely have a shorter stream of benefits over time when compared to a modernization or expansion solution. To address the varying lengths of benefit streams, each solution is classified as a 10-year, 20-year, 30-year, or 75-year benefit stream, or the net present value (NPV) factor (F_{NPV}). A 3% discount rate is used to calculate F_{NPV} for each classification of solution. The service lives and respective factors are described below:

- A 10-year service life is generally reflective of preservation solutions such as pavement and bridge preservation; these solutions would likely have a 10-year stream of benefits; for these solutions, a F_{NPV} of 8.8 is used in the PES calculation

- A 20-year service life is generally reflective of modernization solutions that do not include new infrastructure; these solutions would likely have a 20-year stream of benefits; for these solutions, a F_{NPV} of 15.3 is used in the PES calculation
- A 30-year service life is generally reflective of expansion solutions or modernization solutions that include new infrastructure; these solutions would likely have a 30-year stream of benefits; for these solutions, a F_{NPV} of 20.2 is used in the PES calculation
- A 75-year service life is used for bridge replacement solutions; these solutions would likely have a 75-year stream of benefits; for these solutions, a F_{NPV} of 30.6 is used in the PES calculation

Vehicle-Miles Travelled Factor

Another factor in assessing benefits is the number of travelers who would benefit from the implementation of the candidate solution. This factor varies between candidate solutions depending on the length of the solution and the magnitude of daily traffic volumes. Multiplying the solution length by the daily traffic volume results in vehicle-miles travelled (VMT), which provides a measure of the amount of traffic exposure that would receive the benefit of the proposed solution. The VMT is converted to a VMT factor (known as F_{VMT}), which is on a scale between 0 and 5, using the equation below:

$$F_{VMT} = 5 - (5 \times e^{VMT \times -0.0000139})$$

Performance Effectiveness Score

The PES is calculated using the following equation:

PES = ((Sum of all Risk Factored Benefit Scores + Sum of all Risk Factored Emphasis Area Scores) / Cost) x F_{VMT} x F_{NPV}

Where:

Risk Factored Benefit Score = Reduction in Segment-Level Need (benefit) x Performance Area Risk Weighting Factor (calculated for each performance area)

Risk Factored Emphasis Area Score = Reduction in Corridor-Level Need x Performance Area Risk Factors x Emphasis Area Factor (calculated for each emphasis area)

*Cost = estimated cost of candidate solution in millions of dollars (see **Appendix H**)*

F_{VMT} = Factor between 0 and 5 to account for VMT at location of candidate solution based on existing (2014) daily volume and length of solution

F_{NPV} = Factor (ranging from 8.8 to 30.6 as previously described) to address anticipated longevity of service life (and duration of benefits) for each candidate solution

The resulting PES values are shown in **Table 22**. Additional information regarding the calculation of the PES is contained in **Appendix I**.

For candidate solutions with multiple options to address Mobility, Safety, or Freight needs, the PES should be compared to help identify the best performing option. If one option clearly performs better than the other options (e.g., more than twice the PES value and a difference in magnitude of at least 20 points), the other options can be eliminated from further consideration. If multiple options have similar PES values, or there are other factors not accounted for in the performance system that could significantly influence the ultimate selection of an option (e.g., potential environmental concerns, potential adverse economic impacts), those options should all be advanced to the prioritization process. On the SR 64 Corridor, none of the candidate solutions have options to address Mobility, Safety, or Freight needs.

Table 22: Performance Effectiveness Scores

Candidate Solution #	Segment #	Option	Candidate Solution Name	Milepost Location	Estimated Cost* (in millions)	Risk Factored Benefit Score					Risk Factored Emphasis Area Scores			Total Factored Benefit Score	F_{VMT}	F_{NPV}	Performance Effectiveness Score
						Pavement	Bridge	Mobility	Safety	Freight	Pavement	Mobility	Safety				
CS64.1	64-1	-	Williams to Valle Freight and Pavement Improvements	185.5-205	$34.8	7.460	0.000	0.276	0.087	0.932	7.342	0.152	0.063	16.313	1.67	15.3	12.0
CS64.2	64-2	-	Valle Area Freight Improvements	221-224	$7.5	0.000	0.000	2.336	0.137	1.686	0.000	0.094	0.073	4.327	0.78	20.2	9.1

*: See Table 24 for total construction costs

5.3 Solution Risk Analysis

Following the calculation of the PES, an additional step is taken to develop the prioritized list of solutions. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure. **Figure 25** shows the risk matrix used to develop the risk weighting factors.

Figure 25: Risk Matrix

Frequency/ Likelihood		Severity/Consequence				
		Insignificant	Minor	Significant	Major	Catastrophic
	Very Rare	Low	Low	Low	Moderate	Major
	Rare	Low	Low	Moderate	Major	Major
	Seldom	Low	Moderate	Moderate	Major	Severe
	Common	Moderate	Moderate	Major	Severe	Severe
	Frequent	Moderate	Major	Severe	Severe	Severe

Using the risk matrix in **Figure 25**, numeric values were assigned to each category of frequency and severity. The higher the risk, the higher the numeric factor that was assigned. The risk weight for each area of the matrix was calculated by multiplying the severity factor times the frequency factor. These numeric factors are shown in **Figure 26**.

Figure 26: Numeric Risk Matrix

Frequency/ Likelihood			Severity/Consequence				
			Insignificant	Minor	Significant	Major	Catastrophic
		Weight	1.00	1.10	1.20	1.30	1.40
	Very Rare	1.00	1.00	1.10	1.20	1.30	1.40
	Rare	1.10	1.10	1.21	1.32	1.43	1.54
	Seldom	1.20	1.20	1.32	1.44	1.56	1.68
	Common	1.30	1.30	1.43	1.56	1.69	1.82
	Frequent	1.40	1.40	1.54	1.68	1.82	1.96

Using the values in **Figure 26**, risk weighting factors were calculated for each of the following four risk categories: low, moderate, major, and severe. These values are simply the average of the values in **Figure 26** that fall within each category. The resulting average risk weighting factors are:

Low	Moderate	Major	Severe
1.14	1.36	1.51	1.78

The risk weighting factors listed above are assigned to the five performance areas as follows:

- Safety = 1.78
    - The Safety performance area quantifies the likelihood of fatal or incapacitating injury crashes; therefore, it is assigned the Severe (1.78) risk weighting factor
- Bridge = 1.51
    - The Bridge performance area focuses on the structural adequacy of bridges; a bridge failure may result in crashes or traffic being detoured for long periods of time resulting in significant travel time increases; therefore, it is assigned the Major (1.51) risk weighting factor
- Mobility and Freight = 1.36
    - The Mobility and Freight performance areas focus on capacity and congestion; failure in either of these performance areas would result in increased travel times but would not have significant effect on safety (crashes) that would not already be addressed in the Safety performance area; therefore, they are assigned the Moderate (1.36) risk weighing factor
- Pavement = 1.14
    - The Pavement performance area focuses on the ride quality of the pavement; failure in this performance area would likely be a spot location that would not dramatically affect drivers beyond what is already captured in the Safety performance area; therefore, it is assigned the Low (1.14) risk weighting factor

The benefit in each performance area is calculated for each candidate solution as part of the Performance Effectiveness Evaluation. Using this information on benefits and the risk factors listed above, a weighted (based on benefit) solution-level numeric risk factor is calculated for each candidate solution. For example, a solution that has 50% of its benefit in Safety and 50% of its benefit in Mobility has a weighted risk factor of 1.57 (0.50 x 1.36 + 0.50 x 1.78 = 1.57).

5.4 Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score as follows:

Prioritization Score = PES x Weighted Risk Factor x Segment Average Need Score

Where:

*PES = Performance Effectiveness Score as shown in **Table 22***

Weighted Risk Factor = Weighted factor to address risk of not implementing a solution based on the likelihood and severity of the performance failure

*Segment Average Need Score = Segment average need score as shown in **Table 17***

Table 23 shows the prioritization scores for the candidate solutions subjected to the solution evaluation and prioritization process. Solutions that address multiple performance areas tend to score higher in this process. A prioritized list of candidate solutions is provided in the subsequent section. See **Appendix J** for additional information on the prioritization process.

Table 23: Prioritization Scores

Candidate Solution #	Segment #	Option	Candidate Solution Name	Milepost Location	Estimated Cost (in millions)	Performance Effectiveness Score	Weighted Risk Factor	Segment Average Need Score	Prioritization Score	Percentage by which Solution Reduces Performance Area Segment Needs				
										Pavement	Bridge	Mobility	Safety	Freight
CS64.1	64-1	-	Williams to Valle Freight and Pavement Improvements	185.5-205	$34.8	12.0	1.164	1.38	**19**	86.5%	0.0%	16.4%	2.2%	2.3%
CS64.2	64-2	-	Valle Area Freight Improvements	221-224	$7.5	9.1	1.380	0.69	**9**	0.0%	0.0%	19.1%	10.9%	2.9%

6.0 SUMMARY OF CORRIDOR RECOMMENDATIONS

6.1 Prioritized Candidate Solution Recommendations

Table 24 and **Figure 27** show the prioritized candidate solutions recommended for the SR 64 corridor in ranked order of priority. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Implementation of these solutions is anticipated to improve performance of the SR 64 corridor. The following observations were noted about the prioritized solutions:

- Most of the anticipated improvements in performance are in the Freight performance areas
- The highest priority solutions address needs in the Williams to Valle Area (MP 185-205) along SR 64

6.2 Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor-specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the SR 64 corridor:

- Project P9100 07P, proposed in an ADOT Scoping Letter in January 2017, is a pavement preservation project on the SR 64 Corridor with proposed project limits beginning at MP 185.46 and ending at MP 205. This proposed project added the pavement preservation item from MP 185.5-205 to the scope of CS64.1
- Conduct future wildlife mitigation studies to address and reduce the high number of animal crashes on the SR 64 Corridor. According to data used for this study, animal-vehicle collisions (not resulting in fatal or incapacitating crashes) are concentrated in the following locations:
  - Eastbound: MP 186-196, MP 204-210, MP 211-213, MP 218-237
  - Westbound: MP 186-194, MP 196-199, MP 219, MP 222-223, MP 224-237

6.3 Policy and Initiative Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through this process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the SR 64 corridor, but across the entire state highway system where the conditions are applicable. The following list, which is in no particular order of priority, was derived from the four CPS rounds:

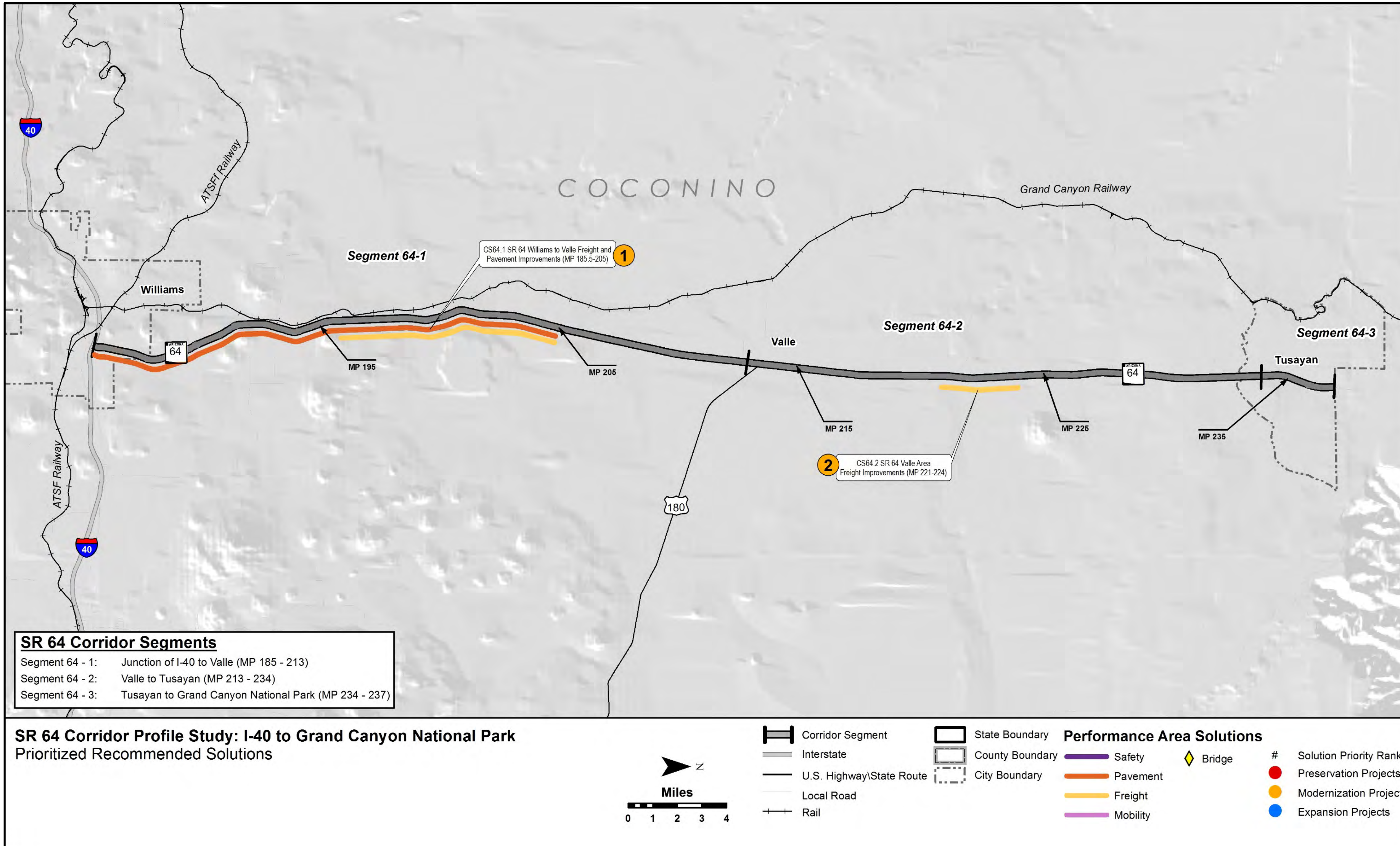
- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic message signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is required to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network
- At traffic interchanges with existing communication connectivity to the ADOT TOC, consideration should be given to adding thermal detection cameras for vehicle detection with the capability for wrong way vehicle detection
- Improved vehicle detection systems, as recommended by ADOT Systems Technology group, should be deployed at traffic interchanges for improved traffic control

Table 24: Prioritized Recommended Solutions

Rank	Candidate Solution #	Option	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS64.1	-	Williams to Valle Freight and Pavement Improvements (SR 64 MP 185.5-205)	• Construct EB climbing lanes, MP 196-198 and MP 203-205 • Construct WB climbing lane, MP 200-202 • Pavement Preservation EB and WB, MP 185.5 - 205	$34.8	P, M	**19**
2	CS64.2	-	Valle Area Freight Improvements (SR 64 MP 221-224)	• Construct EB climbing lane, MP 223-224 • Construct WB climbing lane, MP 221-222	$7.5	M	**9**

* '-': Indicates only one solution is being proposed and no options are being considered

Figure 27: Prioritized Recommended Solutions

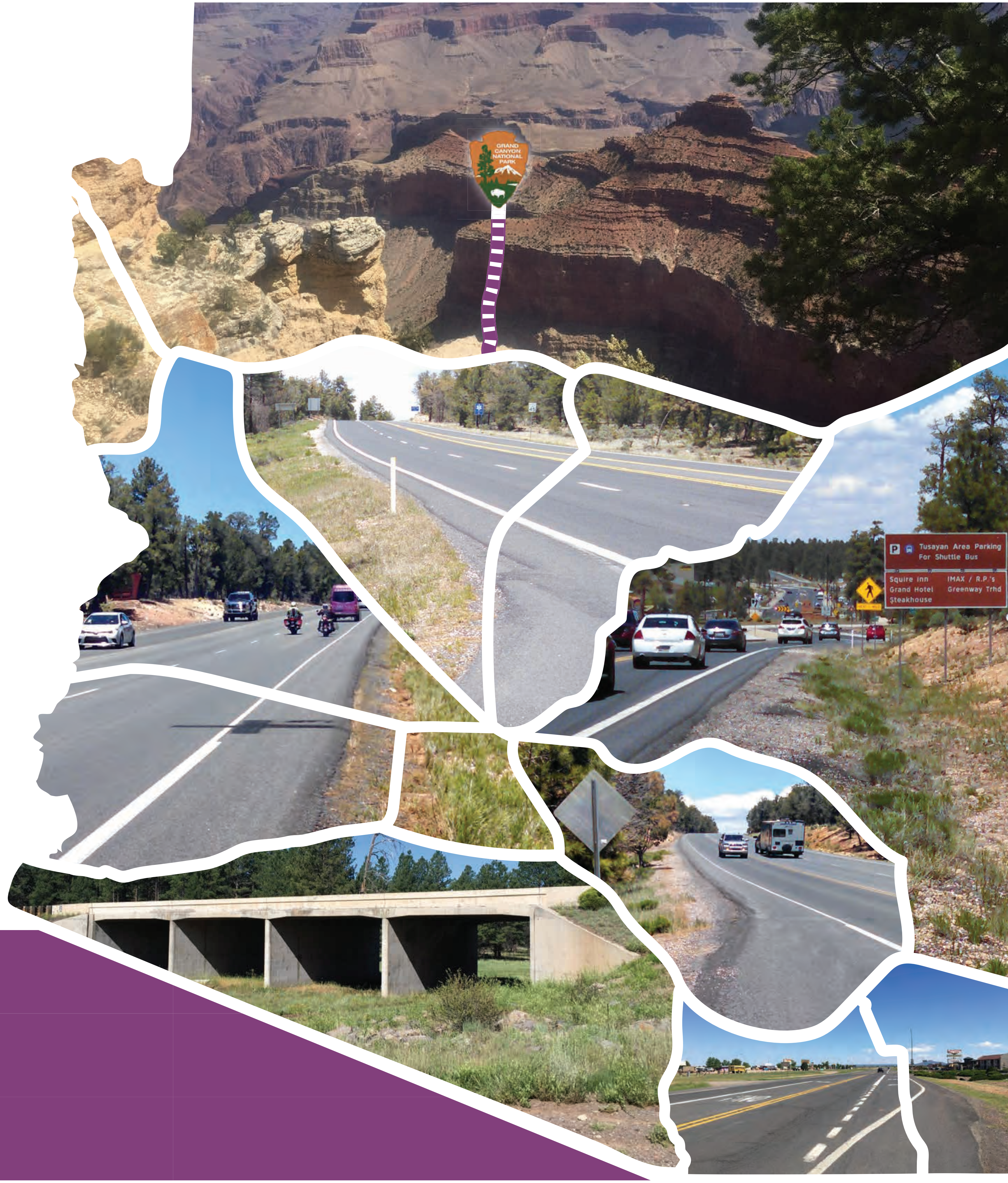


6.4 Next Steps

The candidate solutions recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the SR 64 corridor will be considered along with other candidate projects in the ADOT statewide programming process.

It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

Upon completion of all four CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.



Appendices

Appendices

Appendix A: Corridor Performance Maps

This appendix contains maps of each primary and secondary measure associated with the five performance areas for the SR 64 corridor. The following are the areas and maps included:

Pavement Performance Area:

- Pavement Index and Hot Spots
- Pavement Serviceability and Hot Spots (directional)
- Percentage of Pavement Area Failure

Bridge Performance Area:

- Bridge Index and Hot Spots
- Bridge Sufficiency
- Percent of Deck Area on Functionally Obsolete Bridges
- Lowest Bridge Rating

Mobility Performance Area:

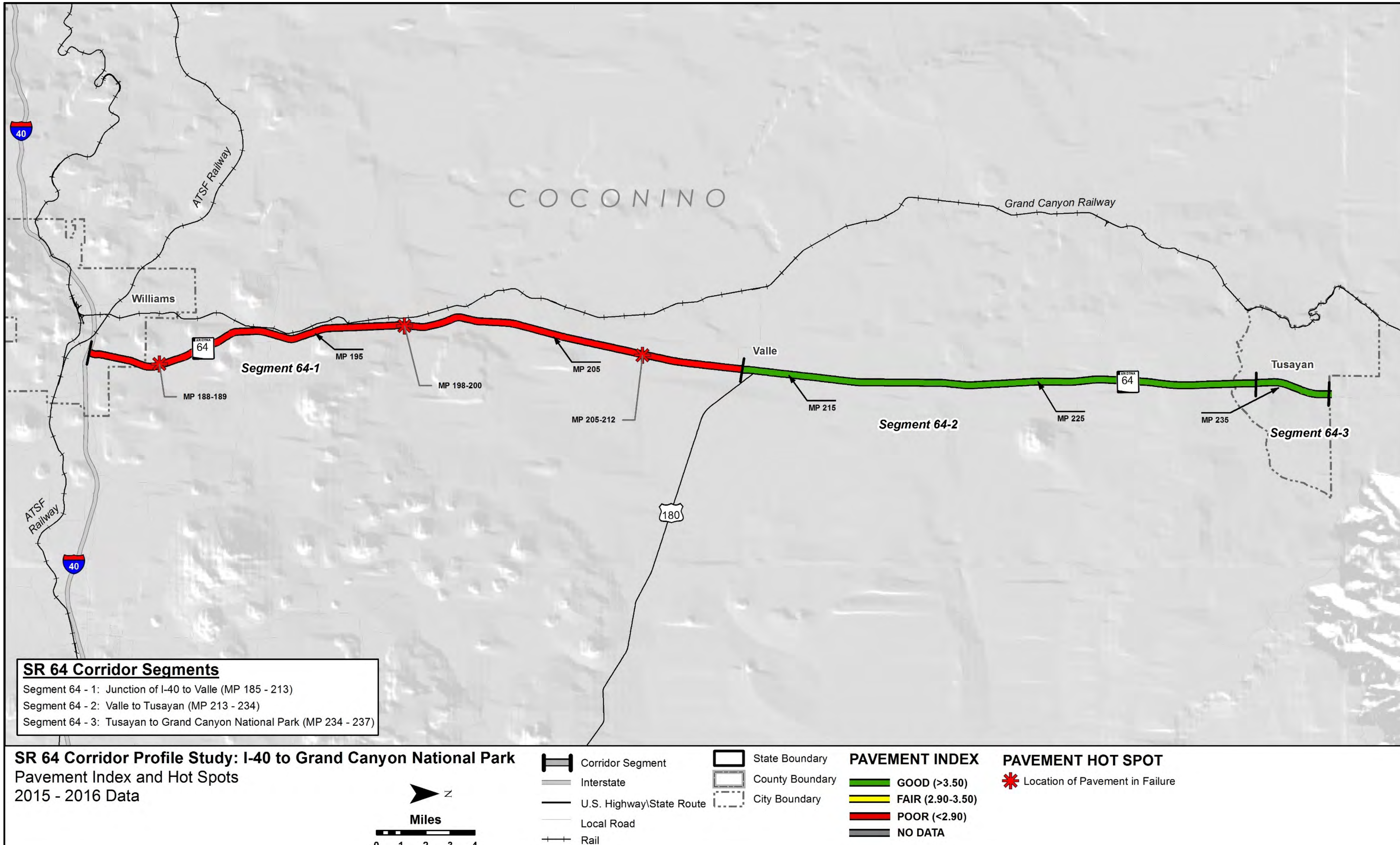
- Mobility Index
- Future Daily V/C
- Existing Peak Hour V/C (directional)
- Closure Frequency (directional)
- Travel Time Index (directional)
- Planning Time Index (directional)
- Multimodal Opportunities
- Percentage of Bicycle Accommodation

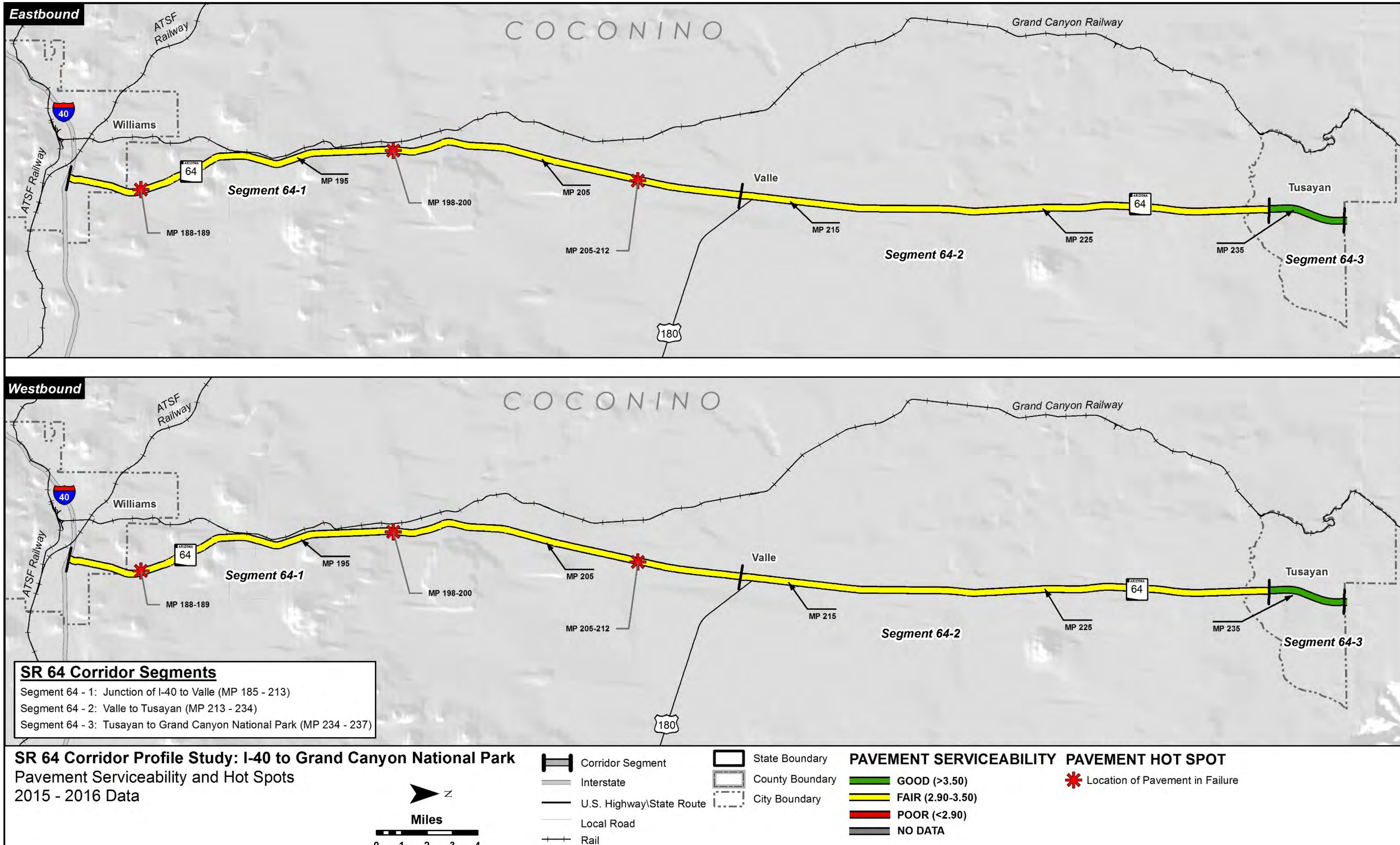
Safety Performance Area:

- Safety Index and Hot Spots
- Safety Index and Hot Spots (directional)
- Relative Frequency of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors Compared to the Statewide Average for Similar Segments (insufficient data – not included)
- Relative Frequency of Fatal + Incapacitating Injury Crashes Involving Motorcycles Compared to the Statewide Average for Similar Segments (insufficient data – not included)
- Relative Frequency of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers Compared to the Statewide Average for Similar Segments (insufficient data – not included)

Freight Performance Area:

- Freight Index and Hot Spots
- Truck Travel Time Index (directional)
- Truck Planning Time Index (directional)
- Closure Duration (directional)
- Bridge Vertical Clearance


COCONINO
Grand Canyon Railway
ATSF Railway
Williams
Valle
Tusayan
Segment 64-1
Segment 64-2
Segment 64-3
MP 188-189
MP 195
MP 198-200
MP 205
MP 205-212
MP 215
MP 225
MP 235
64
40
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Pavement Index and Hot Spots
2015 - 2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
PAVEMENT INDEX
GOOD (>3.50)
FAIR (2.90-3.50)
POOR (<2.90)
NO DATA
PAVEMENT HOT SPOT
Location of Pavement in Failure


Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 188-189
MP 195
MP 198-200
MP 205
MP 205-212
Valle
180
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
Westbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
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64
Segment 64-1
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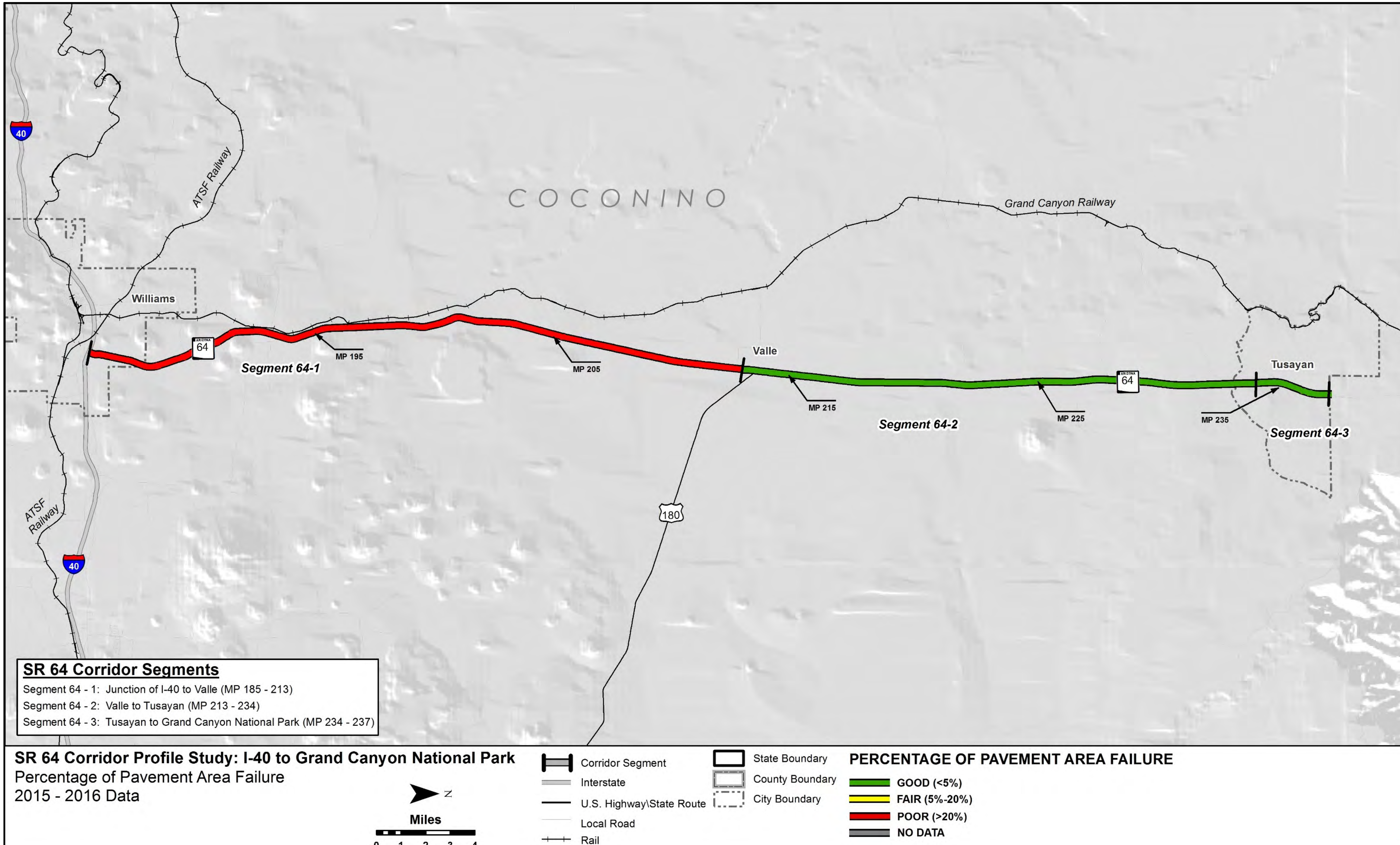
Pavement Serviceability and Hot Spots
2015 - 2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
PAVEMENT SERVICEABILITY
GOOD (>3.50)
FAIR (2.90-3.50)
POOR (<2.90)
NO DATA
PAVEMENT HOT SPOT
Location of Pavement in Failure


COCONINO
Grand Canyon Railway
ATSF Railway
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64
180
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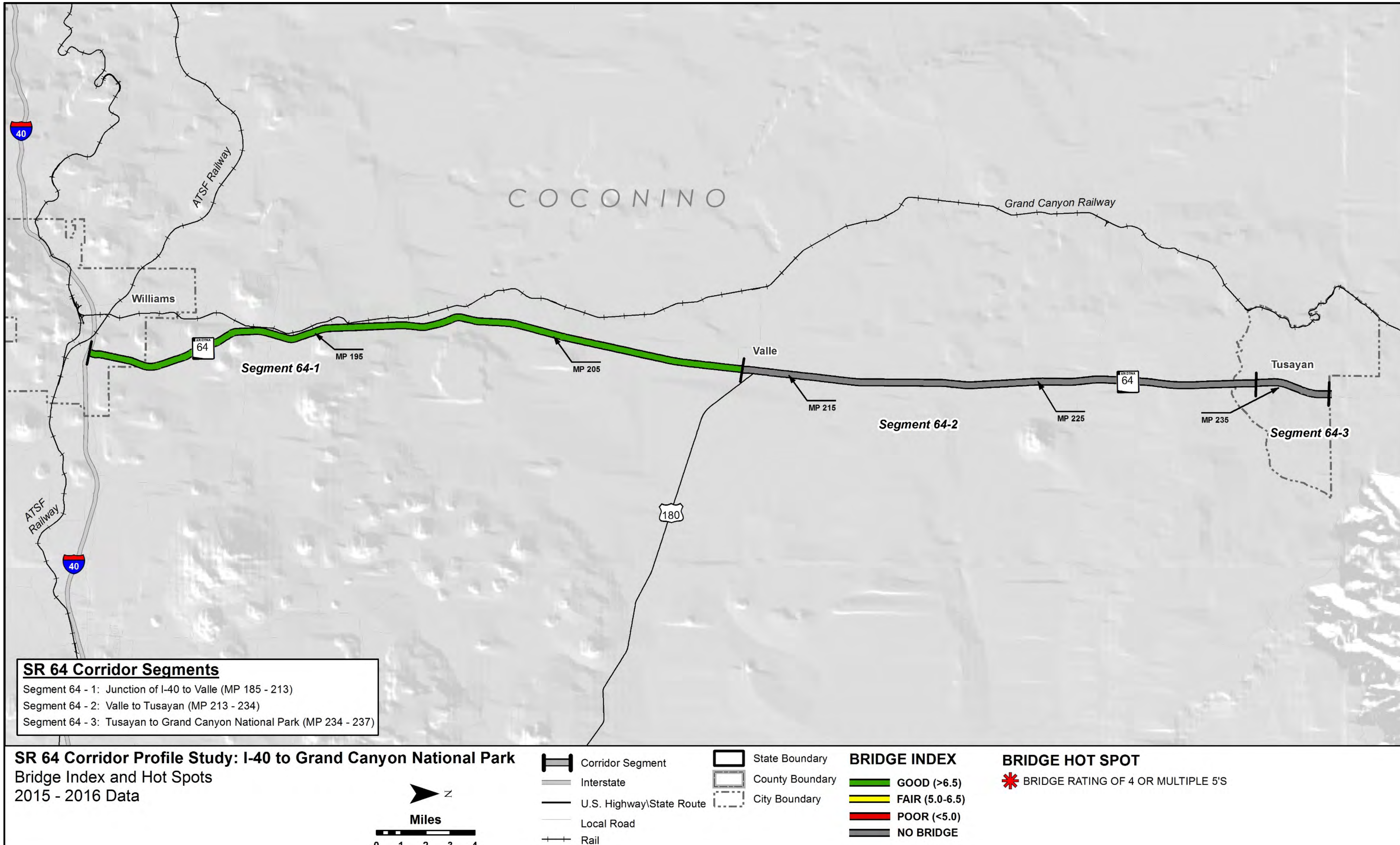
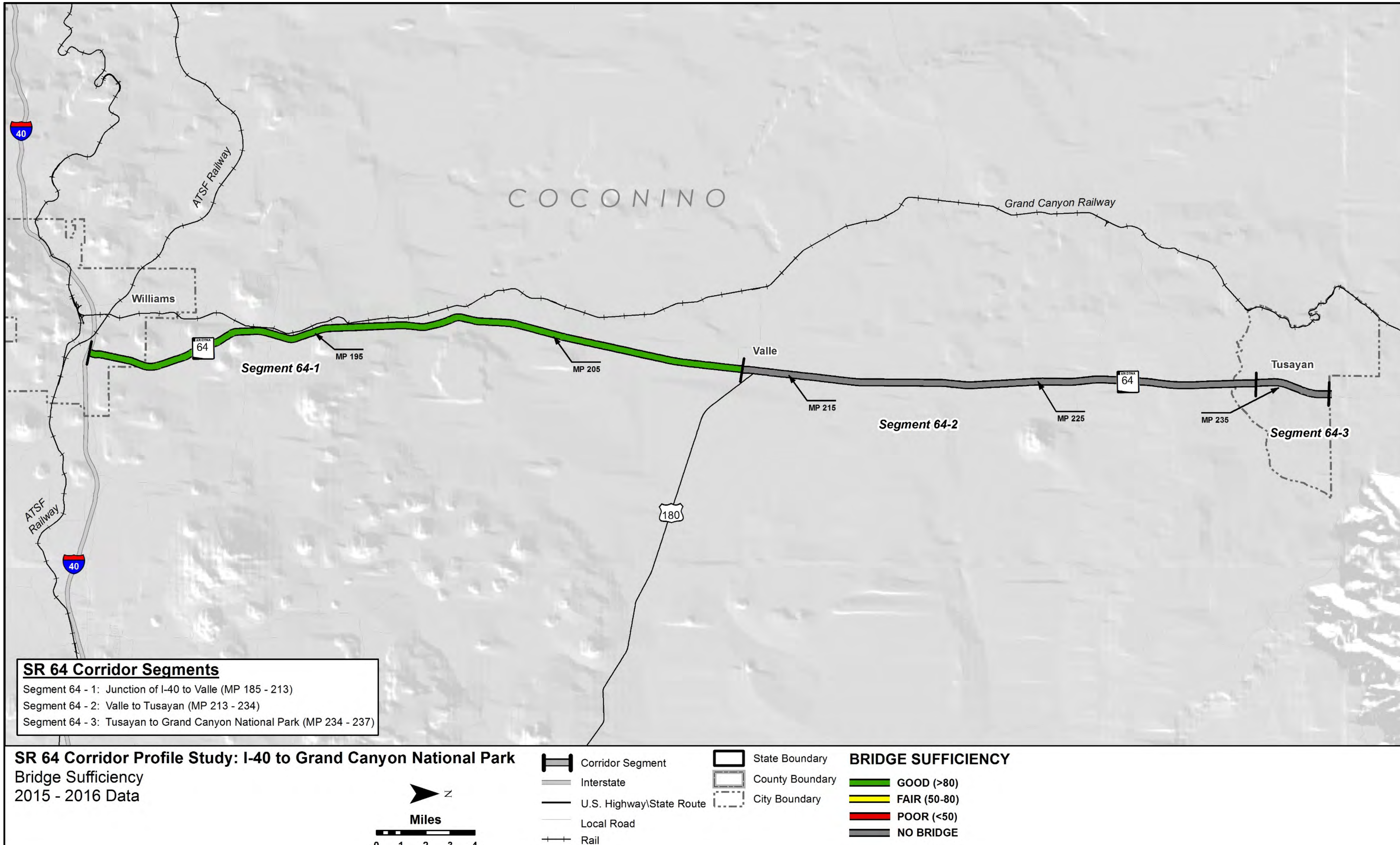
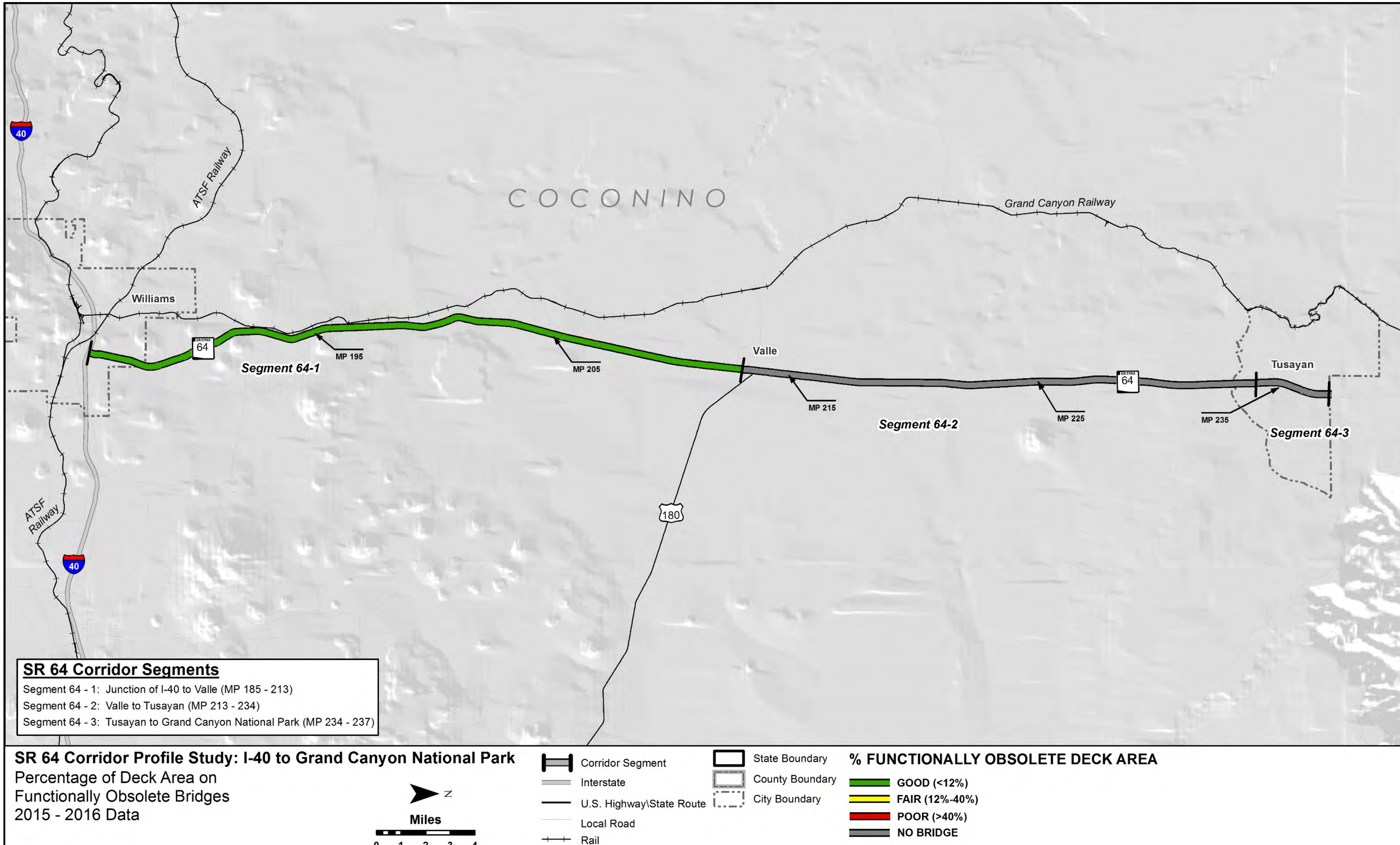
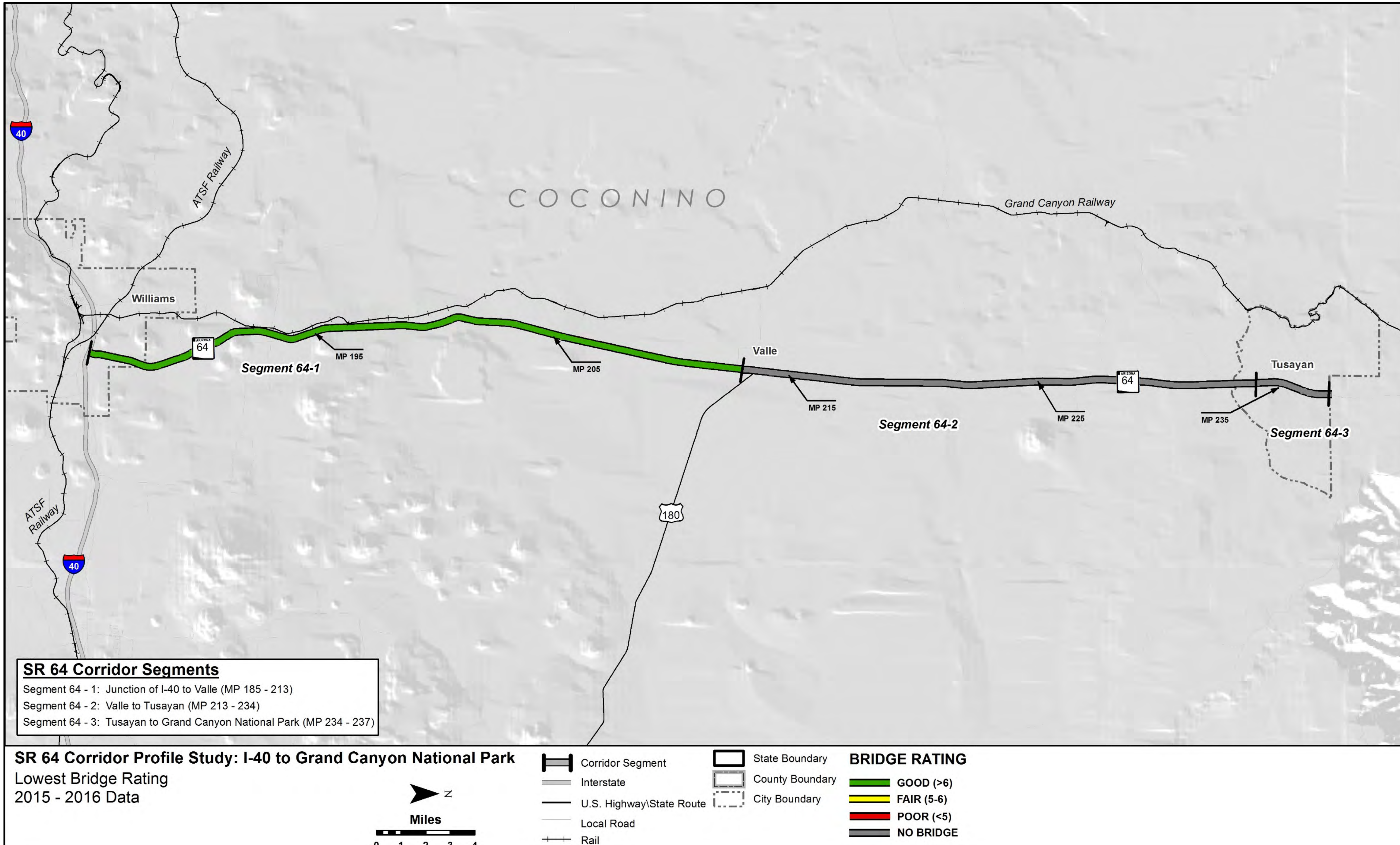
Percentage of Pavement Area Failure
2015 - 2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
PERCENTAGE OF PAVEMENT AREA FAILURE
GOOD (<5%)
FAIR (5%-20%)
POOR (>20%)
NO DATA

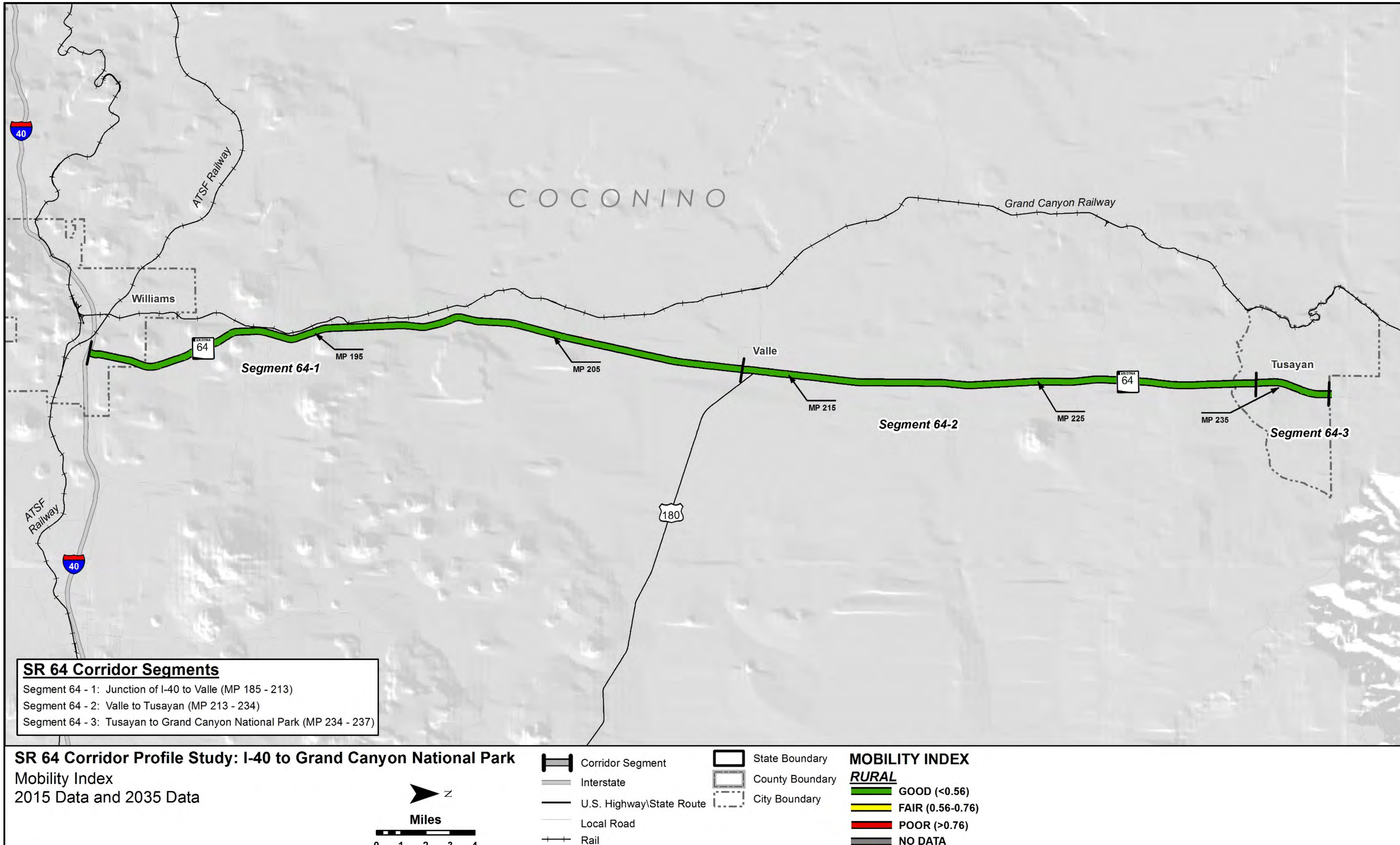

COCONINO
ATSF Railway
Grand Canyon Railway
Williams
Valle
Tusayan
40
64
180
MP 195
MP 205
MP 215
MP 225
MP 235
Segment 64-1
Segment 64-2
Segment 64-3
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Bridge Index and Hot Spots
2015 - 2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
BRIDGE INDEX
GOOD (>6.5)
FAIR (5.0-6.5)
POOR (<5.0)
NO BRIDGE
BRIDGE HOT SPOT
BRIDGE RATING OF 4 OR MULTIPLE 5'S


SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Bridge Sufficiency
2015 - 2016 Data
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
COCONINO
Williams
Valle
Tusayan
ATSF Railway
ATSF Railway
Grand Canyon Railway
40
40
64
64
180
Segment 64-1
Segment 64-2
Segment 64-3
MP 195
MP 205
MP 215
MP 225
MP 235
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
BRIDGE SUFFICIENCY
GOOD (>80)
FAIR (50-80)
POOR (<50)
NO BRIDGE

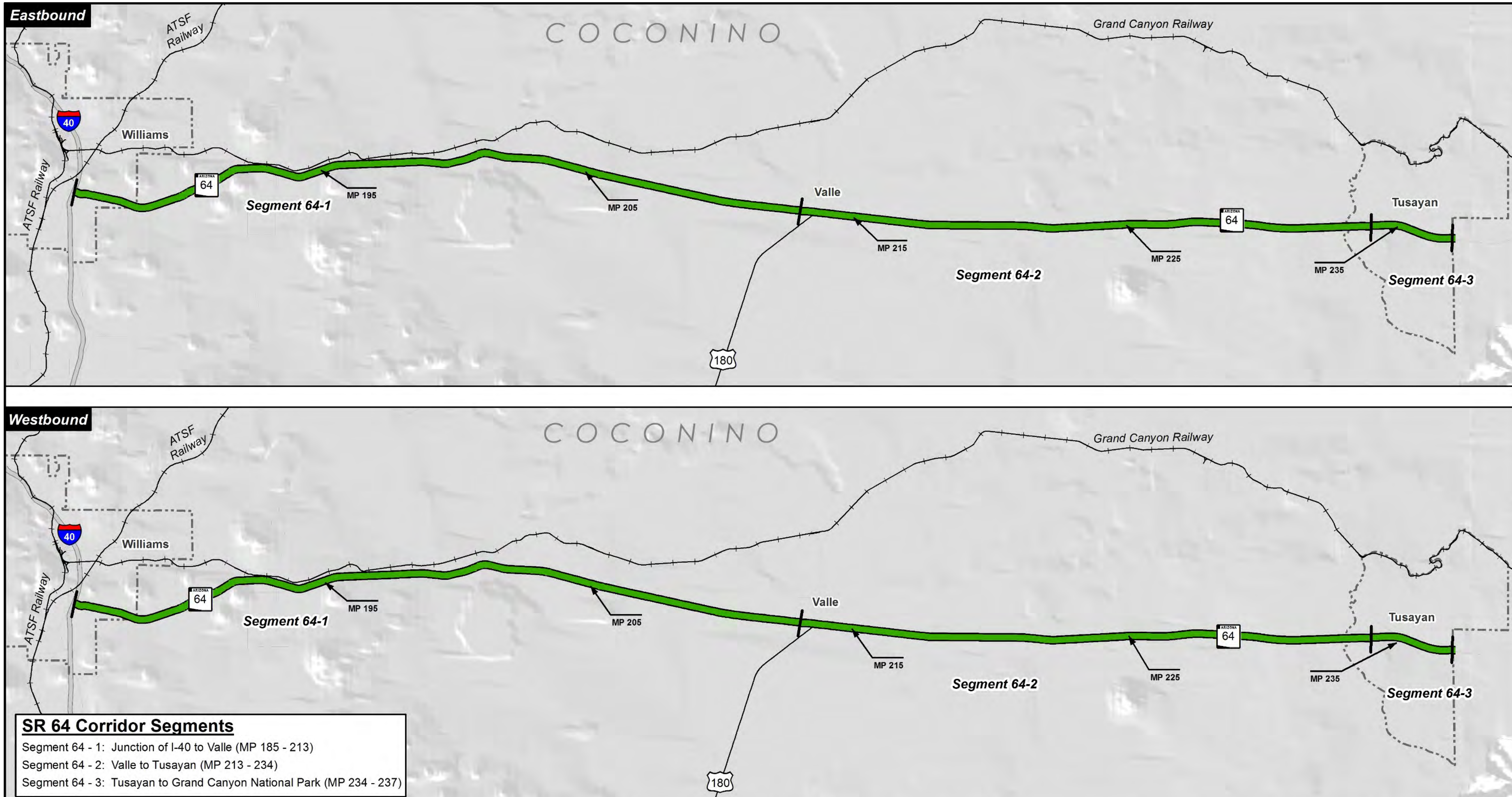


SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Percentage of Deck Area on
Functionally Obsolete Bridges
2015 - 2016 Data

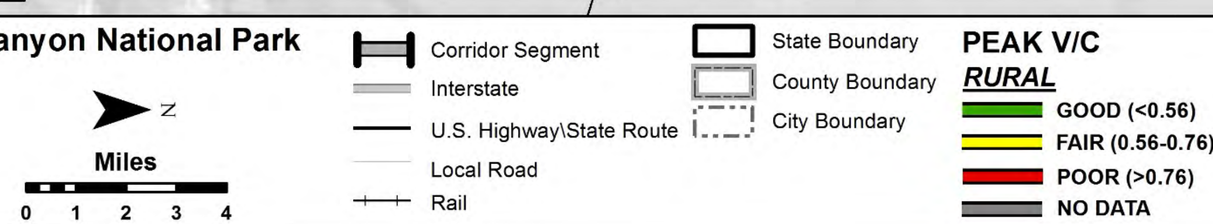

COCONINO
Grand Canyon Railway
ATSF Railway
Williams
Valle
Tusayan
Segment 64-1
Segment 64-2
Segment 64-3
MP 195
MP 205
MP 215
MP 225
MP 235
40
64
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Lowest Bridge Rating
2015 - 2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
BRIDGE RATING
GOOD (>6)
FAIR (5-6)
POOR (<5)
NO BRIDGE

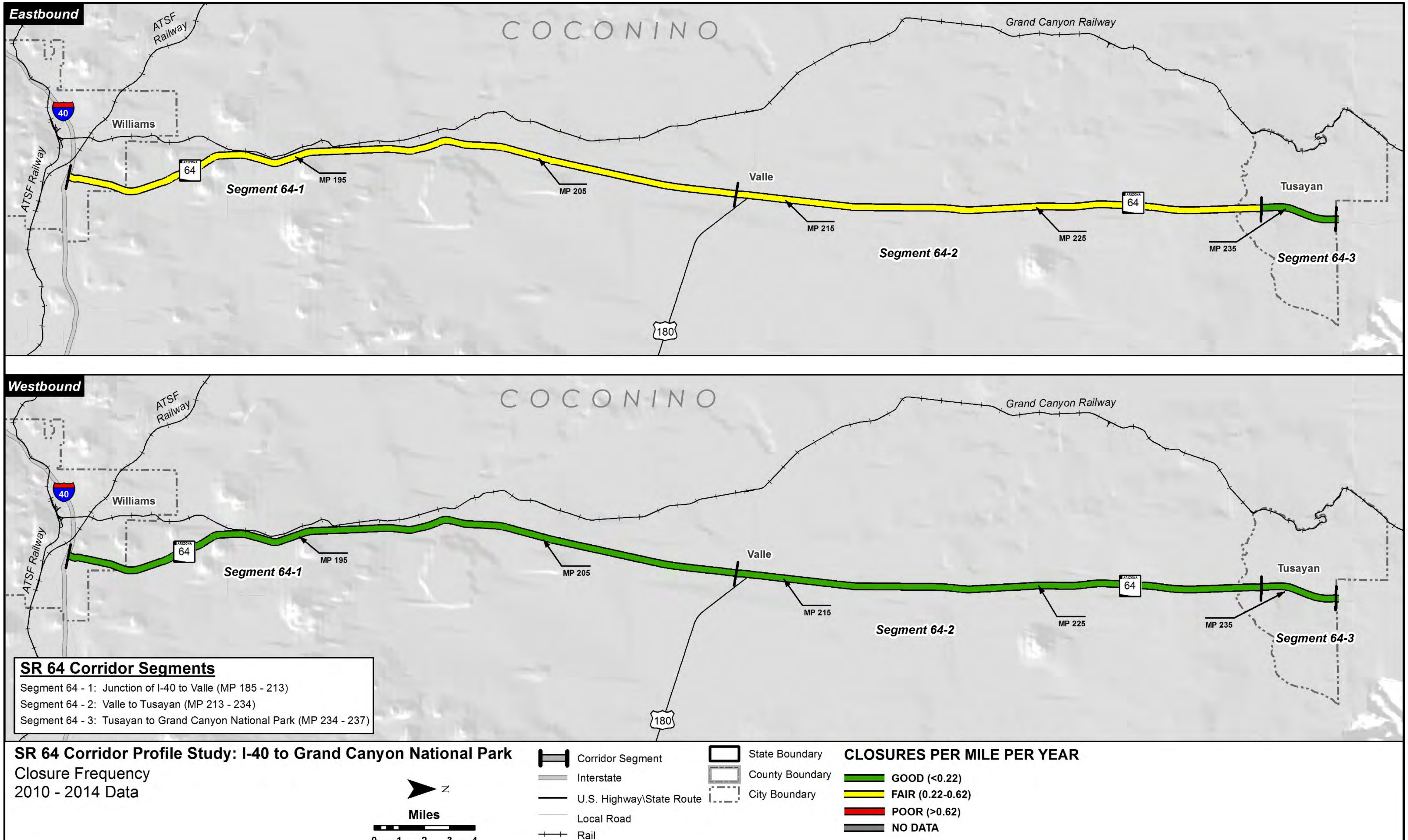

COCONINO
ATSF Railway
Grand Canyon Railway
Williams
Valle
Tusayan
40
64
180
MP 195
MP 205
MP 215
MP 225
MP 235
Segment 64-1
Segment 64-2
Segment 64-3
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Mobility Index
2015 Data and 2035 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
MOBILITY INDEX
RURAL
GOOD (<0.56)
FAIR (0.56-0.76)
POOR (>0.76)
NO DATA

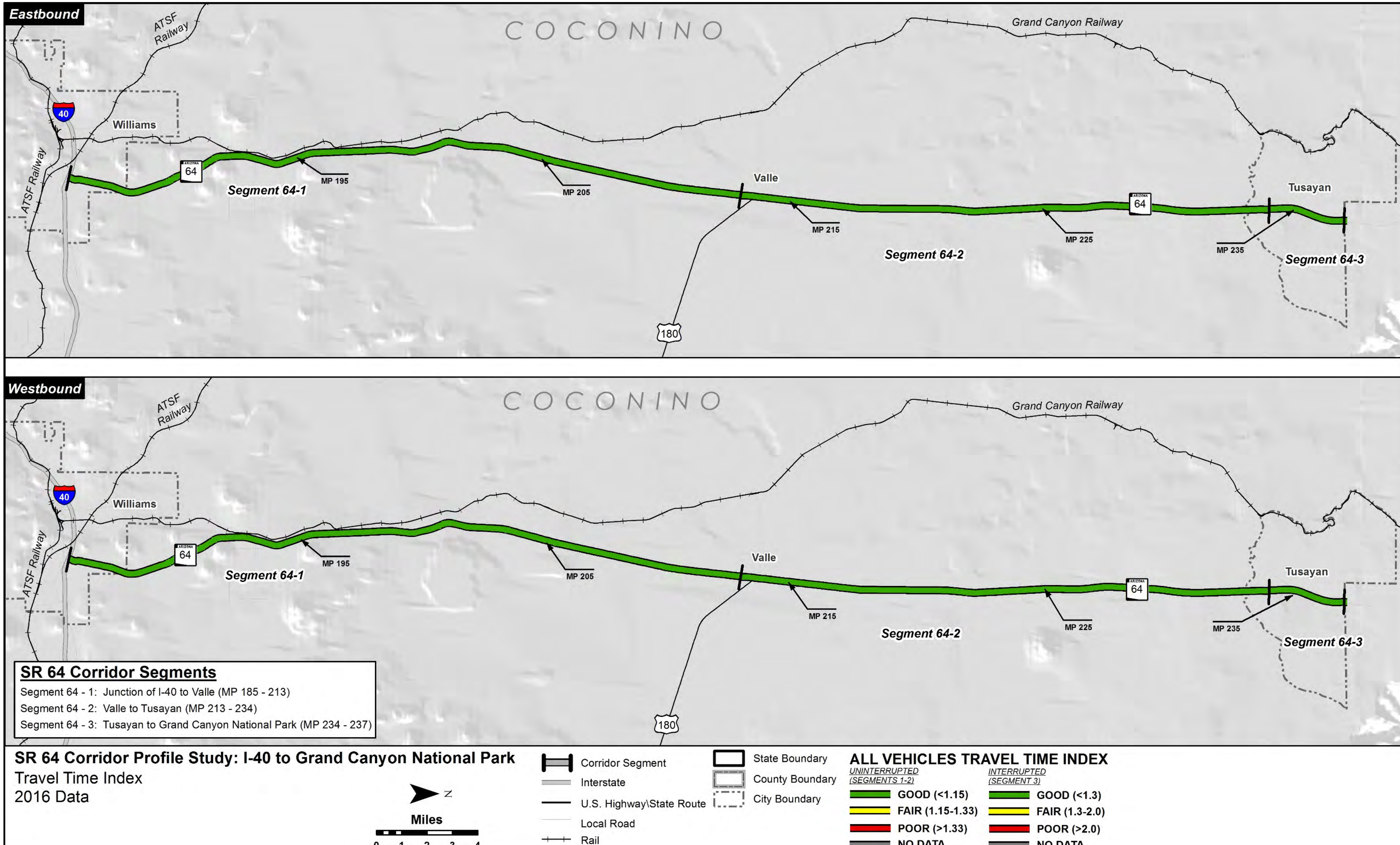
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Future Daily Volume/Capacity (V/C) Ratio
2035 Data

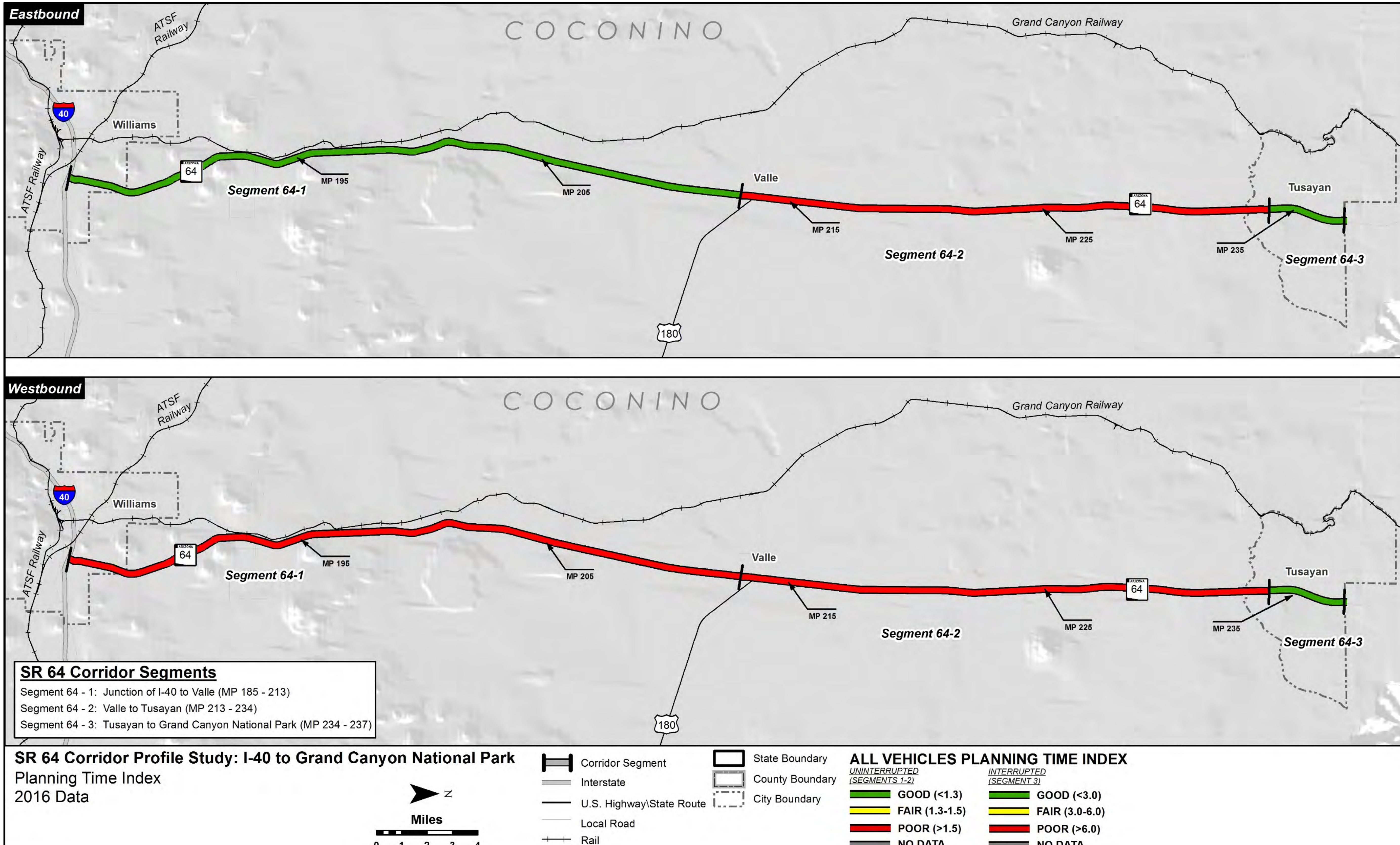


SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Existing Peak Hour V/C Ratio
2015 Data

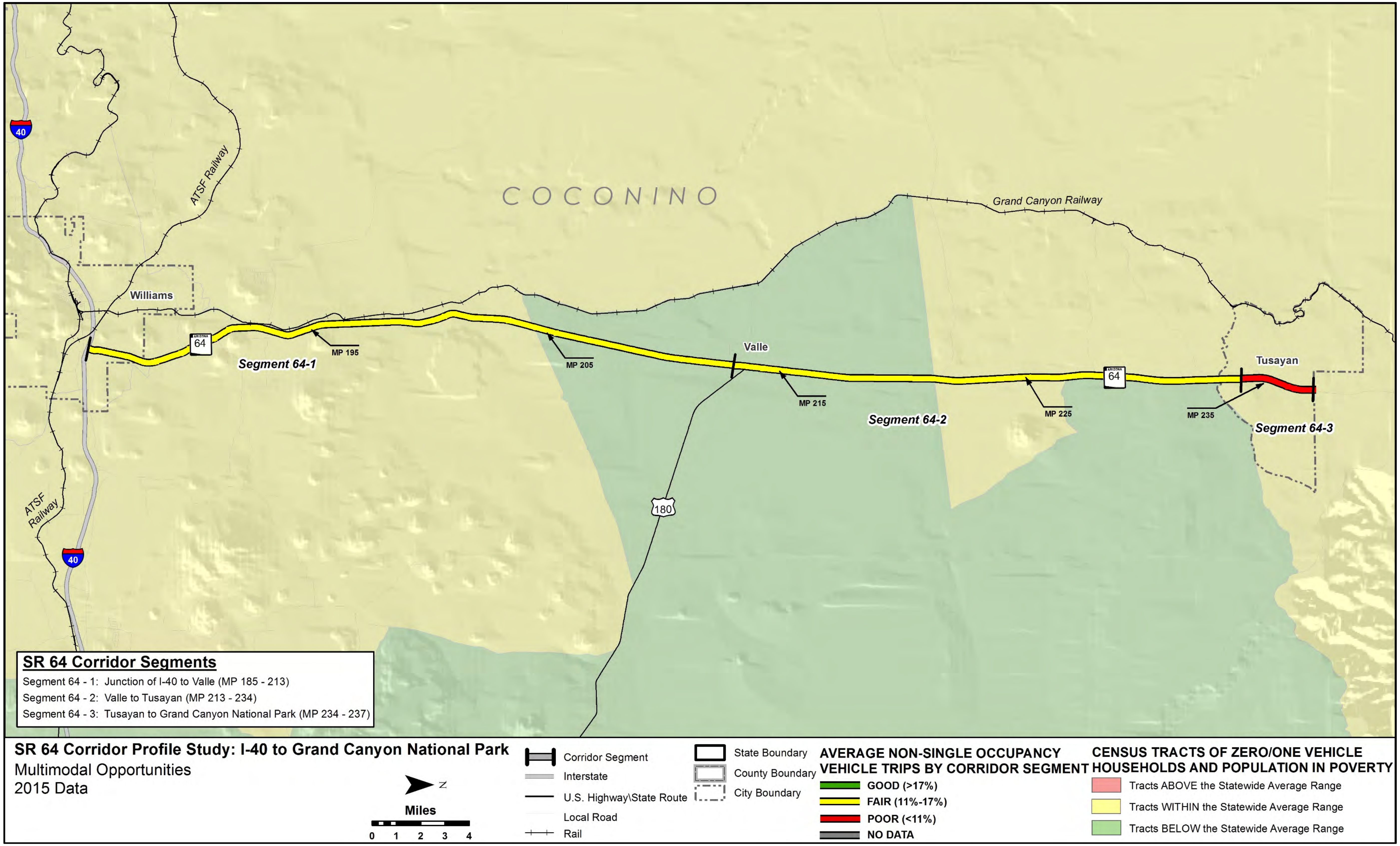


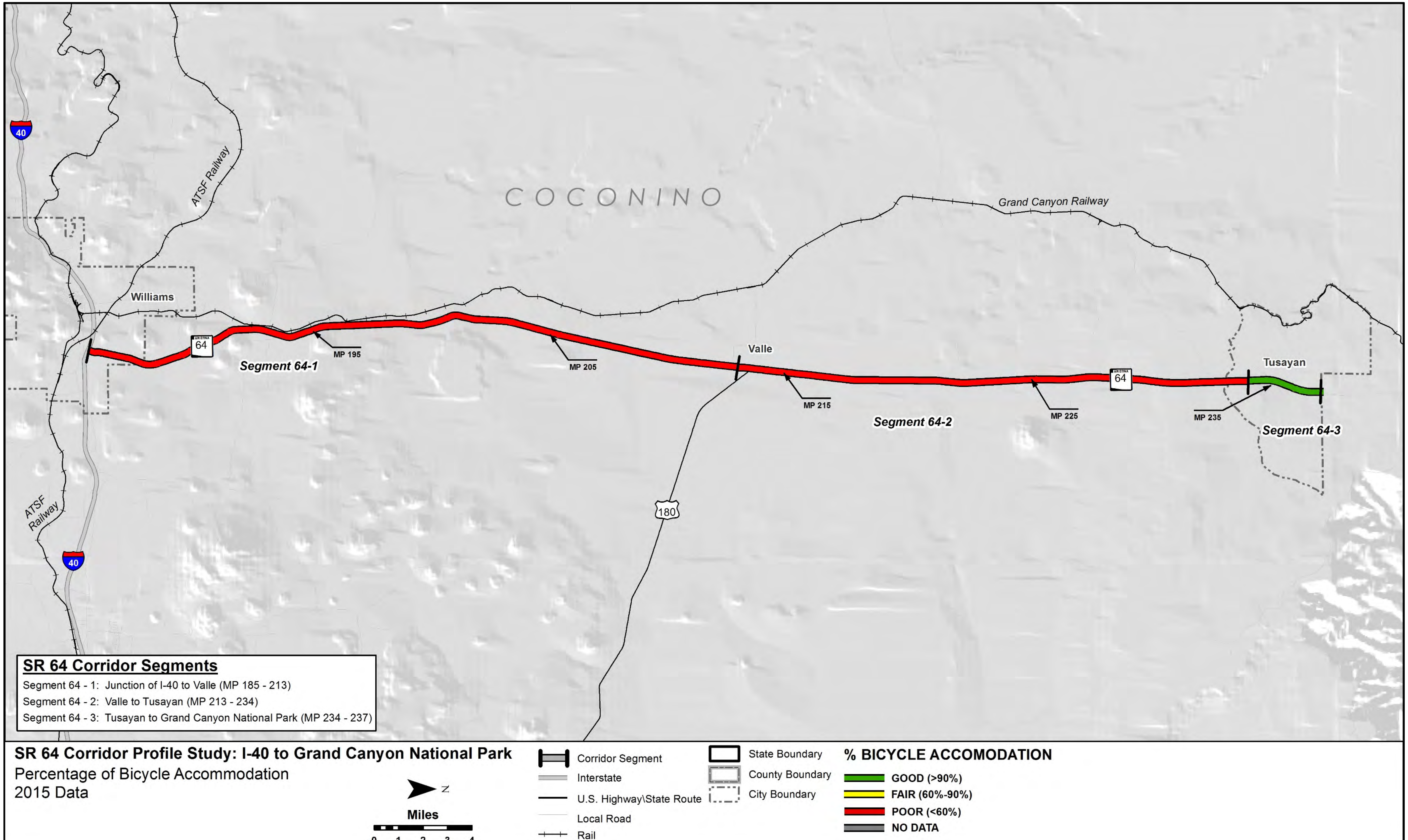

Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
180
Westbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Closure Frequency
2010 - 2014 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
CLOSURES PER MILE PER YEAR
GOOD (<0.22)
FAIR (0.22-0.62)
POOR (>0.62)
NO DATA


Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
MP 225
MP 235
Segment 64-2
Tusayan
Segment 64-3
180
Westbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
MP 225
MP 235
Segment 64-2
Tusayan
Segment 64-3
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Travel Time Index
2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
ALL VEHICLES TRAVEL TIME INDEX
UNINTERRUPTED (SEGMENTS 1-2)
GOOD (<1.15)
FAIR (1.15-1.33)
POOR (>1.33)
NO DATA
INTERRUPTED (SEGMENT 3)
GOOD (<1.3)
FAIR (1.3-2.0)
POOR (>2.0)
NO DATA



Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
180
Westbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Planning Time Index
2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
ALL VEHICLES PLANNING TIME INDEX
UNINTERRUPTED (SEGMENTS 1-2)
GOOD (<1.3)
FAIR (1.3-1.5)
POOR (>1.5)
NO DATA
INTERRUPTED (SEGMENT 3)
GOOD (<3.0)
FAIR (3.0-6.0)
POOR (>6.0)
NO DATA


COCONINO
ATSF Railway
Grand Canyon Railway
Williams
Valle
Tusayan
40
64
180
MP 195
MP 205
MP 215
MP 225
MP 235
Segment 64-1
Segment 64-2
Segment 64-3
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Multimodal Opportunities
2015 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
AVERAGE NON-SINGLE OCCUPANCY VEHICLE TRIPS BY CORRIDOR SEGMENT
GOOD (>17%)
FAIR (11%-17%)
POOR (<11%)
NO DATA
CENSUS TRACTS OF ZERO/ONE VEHICLE HOUSEHOLDS AND POPULATION IN POVERTY
Tracts ABOVE the Statewide Average Range
Tracts WITHIN the Statewide Average Range
Tracts BELOW the Statewide Average Range



COCONINO
Williams
Valle
Tusayan
ATSF Railway
Grand Canyon Railway
40
64
180
MP 195
MP 205
MP 215
MP 225
MP 235
Segment 64-1
Segment 64-2
Segment 64-3
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Percentage of Bicycle Accommodation
2015 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
% BICYCLE ACCOMODATION
GOOD (>90%)
FAIR (60%-90%)
POOR (<60%)
NO DATA

SR 64 Corridor Segments

Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)

SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Safety Index and Hot Spots
2011 - 2015 Data

Miles 0 1 2 3 4

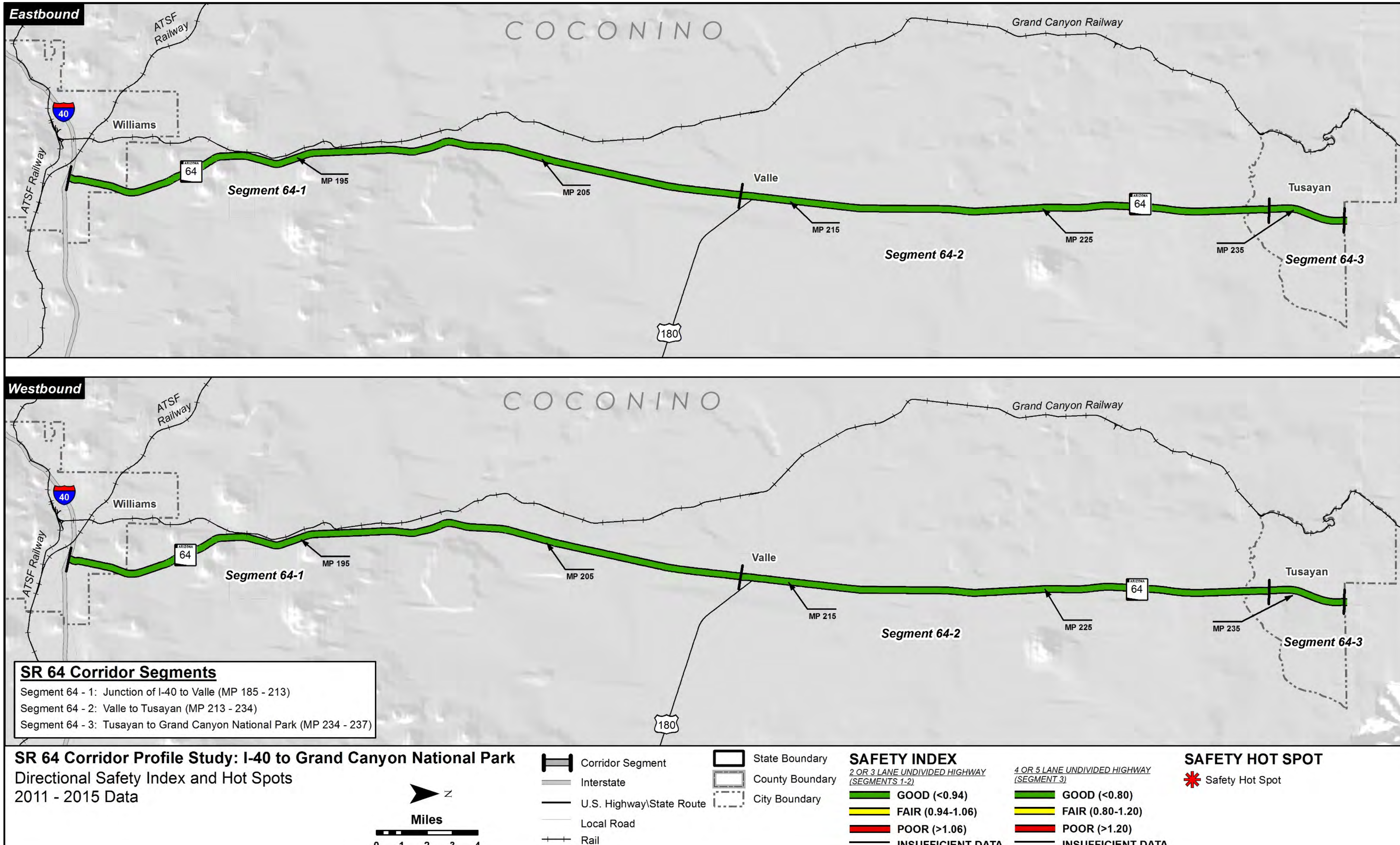
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary

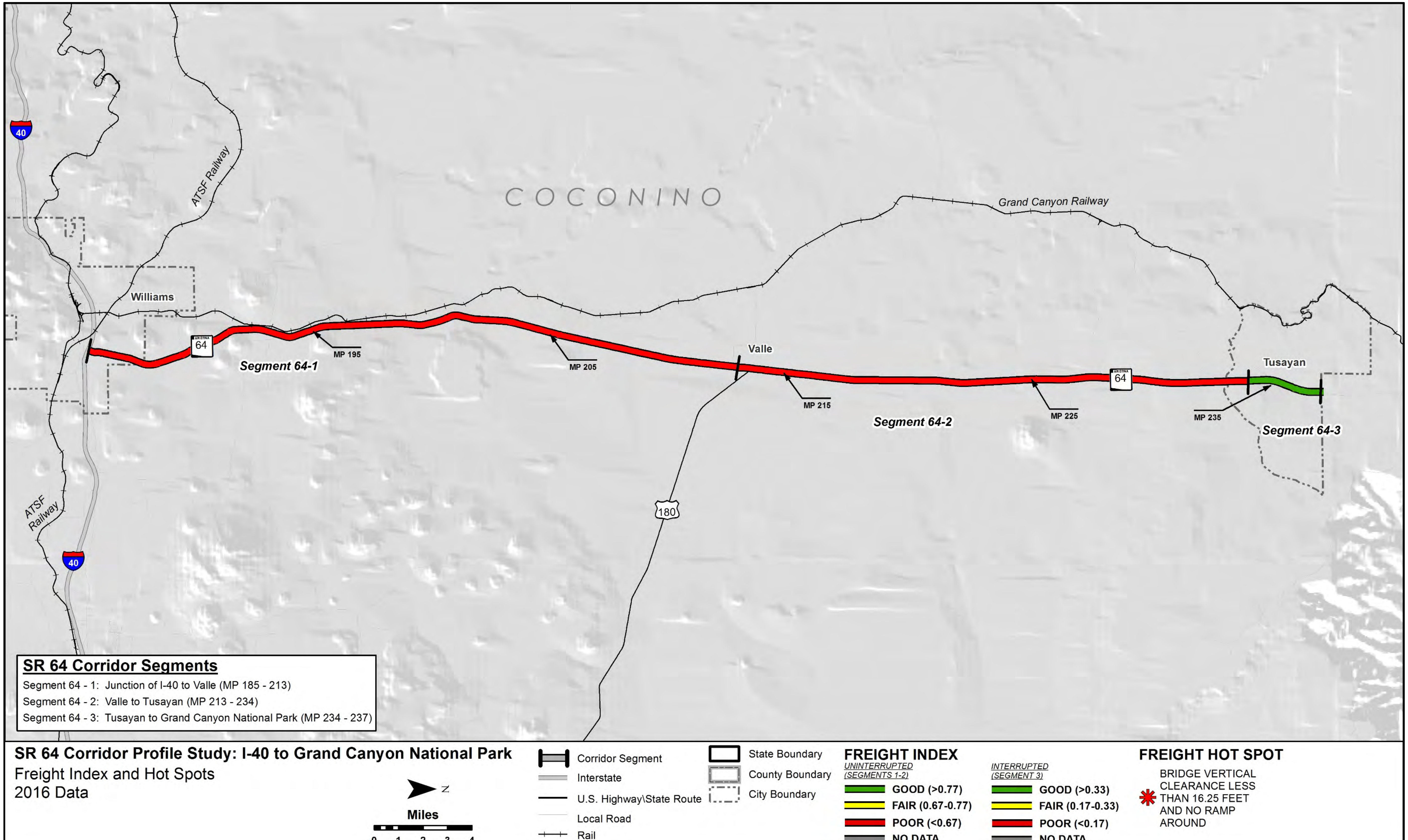
SAFETY INDEX

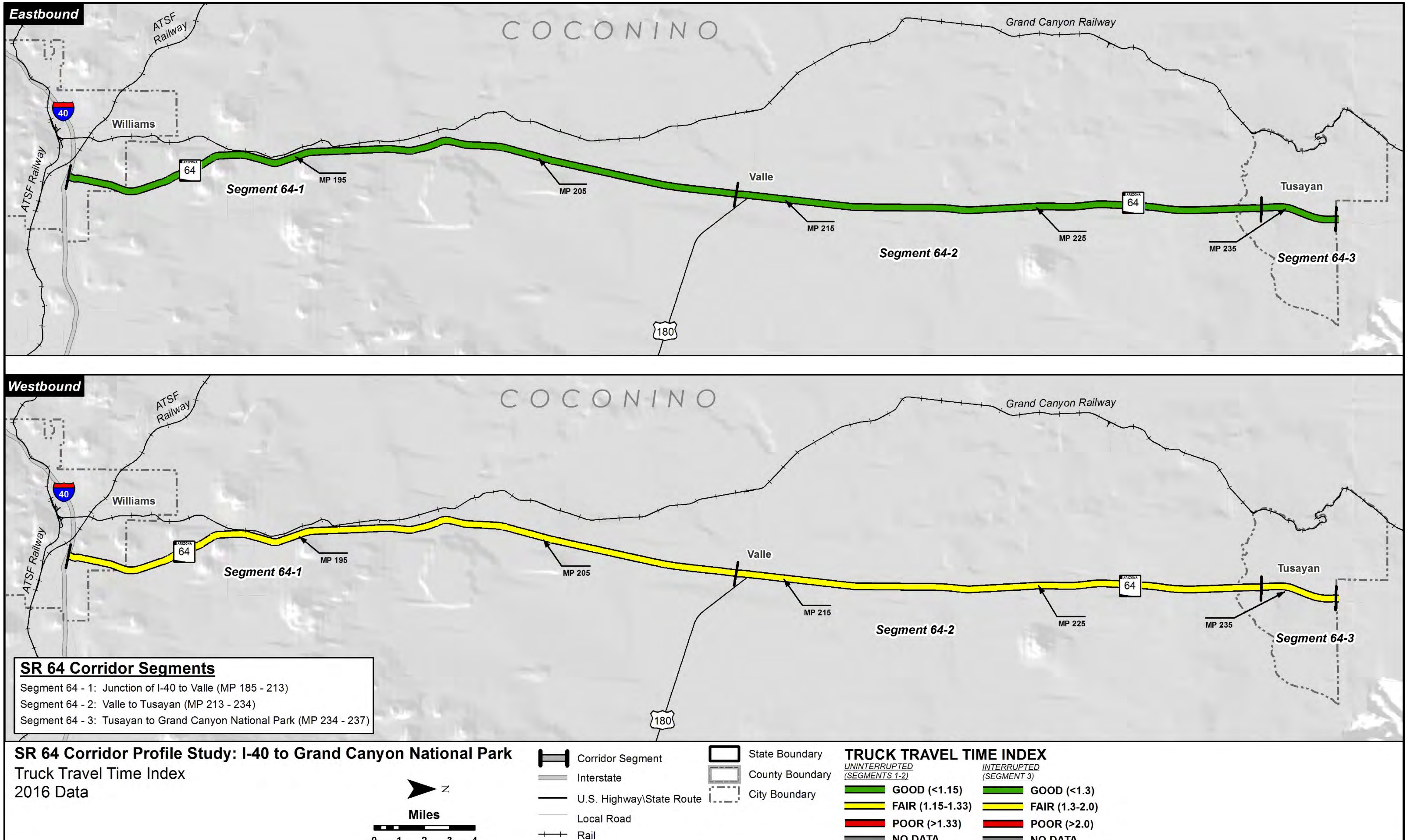
2 OR 3 LANE UNDIVIDED HIGHWAY (SEGMENTS 1-2)	4 OR 5 LANE UNDIVIDED HIGHWAY (SEGMENT 3)
GOOD (<0.94)	GOOD (<0.80)
FAIR (0.94-1.06)	FAIR (0.80-1.20)
POOR (>1.06)	POOR (>1.20)
INSUFFICIENT DATA	INSUFFICIENT DATA

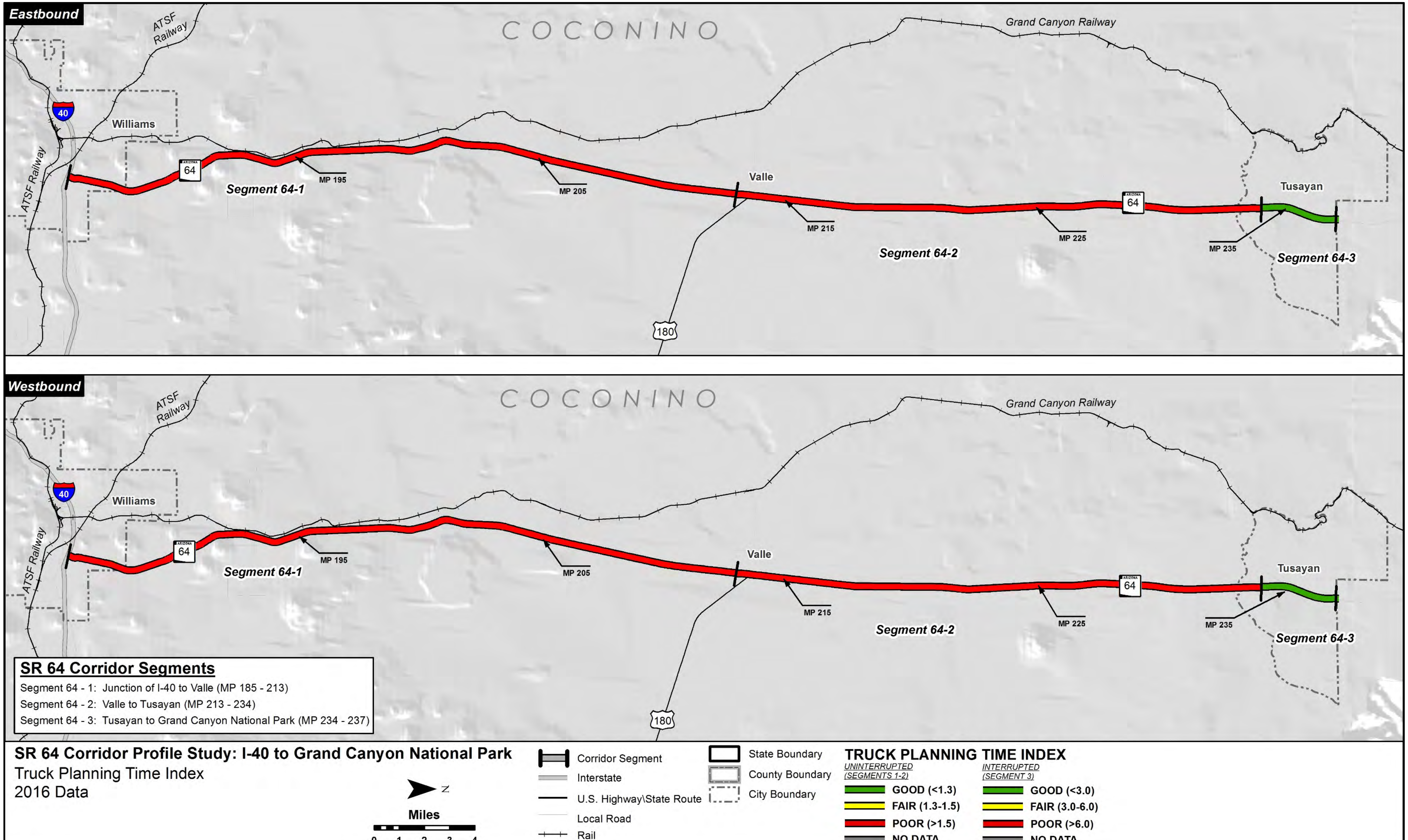
SAFETY HOT SPOT

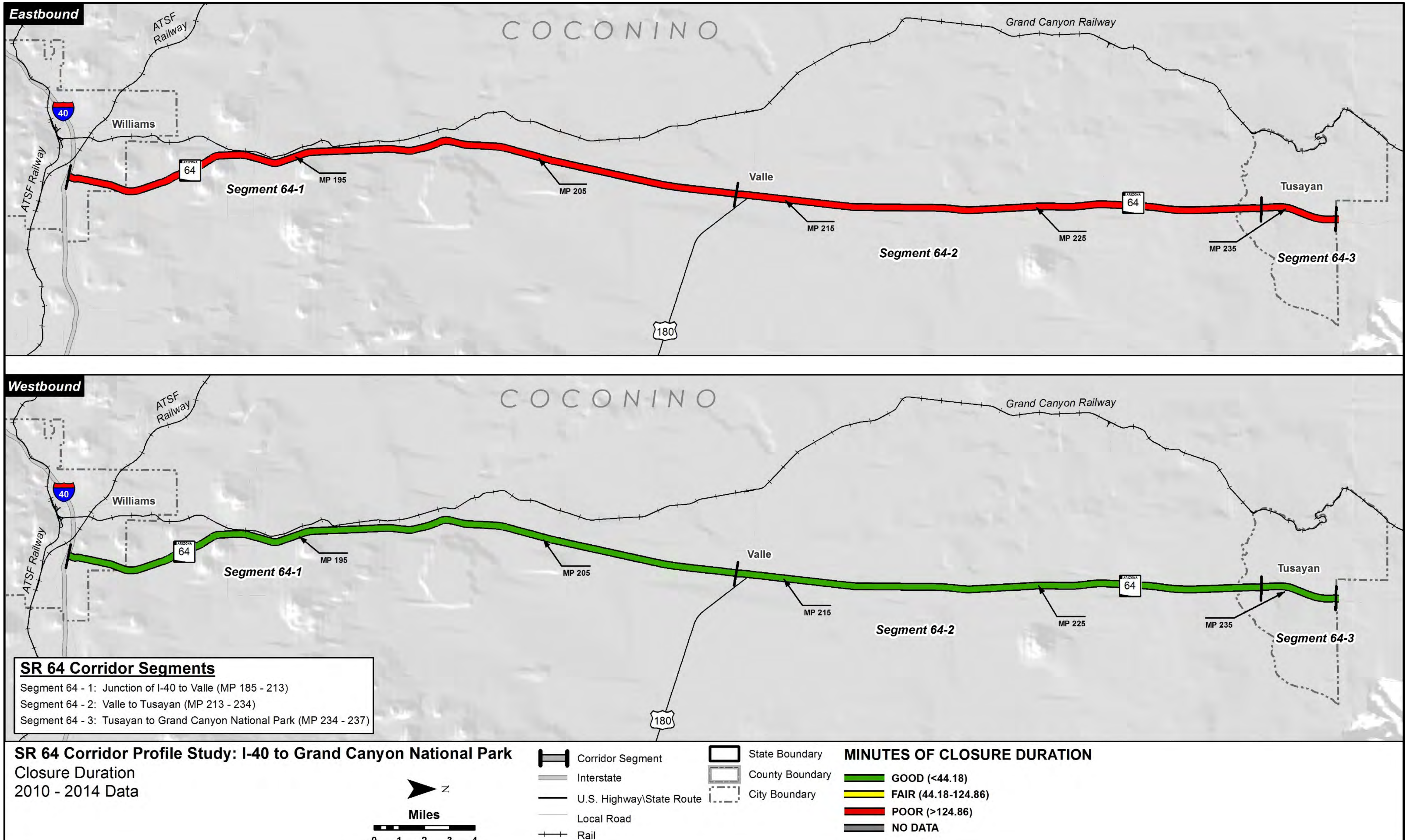
Safety Hot Spot


Eastbound
ATSF Railway
COCONINO
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
MP 225
MP 235
Tusayan
Segment 64-2
Segment 64-3
180
Westbound
ATSF Railway
COCONINO
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
MP 225
MP 235
Tusayan
Segment 64-2
Segment 64-3
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Directional Safety Index and Hot Spots
2011 - 2015 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
SAFETY INDEX
2 OR 3 LANE UNDIVIDED HIGHWAY (SEGMENTS 1-2)
GOOD (<0.94)
FAIR (0.94-1.06)
POOR (>1.06)
INSUFFICIENT DATA
4 OR 5 LANE UNDIVIDED HIGHWAY (SEGMENT 3)
GOOD (<0.80)
FAIR (0.80-1.20)
POOR (>1.20)
INSUFFICIENT DATA
SAFETY HOT SPOT
Safety Hot Spot


COCONINO
Grand Canyon Railway
ATSF Railway
ATSF Railway
Williams
Valle
Tusayan
40
40
64
64
180
MP 195
MP 205
MP 215
MP 225
MP 235
Segment 64-1
Segment 64-2
Segment 64-3
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Freight Index and Hot Spots
2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
FREIGHT INDEX
UNINTERRUPTED (SEGMENTS 1-2)
GOOD (>0.77)
FAIR (0.67-0.77)
POOR (<0.67)
NO DATA
INTERRUPTED (SEGMENT 3)
GOOD (>0.33)
FAIR (0.17-0.33)
POOR (<0.17)
NO DATA
FREIGHT HOT SPOT
BRIDGE VERTICAL CLEARANCE LESS THAN 16.25 FEET AND NO RAMP AROUND


Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
40
Williams
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
64
Tusayan
MP 235
Segment 64-3
180
Westbound
COCONINO
ATSF Railway
Grand Canyon Railway
40
Williams
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
64
Tusayan
MP 235
Segment 64-3
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Truck Travel Time Index
2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
TRUCK TRAVEL TIME INDEX
UNINTERRUPTED (SEGMENTS 1-2)
GOOD (<1.15)
FAIR (1.15-1.33)
POOR (>1.33)
NO DATA
INTERRUPTED (SEGMENT 3)
GOOD (<1.3)
FAIR (1.3-2.0)
POOR (>2.0)
NO DATA


Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
180
Westbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
40
64
Segment 64-1
MP 195
MP 205
Valle
MP 215
Segment 64-2
MP 225
MP 235
Tusayan
Segment 64-3
180
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Truck Planning Time Index
2016 Data
N
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
TRUCK PLANNING TIME INDEX
UNINTERRUPTED (SEGMENTS 1-2)
GOOD (<1.3)
FAIR (1.3-1.5)
POOR (>1.5)
NO DATA
INTERRUPTED (SEGMENT 3)
GOOD (<3.0)
FAIR (3.0-6.0)
POOR (>6.0)
NO DATA


Eastbound
COCONINO
ATSF Railway
Grand Canyon Railway
Williams
Valle
Tusayan
MP 195
MP 205
MP 215
MP 225
MP 235
Segment 64-1
Segment 64-2
Segment 64-3
Westbound
SR 64 Corridor Segments
Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)
SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Closure Duration
2010 - 2014 Data
Miles
0 1 2 3 4
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary
MINUTES OF CLOSURE DURATION
GOOD (<44.18)
FAIR (44.18-124.86)
POOR (>124.86)
NO DATA

SR 64 Corridor Segments

Segment 64 - 1: Junction of I-40 to Valle (MP 185 - 213)
Segment 64 - 2: Valle to Tusayan (MP 213 - 234)
Segment 64 - 3: Tusayan to Grand Canyon National Park (MP 234 - 237)

SR 64 Corridor Profile Study: I-40 to Grand Canyon National Park
Bridge Vertical Clearance
2015 - 2016 Data

N
Miles
0 1 2 3 4

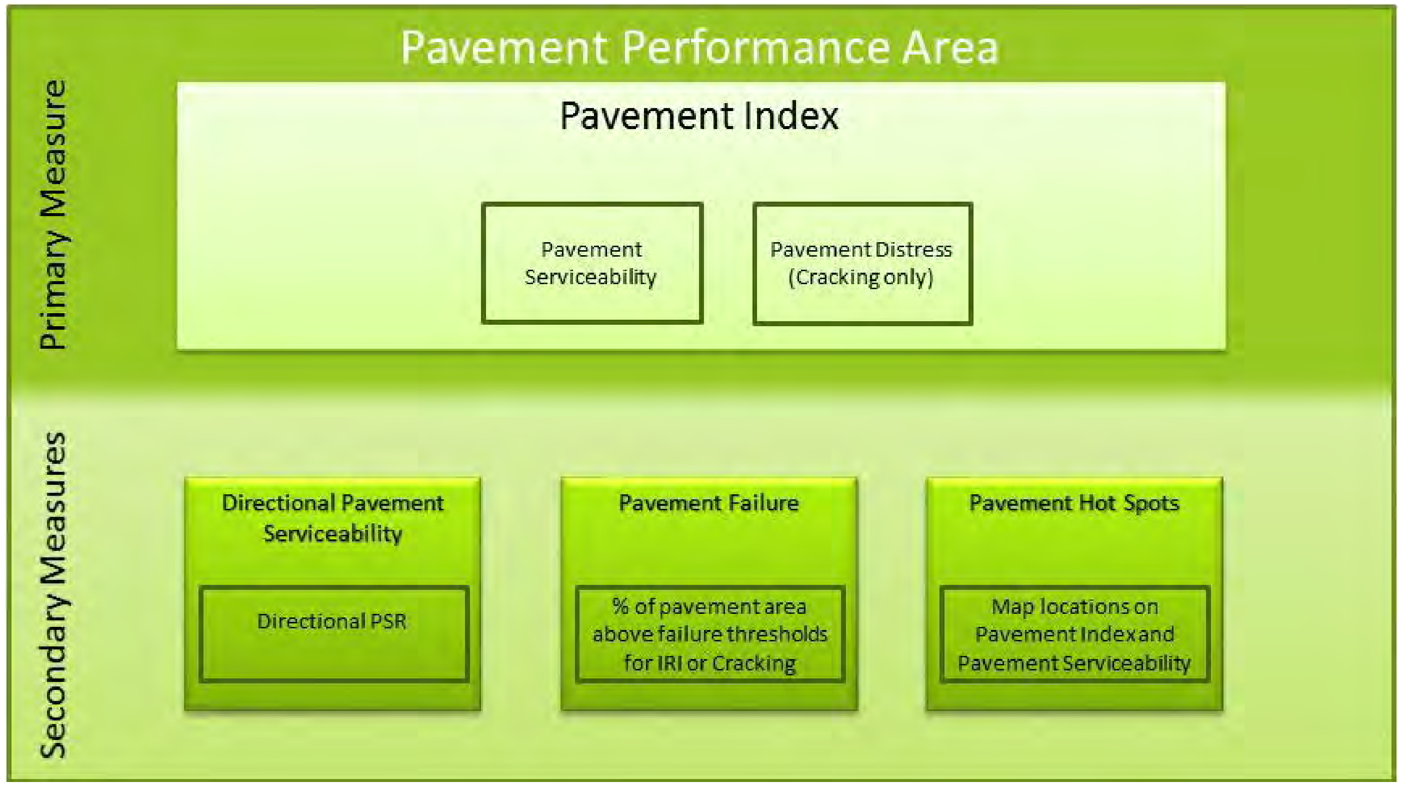
Corridor Segment
Interstate
U.S. Highway\State Route
Local Road
Rail
State Boundary
County Boundary
City Boundary

BRIDGE VERTICAL CLEARANCE
- **GOOD (>16.5)**
- **FAIR (16.0-16.5)**
- **POOR (<16.0)**
- **NO UP**

Appendix B: Performance Area Detailed Calculation Methodologies

Pavement Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Pavement performance area as shown in the following graphic:



This performance area is used to evaluate mainline pavement condition. Pavement condition data for ramps, frontage roads, crossroads, etc. was not included in the evaluation.

<u>Primary Pavement Index</u>

The Pavement Index is calculated based on the use of two pavement condition ratings from the ADOT Pavement Database. The two ratings are the International Roughness Index (IRI) and the Cracking rating. The calculation of the Pavement Index uses a combination of these two ratings.

The IRI is a measurement of the pavement roughness based on field-measured longitudinal roadway profiles. To facilitate the calculation of the index, the IRI rating was converted to a Pavement Serviceability Rating (PSR) using the following equation:

$$PSR = 5 * e^{-0.0038*IRI}$$

The Cracking Rating is a measurement of the amount of surface cracking based on a field-measured area of 1,000 square feet that serves as a sample for each mile. To facilitate the calculation of the index, the Cracking Rating was converted to a Pavement Distress Index (PDI) using the following equation:

$$PDI = 5 - (0.345 * C^{0.66})$$

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest performance. The performance thresholds for interstates and non-interstates shown in the tables below were used for the PSR and PDI.

Performance Level for Interstates	IRI (PSR)	Cracking (PDI)
Good	<75 (>3.75)	<7 (>3.75)
Fair	75 - 117 (3.20 - 3.75)	7 - 12 (3.22 - 3.75)
Poor	>117 (<3.20)	>12 (<3.22)

Performance Level for Non-Interstates	IRI (PSR)	Cracking (PDI)
Good	<94 (>3.5)	<9 (>3.5)
Fair	94 - 142 (2.9 - 3.5)	9 - 15 (2.9 - 3.5)
Poor	>142 (<2.9)	>15 (<2.9)

The PSR and PDI are calculated for each 1-mile section of roadway. If PSR or PDI falls into a poor rating (<3.2 for interstates, for example) for a 1-mile section, then the score for that 1-mile section is entirely (100%) based on the lower score (either PSR or PDI). If neither PSR or PDI fall into a poor rating for a 1-mile section, then the score for that 1-mile section is based on a combination of the lower rating (70% weight) and the higher rating (30% weight). The result is a score between 0 and 5 for each direction of travel of each mile of roadway based on a combination of both the PSR and the PDI.

The project corridor has been divided into segments. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than a section with fewer travel lanes.

<u>Secondary Pavement Measures</u>

Three secondary measures are evaluated:

- Directional Pavement Serviceability
- Pavement Failure
- Pavement Hot Spots

Directional Pavement Serviceability: Similar to the Pavement Index, the Directional Pavement Serviceability is calculated as a weighted average (based on number of lanes) for each segment. However, this rating only utilizes the PSR and is calculated separately for each direction of travel. The PSR uses a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest performance.

Pavement Failure: The percentage of pavement area rated above the failure thresholds for IRI or Cracking is calculated for each segment. In addition, the Standard score (z-score) is calculated for each segment.

The Standard score (z-score) is the number of standard deviations above or below the mean. Therefore, a Standard score between -0.5 and +0.5 is "average", less than -0.5 is lower (better) than average, and higher than +0.5 is above (worse) than average.

Pavement Hot Spots: The Pavement Index map identifies locations that have an IRI rating or Cracking rating that fall above the failure threshold as identified by ADOT Pavement Group. For interstates, an IRI rating above 105 or a Cracking rating above 15 will be used as the thresholds which are slightly different than the ratings shown previously. For non-interstates, an IRI rating above 142 or a Cracking rating above 15 will be used as the thresholds.

Scoring

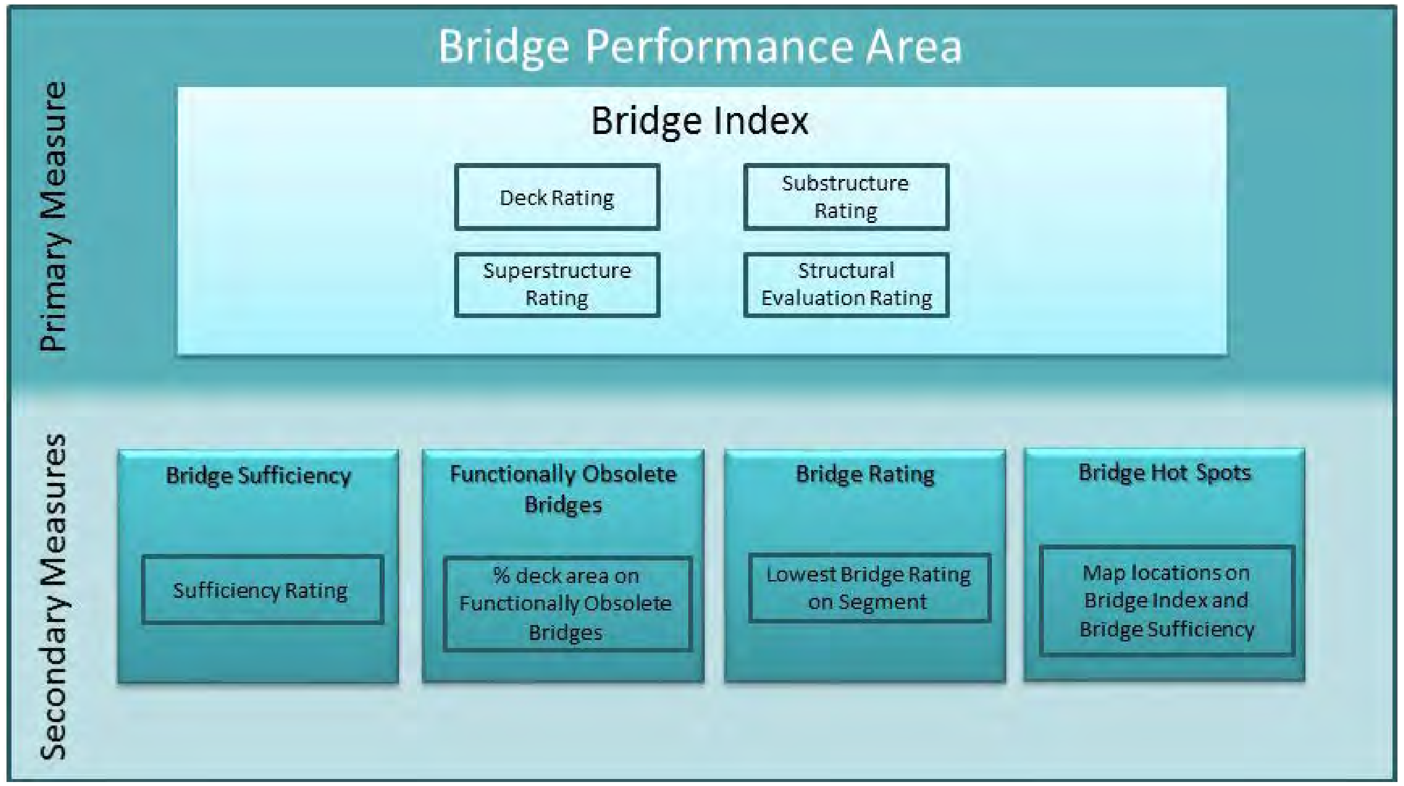
Performance Level	Pavement Index	
	Interstates	Non-Interstates
Good	>3.75	>3.5
Fair	3.2 - 3.75	2.9 - 3.5
Poor	<3.2	<2.9

Performance Level	Directional Pavement Serviceability	
	Interstates	Non-Interstates
Good	>3.75	>3.5
Fair	3.2 - 3.75	2.9 - 3.5
Poor	<3.2	<2.9

Performance Level	% Pavement Failure
Good	< 5%
Fair	5% – 20%
Poor	>20%

Bridge Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Bridge performance area as shown in the following graphic:



This performance area is used to evaluate mainline bridges. Bridges on ramps (that do not cross the mainline), frontage roads, etc. should not be included in the evaluation. Basically, any bridge that carries mainline traffic or carries traffic over the mainline should be included and bridges that do not carry mainline traffic, run parallel to the mainline (frontage roads), or do not cross the mainline should not be included.

Primary Bridge Index

The Bridge Index is calculated based on the use of four bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. The calculation of the Bridge Index uses the lowest of these four ratings.

Each of the four condition ratings use a 0 to 9 scale with 0 representing the lowest performance and 9 representing the highest performance.

The project corridor has been divided into segments and the bridges are grouped together according to the segment definitions. In order to report the Bridge Index for each corridor segment, the Bridge Index for each segment is a weighted average based on the deck area for each bridge. Therefore, the condition of a larger bridge will have a greater influence on the resulting segment Bridge Index than a smaller bridge.

Secondary Bridge Measures

Four secondary measures will be evaluated:

- Bridge Sufficiency
- Functionally Obsolete Bridges
- Bridge Rating
- Bridge Hot Spots

Bridge Sufficiency: Similar to the Bridge Index, the Bridge Sufficiency rating is calculated as a weighted average (based on deck area) for each segment. The Bridge Sufficiency rating is a scale of 0 to 100 with 0 representing the lowest performance and 100 representing the highest performance. A rating of 80 or above represents "good" performance, a rating between 50 and 80 represents "fair" performance, and a rating below 50 represents "poor" performance.

Functionally Obsolete Bridges: The percentage of total deck area in a segment that is on functionally obsolete bridges is calculated for each segment. The deck area for each bridge within each segment that has been identified as functionally obsolete is totaled and divided by the total deck area for the segment to calculate the percentage of deck area on functionally obsolete bridges for each segment.

The thresholds for this performance measure are determined based on the Standard score (z-score). The Standard score (z-score) is the number of standard deviations above or below the mean. Therefore, a Standard score between -0.5 and +0.5 is "average", less than -0.5 is lower (better) than average, and higher than +0.5 is above (worse) average.

Bridge Rating: The Bridge Rating simply identifies the lowest bridge rating on each segment. This performance measure is not an average and therefore is not weighted based on the deck area. The Bridge Index identifies the lowest rating for each bridge, as described above. Each of the four condition ratings use a 0 to 9 scale with 0 representing the lowest performance and 9 representing the highest performance.

Bridge Hot Spots: The Bridge Index map identifies individual bridge locations that are identified as hot spots. Hot spots are bridges that have a single rating of 4 in any of the four ratings, or multiple ratings of 5 in the deck, substructure or superstructure ratings.

Scoring:

Performance Level	Bridge Index
Good	>6.5
Fair	5.0-6.5
Poor	<5.0

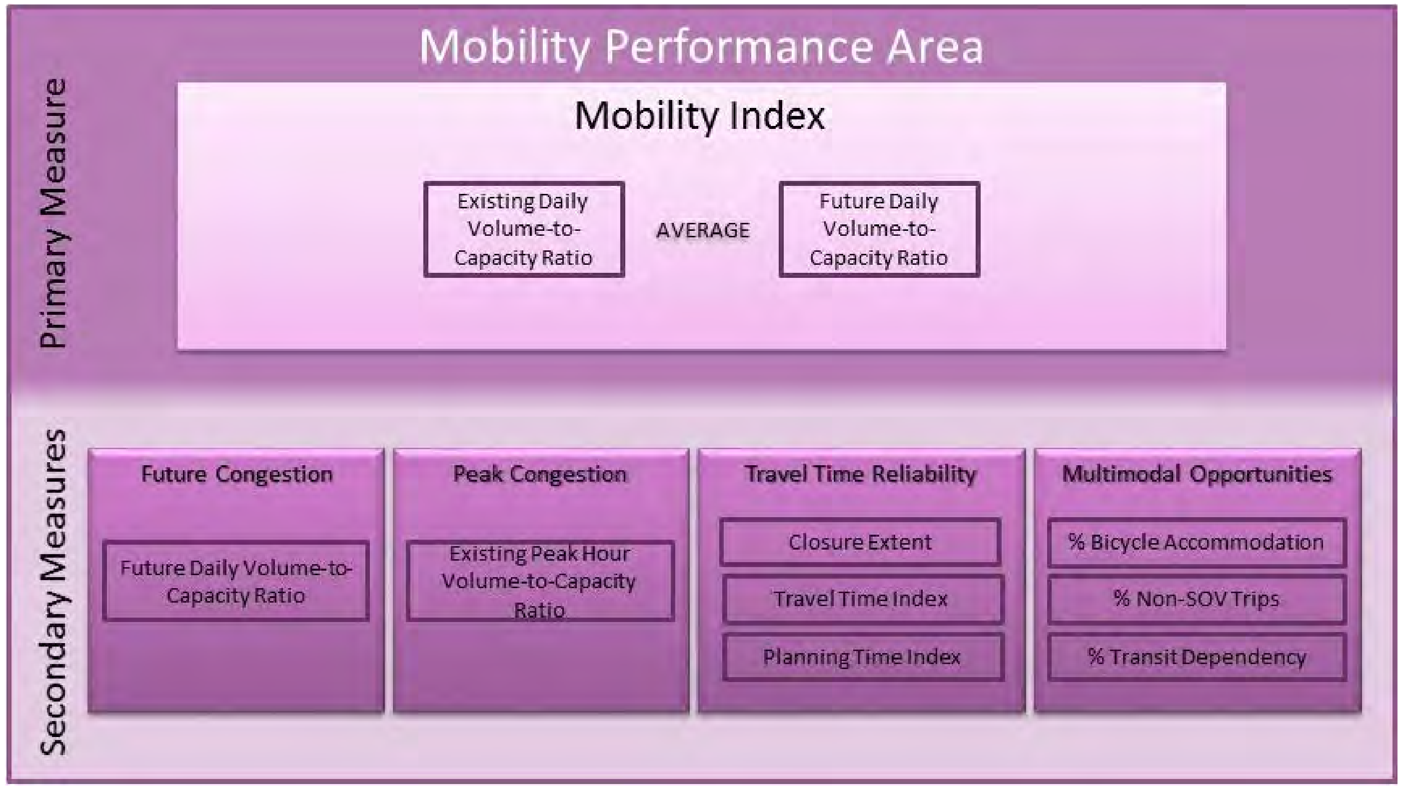
Performance Level	Sufficiency Rating
Good	>80
Fair	50-80
Poor	<50

Performance Level	Bridge Rating
Good	>6
Fair	5-6
Poor	<5

Performance Level	% Functionally Obsolete
Good	< 12%
Fair	12%-40%
Poor	>40%

Mobility Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Mobility performance area as shown in the following graphic:



<u>Primary Mobility Index</u>

The primary Mobility Index is an average of the existing daily volume-to-capacity (V/C) ratio and the future daily V/C ratio for each segment of the corridor.

Existing Daily V/C: The existing daily V/C ratio for each segment is calculated by dividing the 2014 Annual Average Daily Traffic (AADT) volume for each segment by the total Level of Service (LOS) E capacity volume for that segment

The capacity is calculated using the HERS Procedures for Estimating Highway Capacity[1]. The HERS procedure incorporates HCM 2010 methodologies. The methodology includes capacity estimation procedures for multiple facility types including freeways, rural two-lane highways, multilane highways, and signalized and non-signalized urban sections.

[1] HERS Support – 2011, Task 6: Procedures for Estimating Highway Capacity, draft Technical Memorandum. Cambridge Systematics. Prepared for the Federal Highway Administration. March 2013.

The segment capacity is defined as a function of the number of mainline lanes, shoulder width, interrupted or uninterrupted flow facilities, terrain type, percent of truck traffic, and the designated urban or rural environment.

The AADT for each segment is calculated by applying a weighted average across the length of the segment based on the individual 24-hour volumes and distances associated with each HPMS count station within each segment.

The following example equation is used to determine the weighted average of a segment with two HPMS count locations within the corridor

((HPMS 1 Distance x HPMS 1 Volume) + (HPMS 2 Distance x HPMS 2 Volume))/Total Segment Length

For specific details regarding the HERS methodology used, refer to the *Procedures for Estimating Highway Capacity, draft Technical Memorandum.*

Future Daily V/C: The future daily V/C ratio for each segment is calculated by dividing the 2035 AADT volume for each segment by the 2014 LOS E capacity. The capacity volume used in this calculation is the same as is utilized in the existing daily V/C equation.

The future AADT daily volumes are generated by applying an average annual compound growth rate (ACGR) to each 2014 AADT segment volume. The following equation is used to apply the average annual compound growth rate:

2035 AADT = 2014 AADT x ((1+ACGR)^(2035-2014))

The ACGR for each segment is defined by comparing the total volumes in the 2010 Arizona Travel Demand Model (AZTDM2) to the 2035 AZTDM2 traffic volumes at each existing HPMS count station location throughout the corridor. Each 2010 and 2035 segment volume is defined using the same weighted average equation described in the *Existing Daily V/C* section above and then summing the directional volumes for each location. The following equation is used to determine the ACGR for each segment:

ACGR = ((2035 Volume/2010 Volume)^(1/(2035-2010))))-1

<u>Secondary Mobility Measures</u>

Four secondary measures are evaluated:

- Future Congestion
- Peak Congestion
- Travel Time Reliability
    - Closure Extent
    - Directional Travel Time Index
    - Directional Planning Time Index

- Multimodal Opportunities
  - % Bicycle Accommodation
  - % Non-Single Occupancy Vehicle (SOV) Trips
  - % Transit Dependency

Future Congestion: The future daily V/C ratios for each segment in the corridor that are calculated and used in the Mobility Index as part of the overall average between Existing Daily V/C and Future Daily V/C are applied independently as a secondary measure. The methods to calculate the Future Daily V/C can be referenced in the Mobility Index section.

Peak Congestion: Peak Congestion has been defined as the peak hour V/C ratio in both directions of the corridor. The peak hour V/C ratio is calculated using the HERS method as described previously. The peak hour volume utilizes the directional AADT for each segment, which is calculated by applying a weighted average across the length of the segment based on the individual directional 24-hour volumes and distances associated with each HPMS count station within each segment. The segment capacity is defined based on the characteristics of each segment including number of lanes, terrain type, and environment, similar to the 24-hour volumes using the HERS method.

Travel Time Reliability: Travel time reliability is a secondary measure that includes three indicators. The three indicators are the number of times a piece of a corridor is closed for any specific reason, the directional Travel Time Index (TTI), and the directional Planning Time Index (PTI).

Closure Extent: The number of times a roadway is closed is documented through the HCRS dataset. Closure Extent is defined as the average number of times a particular milepost of the corridor is closed per year per mile in a specific direction of travel. The weighted average of each occurrence takes into account the distance over which a specific occurrence spans.

Thresholds that determine levels of good, fair, and poor are based on the average number of closures per mile per year within each of the identified statewide significant corridors by ADOT. The thresholds shown at the end of this section represent statewide averages across those corridors.

Directional Travel Time and Planning Time Index: In terms of overall mobility, the TTI is the relationship of the mean peak period travel time in a specific section of the corridor to the free-flow travel time in the same location. The PTI is the relationship of the 95th percentile highest travel time to the free-flow travel time (based on the posted speed limit) in a specific section of the corridor. The TTI and PTI can be converted into speed-based indices by recognizing that speed is equal to distance traveled divided by travel time. The inverse relationship between travel time and speed means that the 95th percentile highest travel time corresponds to the 5th percentile lowest speed.

Using HERE data provided by ADOT, four time periods for each data point were collected throughout the day (AM peak, mid-day, PM peak, and off-peak). Using the mean speeds and 5th percentile lowest mean speeds collected over 2014 for these time periods for each data location, four TTI and PTI calculations were made using the following formulas:

TTI = Posted Speed Limit/Mean Peak Hour Speed

PTI = Posted Speed Limit/5th Percentile Lowest Speed

The highest value of the four time periods calculation is defined as the TTI for that data point. The average TTI is calculated within each segment based on the number of data points collected. The value of the average TTI across each entry is used as the TTI for each respective segment within the corridor.

Multimodal Opportunities: Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to a single occupancy vehicle (SOV) for trips along the corridor. The three indicators include the percent bicycle accommodation, non-SOV trips, and transit dependency along the corridor.

Percent Bicycle Accommodation: For this secondary performance evaluation, outside shoulder widths are evaluated considering the roadway's context and conditions. This requires use of the roadway data that includes right shoulder widths, shoulder surface types, and speed limits, all of which are available in the following ADOT geographic information system (GIS) data sets:

- Right Shoulder Widths
- Left Shoulder Widths (for undivided roadways)
- Shoulder Surface Type (Both Left/Right)
- Speed Limit

Additionally, each segment's average AADT, estimated earlier in the Mobility performance area methodology, is used for the criteria to determine if the existing shoulder width meets the effective width.

The criteria for screening if a shoulder segment meets the recommended width criteria are as followed:

(1) If AADT <= 1500 OR Speed Limit <= 25 miles per hour (mph):
The segment's general purpose lane can be shared with bicyclists (no effective shoulder width required)

(2) If AADT > 1500 AND Speed Limit between (25 - 50 mph) AND Pavement Surface is Paved:
Effective shoulder width required is 4 feet or greater

(3) If AADT > 1500 AND Speed Limit >= 50 mph and Pavement Surface is Paved:
Effective shoulder width required is 6 feet or greater

The summation of the length of the shoulder sections that meet the defined effective width criteria, based on criteria above, is divided by the segment's total length to estimate the percent of the segment that accommodates bicycles as illustrated at the end of this section. If shoulder data is not available or appears erroneous, field measurements can substitute for the shoulder data.

Percent Non-SOV Trips: The percentage of non-SOV trips over distances less than 50 miles gives an indication of travel patterns along a section of the corridor that could benefit from additional multimodal options in the future.

Thresholds that determine levels of good, fair, and poor are based on the percent non-SOV trips within each of the identified statewide significant corridors by ADOT. The thresholds shown at the end of this section represent statewide averages across those corridors.

Percent Transit Dependency: 2008-2012 U.S. Census American Community Survey tract and state level geographic data and attributes from the tables B08201 (Number of Vehicles Available by Household Size) and B17001 (Population in Poverty within the Last 12 Months) were downloaded with margins of error included from the Census data retrieval application Data Ferret. Population ranges for each tract were determined by adding and subtracting the margin of error to each estimate in excel. The tract level attribute data was then joined to geographic tract data in GIS. Only tracts within a one mile buffer of each corridor are considered for this evaluation.

Tracts that have a statistically significantly larger number of either people in poverty or households with only one or no vehicles available than the state average are considered potentially transit dependent.

Example: The state average for zero or one vehicles households (HHs) is between 44.1% and 45.0%. Tracts which have the lower bound of their range above the upper bound of the state range have a greater percentage of zero/one vehicle HHs than the state average. Tracts that have their upper bound beneath the lower bound of the state range have a lesser percentage of zero/one vehicles HHs than the state average. All other tracts that have one of their bounds overlapping with the state average cannot be considered statistically significantly different because there is a chance the value is actually the same.

In addition to transit dependency, the following attributes are added to the Multimodal Opportunities map based on available data.

- Shoulder width throughout the corridor based on 'Shoulder Width' GIS dataset provided by ADOT
- Intercity bus routes
- Multiuse paths within the corridor right-of-way, if applicable

Scoring:

Volume-to-Capacity Ratios		
Urban and Fringe Urban		
Good - LOS A-C	V/C ≤ 0.71	*Note - ADOT Roadway Design Standards indicate Urban and Fringe Urban roadways should be designed to level of service C or better
Fair - LOS D	V/C > 0.71 & ≤ 0.89	
Poor - LOS E or less	V/C > 0.89	
Rural		
Good - LOS A-B	V/C ≤ 0.56	*Note - ADOT Roadway Design Standards indicate Rural roadways should be designed to level of service B or better
Fair - LOS C	V/C > 0.56 & ≤ 0.76	
Poor - LOS D or less	V/C > 0.76	

Performance Level	Closure Extent
Good	≤ 0.22
Fair	> 0.22 & ≤ 0.62
Poor	V/C > 0.62

Performance Level	TTI on Uninterrupted Flow Facilities
Good	< 1.15
Fair	≥ 1.15 & < 1.33
Poor	≥ 1.33

Performance Level	TTI on Interrupted Flow Facilities
Good	< 1.30
Fair	≥ 1.30 & < 1.2.00
Poor	≥ 2.00

Performance Level	PTI on Uninterrupted Flow Facilities
Good	< 1.30
Fair	≥ 1.30 & < 1.50
Poor	≥ 1.50

Performance Level	PTI Interrupted Flow Facilities
Good	< 3.00
Fair	≥ 3.00 & < 6.00
Poor	≥ 6.00

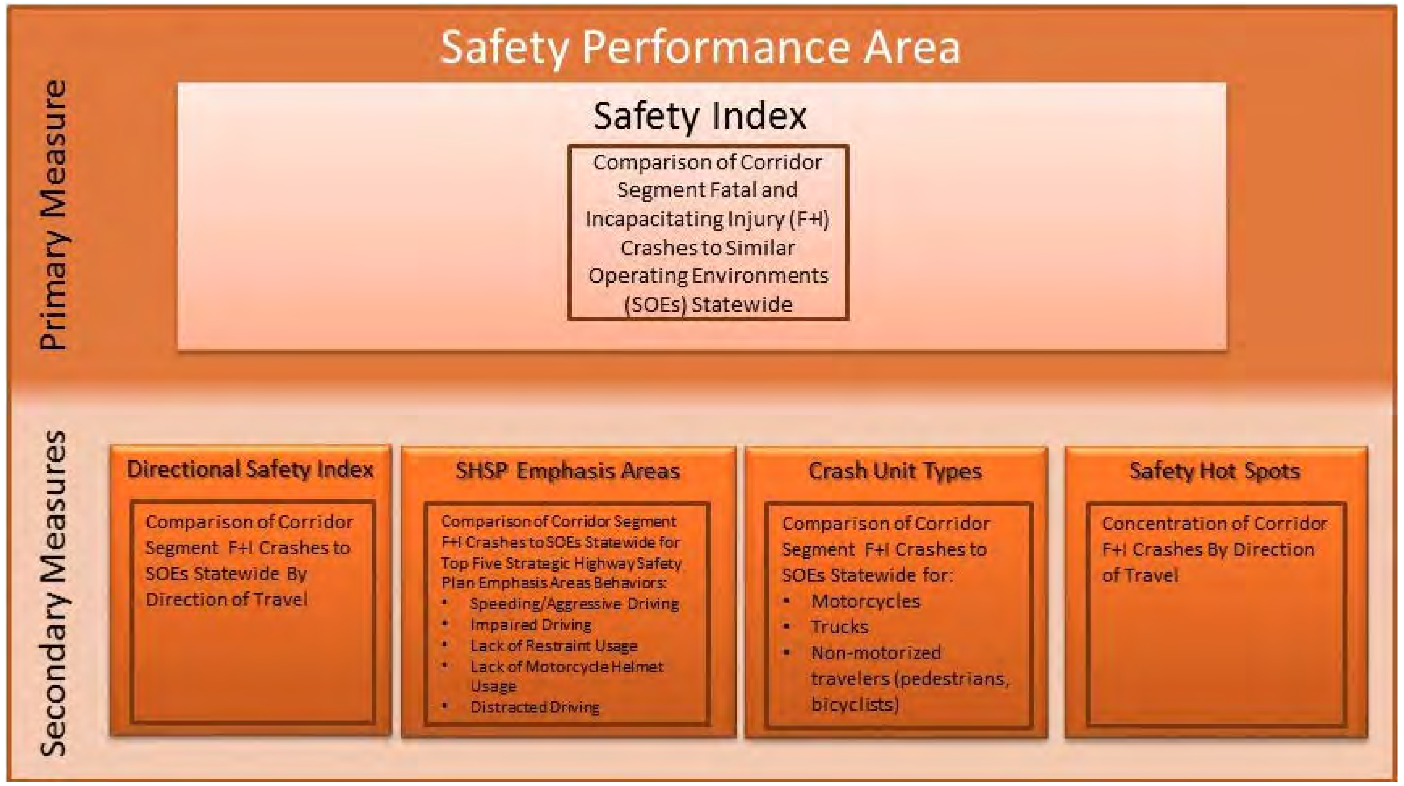
Performance Level	Percent Bicycle Accommodation
Good	≥ 90%
Fair	> 60% & ≤ 90%
Poor	< 60%

Performance Level	Percent Non-SOV Trips
Good	≥ 17%
Fair	> 11% & ≤ 17%
Poor	< 11%

Performance Level	Percent Transit Dependency
Good	Tracts with both zero and one vehicle household population in poverty percentages below the statewide average
Fair	Tracts with either zero and one vehicle household or population in poverty percentages below the statewide average
Poor	Tracts with both zero and one vehicle household and population in poverty percentages above the statewide average

Safety Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Safety performance area as shown in the following graphic:



<u>Primary Safety Index</u>

The Safety Index is a safety performance measure based on the bi-directional (i.e., both directions combined) frequency and rate of fatal and incapacitating injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT's 2010 Highway Safety Improvement Program Manual, fatal crashes have an estimated cost that is 14.5 times the estimated cost of incapacitating injury crashes ($5.8 million compared to $400,000).

The Combined Safety Score (CSS) is an interim measure that combines fatal and incapacitating injury crashes into a single value. The CSS is calculated using the following generalized formula:

*CSS = 14.5 * (Normalized Fatal Crash Rate + Frequency) + (Normalized Incapacitating Injury Crash Rate + Frequency)*

Because crashes vary depending on the operating environment of a particular roadway, statewide CSS values were developed for similar operating environments defined by functional classification, urban vs. rural setting, number of travel lanes, and traffic volumes. To determine the Safety Index of a particular segment, the segment CSS is compared to the average statewide CSS for the similar statewide operating environment.

The Safety Index is calculated using the following formula:

Safety Index = Segment CSS / Statewide Similar Operating Environment CSS

The average annual Safety Index for a segment is compared to the statewide similar operating environment annual average, with one standard deviation from the statewide average forming the scale break points.

The more a particular segment's Safety Index value is below the statewide similar operating environment average, the better the safety performance is for that particular segment as a lower value represents fewer crashes.

<u>Scoring:</u>

The scale for rating the Safety Index depends on the operating environments selected, as shown in the table below.

Similar Operating Environment	Safety Index (Overall & Directional)	
	Lower Limit of Average*	**Upper Limit of Average***
2 or 3 Lane Undivided Highway	0.94	1.06
2 or 3 or 4 Lane Divided Highway	0.77	1.23
4 or 5 Lane Undivided Highway	0.80	1.20
6 Lane Highway	0.56	1.44
Rural 4 Lane Freeway with Daily Volume < 25,000	0.73	1.27
Rural 4 Lane Freeway with Daily Volume > 25,000	0.68	1.32
Urban 4 Lane Freeway	0.79	1.21
Urban or Rural 6 Lane Freeway	0.82	1.18
Urban > 6 Lane Freeway	0.80	1.20

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Some corridor segments may have a very low number of total fatal and incapacitating injury crashes. Low crash frequencies (i.e., a small sample size) can translate into performance ratings that can be unstable. In some cases, a change in crash frequency of one crash (one additional crash or one less crash) could result in a change in segment performance of two levels. To avoid reliance on performance ratings where small changes in crash frequency result in large changes in performance, the following two criteria were developed to identify segments with "insufficient data" for assessing performance for the Safety Index. Both of these criteria must be met for a segment to have "insufficient data" to reliably rate the Safety Index performance:

- If the crash sample size (total fatal plus incapacitating injury crashes) for a given segment is less than five crashes over the five-year analysis period; AND

- If a change in one crash results in a change in segment performance by two levels (i.e., a change from below average to above average performance or a change from above average to below average frequency), the segment has "insufficient data" and Safety Index performance ratings are unreliable.

Secondary Safety Measures

The Safety performance area has four secondary measures related to fatal and incapacitating injury crashes:

- Directional Safety Index
- Strategic Highway Safety Plan (SHSP) Behavior Emphasis Areas
- Crash Unit Types
- Safety Hot Spots

Directional Safety Index: The Direction Safety Index shares the same calculation procedure and thresholds as the Safety Index. However, the measure is based on the directional frequency and rate of fatal and incapacitating injury crashes.

Similar to the Safety Index, the segment CSS is compared to the average statewide CSS for the similar statewide operating environment. The Directional Safety Index follows the lead of the Safety Index in terms of "insufficient data" status. If the Safety Index meets both criteria for "insufficient data", the Directional Safety Index should also be changed to "insufficient data". If the Safety Index does not meet both criteria for "insufficient data", the Directional Safety Index would also not change to say "insufficient data"

SHSP Behavior Emphasis Areas: ADOT's 2014 SHSP identifies several emphasis areas for reducing fatal and incapacitating injury crashes. The top five SHSP emphasis areas relate to the following driver behaviors:

- Speeding and aggressive driving
- Impaired driving
- Lack of restraint usage
- Lack of motorcycle helmet usage
- Distracted driving

To develop a performance measure that reflects these five emphasis areas, the percentage of total fatal and incapacitating injury crashes that involves at least one of the emphasis area driver behaviors on a particular segment is compared to the statewide average percentage of crashes involving at least one of the emphasis area driver behaviors on roads with similar operating environments in a process similar to how the Safety Index is developed.

To increase the crash sample size for this performance measure, the five behavior emphasis areas are combined to identify fatal and incapacitating injury crashes that exhibit one or more of the behavior emphasis areas.

The SHSP behavior emphasis areas performance is calculated using the following formula:

% Crashes Involving SHSP Behavior Emphasis Areas = Segment Crashes Involving SHSP Behavior Emphasis Areas / Total Segment Crashes

The percentage of total crashes involving SHSP behavior emphasis areas for a segment is compared to the statewide percentages on roads with similar operating environments. One standard deviation from the statewide average percentage forms the scale break points.

When assessing the performance of the SHSP behavior emphasis areas, the more the frequency of crashes involving SHSP behavior emphasis areas is below the statewide average implies better levels of segment performance. Thus, lower values are better, similar to the Safety Index.

Scoring:

The scale for rating the SHSP behavior emphasis areas performance depends on the crash history on similar statewide operating environments, as shown in the table below:

Similar Operating Environment	Crashes in SHSP Top 5 Emphasis Areas	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	51.2%	57.5%
2 or 3 or 4 Lane Divided Highway	44.4%	54.4%
4 or 5 Lane Undivided Highway	42.4%	51.1%
6 Lane Highway	35.3%	46.5%
Rural 4 Lane Freeway with Daily Volume < 25,000	42.8%	52.9%
Rural 4 Lane Freeway with Daily Volume > 25,000	40.8%	57.1%
Urban 4 Lane Freeway	49.1%	59.4%
Urban or Rural 6 Lane Freeway	33.5%	57.2%
Urban > 6 Lane Freeway	42.6%	54.8%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

The SHSP behavior emphasis areas secondary safety performance measure for the Safety performance area includes proportions of specific types of crashes within the total fatal and incapacitating injury crash frequencies. This more detailed categorization of fatal and incapacitating injury crashes can result in low crash frequencies (i.e., a small sample size) that translate into performance ratings that can be unstable. In some cases, a change in crash frequency of one crash (one additional crash or one less crash) could result in a change in segment performance of two levels. To avoid reliance on performance ratings where small changes in crash frequency result in large changes in performance, the following criteria were developed to identify segments with "insufficient data" for assessing performance for the SHSP behavior emphasis areas secondary safety performance measure. If any of these criteria are met for a segment, that segment has "insufficient data" to reliably rate the SHSP behavior emphasis areas performance:

- If the crash sample size (total fatal plus incapacitating injury crashes) for a given segment is less than five crashes over the five-year analysis period, the segment has "insufficient data" and performance ratings are unreliable. OR
- If a change in one crash results in a change in segment performance by two levels (i.e., a change from below average to above average performance or a change from above average to below average frequency), the segment has "insufficient data" and performance ratings are unreliable. OR
- If the corridor average segment crash frequency for the SHSP behavior emphasis areas performance measure is less than two crashes over the five-year analysis period, the entire SHSP behavior emphasis areas performance measure has "insufficient data" and performance ratings are unreliable.

Crash Unit Type Emphasis Areas: ADOT's SHSP also identifies emphasis areas that relate to the following "unit-involved" crashes:

- Heavy vehicle (trucks)-involved crashes
- Motorcycle-involved crashes
- Non-motorized traveler (pedestrians and bicyclists)-involved crashes

To develop a performance measure that reflects the aforementioned crash unit type emphasis areas, the percentage of total fatal and incapacitating injury crashes that involves a given crash unit type emphasis area on a particular segment is compared to the statewide average percentage of crashes involving that same crash unit type emphasis area on roads with similar operating environments in a process similar to how the Safety Index is developed.

The SHSP crash unit type emphasis areas performance is calculated using the following formula:

% Crashes Involving Crash Unit Type = Segment Crashes Involving Crash Unit Type / Total Segment Crashes

The percentage of total crashes involving crash unit types for a segment is compared to the statewide percentages on roads with similar operating environments. One standard deviation from the statewide average percentage forms the scale break points.

When assessing the performance of the crash unit types, the more the frequency of crashes involving crash unit types is below the statewide average implies better levels of segment performance. Thus, lower values are better, similar to the Safety Index. The scale for rating the unit-involved crash performance depends on the crash history on similar statewide operating environments, as shown in the following tables.

<u>Scoring:</u>

Similar Operating Environment	Crashes Involving Trucks	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	5.2%	7.1%
2 or 3 or 4 Lane Divided Highway	3.5%	7.3%
4 or 5 Lane Undivided Highway	6.1%	9.6%
6 Lane Highway	0.3%	8.7%
Rural 4 Lane Freeway with Daily Volume < 25,000	13.2%	17.0%
Rural 4 Lane Freeway with Daily Volume > 25,000	7.2%	12.9%
Urban 4 Lane Freeway	6.8%	10.9%
Urban or Rural 6 Lane Freeway	6.2%	11.0%
Urban > 6 Lane Freeway	2.5%	6.0%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Similar Operating Environment	Crashes Involving Motorcycles	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	18.5%	26.5%
2 or 3 or 4 Lane Divided Highway	16.3%	26.3%
4 or 5 Lane Undivided Highway	6.4%	9.4%
6 Lane Highway	0.0%	20.0%
Rural 4 Lane Freeway with Daily Volume < 25,000	5.0%	8.5%
Rural 4 Lane Freeway with Daily Volume > 25,000	7.7%	17.1%
Urban 4 Lane Freeway	9.3%	11.5%
Urban or Rural 6 Lane Freeway	6.7%	12.9%
Urban > 6 Lane Freeway	12.6%	20.5%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

Similar Operating Environment	Crashes Involving Non-Motorized Travelers	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	2.2%	4.2%
2 or 3 or 4 Lane Divided Highway	2.4%	4.5%
4 or 5 Lane Undivided Highway	4.7%	7.9%
6 Lane Highway	8.4%	17.4%
Rural 4 Lane Freeway with Daily Volume < 25,000	1.7%	2.5%
Rural 4 Lane Freeway with Daily Volume > 25,000	0.0%	0.0%
Urban 4 Lane Freeway	4.8%	10.3%
Urban or Rural 6 Lane Freeway	0.9%	6.7%
Urban > 6 Lane Freeway	0.5%	1.5%

** Lower/upper limit of Average calculated as one standard deviation below/above the Mean*

The crash unit types have the same "insufficient data" criteria as the SHSP behavior emphasis areas.

Safety Hot Spots: A hot spot analysis was conducted that identified abnormally high concentrations of fatal and incapacitating injury crashes along the study corridor by direction of travel. The identification of crash concentrations involves a GIS-based function known as "kernel density analysis". This measure is mapped for graphical display purposes with the Directional Safety Index but is not included in the Safety performance area rating calculations.

Freight Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Freight performance area as shown in the following graphic:

<u>Primary Freight Index</u>

The Freight Index is a reliability performance measure based on the planning time index for truck travel. The industry standard definition for the Truck Planning Time Index (TPTI) is the ratio of total travel time needed for 95% on-time arrival to free-flow travel time. The TPTI reflects the extra buffer time needed for on-time delivery while accounting for non-recurring delay. Non-recurring delay refers to unexpected or abnormal delay due to closures or restrictions resulting from circumstances such as crashes, inclement weather, and construction activities.

The TPTI can be converted into a speed-based index by recognizing that speed is equal to distance traveled divided by travel time. The inverse relationship between travel time and speed means that the 95th percentile highest travel time corresponds to the 5th percentile lowest speed. The speed-based TPTI is calculated using the following formula:

TPTI = Free-Flow Truck Speed / Observed 5th Percentile Lowest Truck Speed

Observed 5th percentile lowest truck speeds are available in the 2014 American Digital Cartography, Inc. HERE (formerly NAVTEQ) database to which ADOT has access. The free-flow truck speed is assumed to be 65 miles per hour or the posted speed, whichever is less. This upper limit of 65 mph accounts for governors that trucks often have that restrict truck speeds to no more than 65 mph, even when the speed limit may be higher.

For each corridor segment, the TPTI is calculated for each direction of travel and then averaged to create a bi-directional TPTI. When assessing performance using TPTI, the higher the TPTI value is above 1.0, the more buffer time is needed to ensure on-time delivery.

The Freight Index is calculated using the following formula to invert the overall TPTI:

Freight Index = 1 / Bi-directional TPTI

Inversion of the TPTI allows the Freight Index to have a scale where the higher the value, the better the performance, which is similar to the directionality of the scales of most of the other primary measures. This Freight Index scale is based on inverted versions of TPTI scales created previously by ADOT. The scale for rating the Freight Index differs between uninterrupted and interrupted flow facilities.

<u>Secondary Freight Measures</u>

The Freight performance area includes five secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

- Recurring Delay (Directional TTTI)
- Non-Recurring Delay (Directional TPTI)
- Closure Duration
- Bridge Vertical Clearance
- Bridge Vertical Clearance Hot Spots

Recurring Delay (Directional TTTI): The performance measure for recurring delay is the Directional Truck Travel Time Index (TTTI). The industry standard definition for TTTI is the ratio of average peak period travel time to free-flow travel time. The TTTI reflects the extra time spent in traffic during peak times due to recurring delay. Recurring delay refers to expected or normal delay due to roadway capacity constraints or traffic control devices.

Similar to the TPTI, the TTTI can be converted into a speed-based index by recognizing that speed is equal to distance traveled divided by travel time. The speed-based TTTI can be calculated using the following formula:

TTTI = Free-Flow Truck Speed / Observed Average Peak Period Truck Speed

Observed average peak period truck speeds are available in the 2014 American Digital Cartography, Inc. HERE (formerly NAVTEQ) database to which ADOT has access. The free-flow truck speed is assumed to be 65 mph or the posted speed, whichever is less.

For each corridor segment, the TTTI is calculated for each direction of travel. With the TTTI, the higher the TTTI value is above 1.0, the more time is spent in traffic during peak times. TTTI values are generally lower than TPTI values. The Directional TTTI scale is based on TTTI scales created previously by ADOT.

Non-Recurring Delay (Directional TPTI): The performance measure for non-recurring delay is the Directional TPTI. Directional TPTI is calculated as described previously as an interim step in the development of the Freight Index.

For each corridor segment, the TPTI is calculated for each direction of travel. With the TPTI, the higher the TPTI value is above 1.0, the more buffer time is needed to ensure on-time delivery.

Closure Duration: This performance measure related to road closures is average roadway closure (i.e., full lane closure) duration time in minutes. There are three main components to full closures that affect reliability – frequency, duration, and extent. In the freight industry, closure duration is the most important component because trucks want to minimize travel time and delay.

Data on the frequency, duration, and extent of full roadway closures on the ADOT State Highway System is available for 2010-2014 in the HCRS database that is managed and updated by ADOT.

The average closure duration in a segment – in terms of the average time a milepost is closed per mile per year on a given segment – is calculated using the following formula:

*Closure Duration = Sum of Segment (Closure Clearance Time * Closure Extent) / Segment Length*

The segment closure duration time in minutes can then be compared to statewide averages for closure duration in minutes, with one-half standard deviation from the average forming the scale break points. The scale for rating closure duration in minutes is found at the end of this section.

Bridge Vertical Clearance: This performance measure uses the vertical clearance information from the ADOT Bridge Database to identify locations with low vertical clearance. The minimum vertical clearance for all underpass structures (i.e., structures under which mainline traffic passes) is determined for each segment.

Bridge Vertical Clearance Hot Spots: This performance measure related to truck restrictions is the locations, or hot spots, where bridge vertical clearance issues restrict truck travel. Sixteen feet three inches (16.25’) is the minimum standard vertical clearance value for state highway bridges over travel lanes.

Locations with lower vertical clearance values than the minimum standard are categorized by the ADOT Intermodal Transportation Department Engineering Permits Section as either locations where ramps exist that allow the restriction to be avoided or locations where ramps do not exist and the restriction cannot be avoided. The locations with vertical clearances below the minimum standard that cannot be ramped around are considered hot spots. This measure is mapped for graphical display purposes with the bridge vertical clearance map but is not included in the Freight performance area rating calculations.

Scoring:

Performance Level	Freight Index	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	> 0.77	> 0.33
Fair	0.67 – 0.77	0.17 – 0.33
Poor	< 0.67	< 0.17

Performance Level	TTTI	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	< 1.15	< 1.30
Fair	1.15 – 1.33	1.30 – 2.00
Poor	> 1.33	> 2.00

Performance Level	TPTI	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	< 1.30	< 3.00
Fair	1.30 – 1.50	3.00 – 6.00
Poor	> 1.50	> 6.00

Performance Level	Closure Duration (minutes)
Good	< 44.18
Fair	44.18 – 124.86
Poor	> 124.86

Performance Level	Bridge Vertical Clearance
Good	> 16.5’
Fair	16.0’ – 16.5’
Poor	< 16.0’

Appendix C: Performance Area Data

Pavement Performance Area Data

				EB			WB			EB		WB		Composite		Pavement Index	% Pavement Failure	
				# of Lanes	IRI	Cracking	# of Lanes	IRI	Cracking	PSR	PDI	PSR	PDI	EB	WB		EB	WB
Segment 1			*Interstate?*	No														
Milepost	185	to	186	2	120.84	15.00		-	-	3.16	2.9	-	-	3.01	-		0	0
Milepost	186	to	187	2	120.84	15.00		-	-	3.16	2.9	-	-	3.01	-		0	0
Milepost	187	to	188	2	122.43	6.00		-	-	3.14	3.9	-	-	3.36	-		0	0
Milepost	188	to	189	4	91.07	25.00		-	-	3.54	2.1	-	-	2.11	-		4	0
Milepost	189	to	190	2	94.65	4.00		-	-	3.49	4.1	-	-	3.68	-		0	0
Milepost	190	to	191	2	119.32	8.00		-	-	3.18	3.6	-	-	3.32	-		0	0
Milepost	191	to	192	2	114.18	6.00		-	-	3.24	3.9	-	-	3.43	-		0	0
Milepost	192	to	193	2	99.77	12.00		-	-	3.42	3.2	-	-	3.28	-		0	0
Milepost	193	to	194	2	105.28	3.00		-	-	3.35	4.3	-	-	3.63	-		0	0
Milepost	194	to	195	2	97.19	8.00		-	-	3.46	3.6	-	-	3.51	-		0	0
Milepost	195	to	196	2	120.14	4.00		-	-	3.17	4.1	-	-	3.46	-		0	0
Milepost	196	to	197	2	134.76	12.00		-	-	3.00	3.2	-	-	3.06	-		0	0
Milepost	197	to	198	2	99.13	10.00		-	-	3.43	3.4	-	-	3.43	-		0	0
Milepost	198	to	199	2	145.87	9.00		-	-	2.87	3.5	-	-	2.87	-		2	0
Milepost	199	to	200	2	109.80	30.00		-	-	3.29	1.7	-	-	1.74	-		2	0
Milepost	200	to	201	2	106.97	10.00		-	-	3.33	3.4	-	-	3.36	-		0	0
Milepost	201	to	202	2	113.38	9.00		-	-	3.25	3.5	-	-	3.33	-		0	0
Milepost	202	to	203	2	120.17	5.00		-	-	3.17	4.0	-	-	3.42	-		0	0
Milepost	203	to	204	2	129.75	8.00		-	-	3.05	3.6	-	-	3.23	-		0	0
Milepost	204	to	205	2	132.83	9.00		-	-	3.02	3.5	-	-	3.17	-		0	0
Milepost	205	to	206	2	223.83	7.00		-	-	2.14	3.8	-	-	2.14	-		2	0
Milepost	206	to	207	2	223.23	12.00		-	-	2.14	3.2	-	-	2.14	-		2	0
Milepost	207	to	208	2	172.21	20.00		-	-	2.60	2.5	-	-	2.51	-		2	0
Milepost	208	to	209	2	129.48	20.00		-	-	3.06	2.5	-	-	2.51	-		2	0
Milepost	209	to	210	2	142.93	8.00		-	-	2.90	3.6	-	-	3.12	-		2	0
Milepost	210	to	211	2	173.98	30.00		-	-	2.58	1.7	-	-	1.74	-		2	0
Milepost	211	to	212	2	184.75	55.00		-	-	2.48	0.1	-	-	0.14	-		2	0
Milepost	212	to	213	2	102.89	5.00		-	-	3.38	4.0	-	-	3.57	-		0	0
			Total	58			0											22
			Weighted Average							3.09	3.19	-	-	2.88	-			
			Factor							1.00		1.00						
			Indicator Score							**3.09**		**-**						**37.9%**
			Pavement Index													**2.88**		

				EB			WB			EB		WB		Composite		Pavement Index	% Pavement Failure	
				# of Lanes	IRI	Cracking	# of Lanes	IRI	Cracking	PSR	PDI	PSR	PDI	EB	WB		EB	WB
Segment 2		***Interstate?***		**No**														
Milepost	213	to	214	2	133.00	8.00		-	-	3.02	3.6	-	-	3.20	-		0	0
Milepost	214	to	215	2	74.55	1.00		-	-	3.77	4.7	-	-	4.03	-		0	0
Milepost	215	to	216	2	67.86	9.00		-	-	3.86	3.5	-	-	3.63	-		0	0
Milepost	216	to	217	2	72.32	7.00		-	-	3.80	3.8	-	-	3.77	-		0	0
Milepost	217	to	218	2	88.49	5.00		-	-	3.57	4.0	-	-	3.70	-		0	0
Milepost	218	to	219	2	107.56	5.00		-	-	3.32	4.0	-	-	3.53	-		0	0
Milepost	219	to	220	2	104.26	8.00		-	-	3.36	3.6	-	-	3.45	-		0	0
Milepost	220	to	221	2	101.04	4.00		-	-	3.41	4.1	-	-	3.63	-		0	0
Milepost	221	to	222	2	81.58	6.00		-	-	3.67	3.9	-	-	3.73	-		0	0
Milepost	222	to	223	2	98.83	7.00		-	-	3.43	3.8	-	-	3.53	-		0	0
Milepost	223	to	224	2	103.21	6.00		-	-	3.38	3.9	-	-	3.53	-		0	0
Milepost	224	to	225	2	112.97	6.00		-	-	3.25	3.9	-	-	3.44	-		0	0
Milepost	225	to	226	2	109.96	7.00		-	-	3.29	3.8	-	-	3.43	-		0	0
Milepost	226	to	227	2	102.95	8.00		-	-	3.38	3.6	-	-	3.46	-		0	0
Milepost	227	to	228	2	96.56	3.00		-	-	3.46	4.3	-	-	3.71	-		0	0
Milepost	228	to	229	2	104.30	8.00		-	-	3.36	3.6	-	-	3.45	-		0	0
Milepost	229	to	230	2	86.05	6.00		-	-	3.61	3.9	-	-	3.69	-		0	0
Milepost	230	to	231	2	78.76	4.00		-	-	3.71	4.1	-	-	3.84	-		0	0
Milepost	231	to	232	2	98.96	3.00		-	-	3.43	4.3	-	-	3.69	-		0	0
Milepost	232	to	233	2	78.47	12.00		-	-	3.71	3.2	-	-	3.37	-		0	0
Milepost	233	to	234	2	83.73	3.00		-	-	3.64	4.3	-	-	3.83	-		0	0
			Total	42			0											0
			Weighted Average							3.50	3.90	-	-	3.60	-			
			Factor							1.00		1.00						
			Indicator Score							**3.50**		**-**						**0.0%**
			Pavement Index													**3.60**		
Segment 3		***Interstate?***		**No**														
Milepost	234	to	235	2	78.42	9.00		-	-	3.71	3.5	-	-	3.58	-		0	0
Milepost	235	to	236	2	107.50	5.00		-	-	3.32	4.0	-	-	3.53	-		0	0
Milepost	236	to	237	2	92.93	0.00		-	-	3.51	5.0	-	-	3.96	-		0	0
			Total	6			0											0
			Weighted Average							3.52	4.18	-	-	3.69	-			
			Factor							1.00		1.00						
			Indicator Score							**3.52**		**-**						**0.0%**
			Pavement Index													**3.69**		

Bridge Performance Area Data

Structure Name (A209)	Structure # (N8)	Milepost (A232)	Area (A225)	Bridge Sufficiency	Bridge Index					Functionally Obsolete Bridges	Bridge Rating	Hot Spots on Bridge Index map
				Sufficiency Rating	Deck (N58)	Sub (N59)	Super (N60)	Eval (N67)	Lowest	Deck Area on Func Obsolete		
Segment 1												
Cataract Canyon Bridge	2735	187.33	4961	84.60	7.00	7.00	7.00	7.00	7.0	0		
Total			4,961									
Weighted Average				84.60					7.00	0.00%		
Factor				1.00					1.00	1.00		
Indicator Score				**84.60**						**0.00%**	**7**	
Bridge Index									**7.00**			
Segment 2												
#N/A		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		
Total			#N/A									
Weighted Average				#N/A					#N/A	#N/A		
Factor				1.00					1.00	1.00		
Indicator Score				**#N/A**						**#N/A**	**#N/A**	
Bridge Index									**#N/A**			
Segment 3												
#N/A		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		
Total			#N/A									
Weighted Average				#N/A					#N/A	#N/A		
Factor				1.00					1.00	1.00		
Indicator Score				**#N/A**						**#N/A**	**#N/A**	
Bridge Index									**#N/A**			

Mobility Performance Area Data

Segment	Begin MP	End MP	Length (mi)	Facility Type	Flow Type	Terrain	No. of Lanes	Capacity Environment Type	Lane Width (feet)	Weighted Average Posted Speed Limit (mph)	Divided or Undivided	Access Points (per mile)	% No-Passing Zone	Street Parking
64-1	185	213	28	Rural	Uninterrupted	Level	2	Rural Two-Lane, Non-Signalized	12.00	65	Undivided	2.4	40%	N/A
64-2	213	234	21	Rural	Uninterrupted	Level	2	Rural Two-Lane, Non-Signalized	12.00	64	Undivided	2.0	41%	N/A
64-3	234	237	3	Rural	Interrupted	Level	2	Urban/Rural Single or Multilane Signalized	12.00	44	Undivided	10.0	16%	N/A

Car TTI and PTI/Truck TTTI and TPTI – Eastbound

Segment	TMC	timeperiod	week_type	ROAD_NUMBER	cars_mean	trucks_mean	cars_P05	trucks_P05	Posted Speed limit	Assumed car free-flow speed	Assumed truck free-flow speed	cars_TTI	Trucks_TTI	cars_PTI	Trucks_PTI	Cars_PeakTTI	Trucks_PeakTTI	Cars_PeakPTI	Trucks_PeakPTI
64-1	115P05909	1 AM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	No Data	No Data	No Data	No Data
64-1	115P05909	2 Mid Day	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115P05909	3 PM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115P05909	4 Evening	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115P06990	1 AM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	No Data	No Data	No Data	No Data
64-1	115P06990	2 Mid Day	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115P06990	3 PM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115P06990	4 Evening	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115P06991	1 AM Peak	Weekday	AZ-64	65.863	62.6913	55.9792	53.3493	65	65	65	1.00	1.04	1.16	1.22	1.00	1.07	1.20	1.54
64-1	115P06991	2 Mid Day	Weekday	AZ-64	65.33	63.8551	54.821	52.6427	65	65	65	1.00	1.02	1.19	1.23				
64-1	115P06991	3 PM Peak	Weekday	AZ-64	65.496	60.8359	55.5878	42.2822	65	65	65	1.00	1.07	1.17	1.54				
64-1	115P06991	4 Evening	Weekday	AZ-64	65.243	65.0658	54.0752	51.6172	65	65	65	1.00	1.00	1.20	1.26				
64-1	115P06992	1 AM Peak	Weekday	AZ-64	65.993	61.562	56.2595	28.5979	65	65	65	1.00	1.06	1.16	2.27	1.00	1.14	1.24	2.83
64-1	115P06992	2 Mid Day	Weekday	AZ-64	65.474	61.2304	55.9266	22.9966	65	65	65	1.00	1.06	1.16	2.83				
64-1	115P06992	3 PM Peak	Weekday	AZ-64	65.255	56.7884	55.2725	42.2822	65	65	65	1.00	1.14	1.18	1.54				
64-1	115P06992	4 Evening	Weekday	AZ-64	65.179	64.0124	52.3634	56.5964	65	65	65	1.00	1.02	1.24	1.15				
64-1	115P06993	1 AM Peak	Weekday	AZ-64	66.319	63.1831	58.1721	51.9444	65	65	65	1.00	1.03	1.12	1.25	1.00	1.07	1.19	3.74
64-1	115P06993	2 Mid Day	Weekday	AZ-64	65.911	63.532	57.8568	55.8878	65	65	65	1.00	1.02	1.12	1.16				
64-1	115P06993	3 PM Peak	Weekday	AZ-64	66.496	60.7669	57.8568	17.3995	65	65	65	1.00	1.07	1.12	3.74				
64-1	115P06993	4 Evening	Weekday	AZ-64	65.656	64.2067	54.7414	53.5066	65	65	65	1.00	1.01	1.19	1.21				
64-2	115P05910	1 AM Peak	Weekday	AZ-64	64.771	60.4648	49.8938	46.5969	45	45	45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.29
64-2	115P05910	2 Mid Day	Weekday	AZ-64	63.408	59.812	47.5749	41.6437	45	45	45	1.00	1.00	1.00	1.08				
64-2	115P05910	3 PM Peak	Weekday	AZ-64	63.58	56.0745	47.221	13.6719	45	45	45	1.00	1.00	1.00	3.29				
64-2	115P05910	4 Evening	Weekday	AZ-64	62.821	61.1271	45.397	44.7567	45	45	45	1.00	1.00	1.00	1.01				
64-2	115P06986	1 AM Peak	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	No Data	No Data	No Data	No Data
64-2	115P06986	2 Mid Day	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-2	115P06986	3 PM Peak	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-2	115P06986	4 Evening	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-2	115P06987	1 AM Peak	Weekday	AZ-64	63.265	57.5052	43.5067	28.6	65	65	65	1.03	1.13	1.49	2.27	1.08	1.22	2.97	3.74
64-2	115P06987	2 Mid Day	Weekday	AZ-64	61.982	58.2786	44.1081	19.8853	65	65	65	1.05	1.12	1.47	3.27				
64-2	115P06987	3 PM Peak	Weekday	AZ-64	61.596	53.0916	38.9084	24.8609	65	65	65	1.06	1.22	1.67	2.61				
64-2	115P06987	4 Evening	Weekday	AZ-64	60.05	56.26	21.8527	17.4027	65	65	65	1.08	1.16	2.97	3.74				
64-2	115P06988	1 AM Peak	Weekday	AZ-64	66.555	60.5646	58.7484	51.6089	65	65	65	1.00	1.07	1.11	1.26	1.01	1.10	1.21	1.36
64-2	115P06988	2 Mid Day	Weekday	AZ-64	65.555	61.908	57.057	54.6447	65	65	65	1.00	1.05	1.14	1.19				
64-2	115P06988	3 PM Peak	Weekday	AZ-64	66.264	63.4487	58.06	57.8341	65	65	65	1.00	1.02	1.12	1.12				
64-2	115P06988	4 Evening	Weekday	AZ-64	64.427	58.8772	53.7554	47.8691	65	65	65	1.01	1.10	1.21	1.36				
64-3	115P06989	1 AM Peak	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	No Data	No Data	No Data	No Data
64-3	115P06989	2 Mid Day	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-3	115P06989	3 PM Peak	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-3	115P06989	4 Evening	Weekday	AZ-64					45	45	45	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-3	115P06988	1 AM Peak	Weekday	AZ-64	66.555	60.5646	58.7484	51.6089		0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
64-3	115P06988	2 Mid Day	Weekday	AZ-64	65.555	61.908	57.057	54.6447		0	0	1.00	1.00	1.00	1.00				
64-3	115P06988	3 PM Peak	Weekday	AZ-64	66.264	63.4487	58.06	57.8341		0	0	1.00	1.00	1.00	1.00				
64-3	115P06988	4 Evening	Weekday	AZ-64	64.427	58.8772	53.7554	47.8691		0	0	1.00	1.00	1.00	1.00				

Car TTI and PTI/Truck TTTI and TPTI – Westbound

Segment	TMC	timeperiod	week_type	ROAD_NUMBER	cars_mean	trucks_mean	cars_P05	trucks_P05	Posted Speed limit	Assumed car free-flow speed	Assumed truck free-flow speed	cars_TTI	Trucks_TTI	cars_PTI	Trucks_PTI	Cars_PeakTTI	Trucks_PeakTTI	Cars_PeakPTI	Trucks_PeakPTI
64-1	115N05909	1 AM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	No Data	No Data	No Data	No Data
64-1	115N05909	2 Mid Day	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115N05909	3 PM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115N05909	4 Evening	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115N06990	1 AM Peak	Weekday	AZ-64	62.353	61.2667	47.8859	43.9174	65	65	65	1.04	1.06	1.36	1.48	1.07	1.11	1.49	2.05
64-1	115N06990	2 Mid Day	Weekday	AZ-64	60.755	59.8586	43.6761	44.6576	65	65	65	1.07	1.09	1.49	1.46				
64-1	115N06990	3 PM Peak	Weekday	AZ-64	62.417	58.6248	51.6172	31.6695	65	65	65	1.04	1.11	1.26	2.05				
64-1	115N06990	4 Evening	Weekday	AZ-64	61.967	61.3556	51.2842	44.4081	65	65	65	1.05	1.06	1.27	1.46				
64-1	115N06991	1 AM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	No Data	No Data	No Data	No Data
64-1	115N06991	2 Mid Day	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115N06991	3 PM Peak	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115N06991	4 Evening	Weekday	AZ-64					65	65	65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				
64-1	115N06992	1 AM Peak	Weekday	AZ-64	66.167	65.2589	56.4792	59.6345	65	65	65	1.00	1.00	1.15	1.09	1.00	1.03	1.18	1.21
64-1	115N06992	2 Mid Day	Weekday	AZ-64	65.047	63.0869	55.0236	53.5066	65	65	65	1.00	1.03	1.18	1.21				
64-1	115N06992	3 PM Peak	Weekday	AZ-64	65.865	64.6788	57.5449	59.3032	65	65	65	1.00	1.00	1.13	1.10				
64-1	115N06992	4 Evening	Weekday	AZ-64	65.303	65.8012	56.182	55.8878	65	65	65	1.00	1.00	1.16	1.16				
64-1	115N06993	1 AM Peak	Weekday	AZ-64	63.147	61.6314	47.8596	46.5908	65	65	65	1.03	1.05	1.36	1.40	1.03	1.08	1.37	1.50
64-1	115N06993	2 Mid Day	Weekday	AZ-64	62.944	60.3237	47.2873	43.4549	65	65	65	1.03	1.08	1.37	1.50				
64-1	115N06993	3 PM Peak	Weekday	AZ-64	64.164	62.2483	51.2726	50.6163	65	65	65	1.01	1.04	1.27	1.28				
64-1	115N06993	4 Evening	Weekday	AZ-64	62.92	62.6663	49.276	50.9423	65	65	65	1.03	1.04	1.32	1.28				
64-2	115N05910	1 AM Peak	Weekday	AZ-64	46.406	36.4905	19.4616	24.327	45	45	45	1.00	1.23	2.31	1.85	1.04	No Data	2.77	No Data
64-2	115N05910	2 Mid Day	Weekday	AZ-64	43.162	41.1886	16.218	13.9011	45	45	45	1.04	1.09	2.77	3.24				
64-2	115N05910	3 PM Peak	Weekday	AZ-64	43.169	.	16.218	.	45	45	45	1.04	#VALUE!	2.77	#VALUE!				
64-2	115N05910	4 Evening	Weekday	AZ-64	43.62	21.624	16.218	16.218	45	45	45	1.03	2.08	2.77	2.77				
64-2	115N06986	1 AM Peak	Weekday	AZ-64	61.242	59.0953	38.6466	32.9293	45	45	45	1.00	1.00	1.16	1.37	1.00	1.00	1.16	3.29
64-2	115N06986	2 Mid Day	Weekday	AZ-64	61.105	58.3993	41.1971	35.4062	45	45	45	1.00	1.00	1.09	1.27				
64-2	115N06986	3 PM Peak	Weekday	AZ-64	61.823	58.3691	44.7265	31.6936	45	45	45	1.00	1.00	1.01	1.42				
64-2	115N06986	4 Evening	Weekday	AZ-64	60.267	51.4964	42.165	13.6735	45	45	45	1.00	1.00	1.07	3.29				
64-2	115N06987	1 AM Peak	Weekday	AZ-64	64.813	63.5319	56.1942	58.4022	65	65	65	1.00	1.02	1.16	1.11	1.01	1.06	1.20	1.27
64-2	115N06987	2 Mid Day	Weekday	AZ-64	65.494	62.4422	57.2769	51.6089	65	65	65	1.00	1.04	1.13	1.26				
64-2	115N06987	3 PM Peak	Weekday	AZ-64	65.999	63.1498	58.6326	53.7554	65	65	65	1.00	1.03	1.11	1.21				
64-2	115N06987	4 Evening	Weekday	AZ-64	64.458	61.2644	54.345	50.9892	65	65	65	1.01	1.06	1.20	1.27				
64-2	115N06988	1 AM Peak	Weekday	AZ-64	39.255	35.7053	9.9449	5.5932	65	65	65	1.66	1.82	6.54	11.62	1.66	1.92	6.54	11.62
64-2	115N06988	2 Mid Day	Weekday	AZ-64	41.681	46.6909	12.7134	16.776	65	65	65	1.56	1.39	5.11	3.87				
64-2	115N06988	3 PM Peak	Weekday	AZ-64	46.287	45.4801	21.7457	16.776	65	65	65	1.40	1.43	2.99	3.87				
64-2	115N06988	4 Evening	Weekday	AZ-64	40.829	33.9147	12.223	11.1864	65	65	65	1.59	1.92	5.32	5.81				
64-3	115N06989	1 AM Peak	Weekday	AZ-64	38.87	40.1545	23.6207	25.492	45	45	45	1.16	1.12	1.91	1.77	1.21	1.37	2.04	1.96
64-3	115N06989	2 Mid Day	Weekday	AZ-64	38.29	36.3456	22.0623	22.9841	45	45	45	1.18	1.24	2.04	1.96				
64-3	115N06989	3 PM Peak	Weekday	AZ-64	37.918	37.3914	23.3299	24.8603	45	45	45	1.19	1.20	1.93	1.81				
64-3	115N06989	4 Evening	Weekday	AZ-64	37.195	32.8445	24.8603	23.6207	45	45	45	1.21	1.37	1.81	1.91				

Closure Data

Segment	Length (miles)	# of closures	Total miles of closures EB	Total miles of closures WB	Average Occurrences/Mile/Year EB	Average Occurrences/Mile/Year WB
64-1	28	11	46.3	4.0	0.33	0.03
64-2	21	7	29.0	1.0	0.28	0.01
64-3	3	2	3.0	1.0	0.20	0.07

Segment	ITIS Category Description											
	Closures		Incidents/Accidents		Incidents/Crashes		Obstruction Hazards		Winds		Winter Storm Codes	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
64-1	0	0	0	0	0	0	0	0	0	0	0	0
64-2	0	0	0	0	0	0	0	0	0	0	0	0
64-3	0	0	0	0	0	0	0	0	0	0	0	0

HPMS Data

SEGMENT	MP_FROM	MP_TO	WEIGHTED AVERAGE EB AADT	WEIGHTED AVERAGE WB AADT	WEIGHTED AVERAGE AADT	EB AADT	WB AADT	2015 AADT	K Factor	D-Factor	T-Factor
64-1	185	213	2484	2484	4968	2442	2441	4883	10	50	14
64-2	213	234	2570	2464	5035	3155	2946	6102	12	52	16
64-3	234	237	3270	3247	6518	3604	3559	7163	8	50	14

SEGMENT	Loc ID	BMP	EMP	Length	Pos Dir AADT	Neg Dir AADT	Corrected Pos Dir AADT	Corrected Neg Dir AADT	2015 AADT	K Factor	D-Factor	D-Factor Adjusted	T-Factor
64-1	100707	185.00	191.09	6.09	3307	3306	3307	3306	6613	9	53	50	14
	100708	191.09	213.00	21.91	0	0	2201	2201	4402	10	56	50	14
64-2	100708	213.00	213.46	0.46	0	0	2201	2201	4402	10	56	50	14
	100709	213.46	234.00	20.54	3176	2963	3176	2963	6140	12	56	52	17
64-3	100709	234.00	234.64	0.64	3176	2963	3176	2963	6140	12	56	52	17
	100710	234.64	237.00	2.36	0	0	3721	3721	7441	7	58	50	13

Bicycle Accommodation Data

Segment	BMP	EMP	Divided or Non	EB Right Shoulder Width	WB Right Shoulder Width	EB Left Shoulder Width	WB Left Shoulder Width	EB Effective Length of Shoulder	WB Effective Length of Shoulder	% Bicycle Accommodation
64-1	185	213	Undivided	5.3	5.2	N/A	N/A	1.5	1.1	5%
64-2	213	234	Undivided	5.0	5.2	N/A	N/A	0.6	0.9	4%
64-3	234	237	Undivided	8.2	7.9	N/A	N/A	2.9	2.8	95%

AZTDM Data

SEGMENT	Growth Rate	% Non-SOV
64-1	-0.09%	13.9%
64-2	1.53%	16.8%
64-3	1.77%	10.6%

HERS Capacity Calculation Data

Segment	Capacity Environment Type	Facility Type	Terrain	Lane Width	EB Rt. Shoulder	WB Rt. Shoulder	F_{lw} or f_w or f_{LS}	EB F_{lc}	WB F_{lc}	Total Ramp Density	PHF	E_T	f_{HV}	f_M	f_A	g/C	f_G	f_{NP}	Nm	f_p	EB FFS	WB FFS	EB Peak-Hour Capacity	WB Peak-Hour Capacity	Major Direction Peak-Hour Capacity	Daily Capacity
64-1	4	Rural	Rolling	12.00	5.26	5.20	0.0	N/A	N/A	N/A	0.88	1.5	0.934	N/A	0.59	N/A	1	4	3.30	N/A	74.41	74.41	N/A	N/A	1648.30	31,396
64-2	4	Rural	Rolling	12.00	5.04	5.19	0.0	N/A	N/A	N/A	0.88	1.3	0.954	N/A	0.51	N/A	1	4	2.30	N/A	73.49	73.49	N/A	N/A	1687.40	32,141
64-3	3	Rural	Rolling	12.00	8.22	7.87	1.0	N/A	N/A	N/A	0.9	1.5	0.934	N/A	0.59	N/A	1	4	3.30	N/A	N/A	N/A	N/A	N/A	825.00	15,714

Safety Performance Area Data

Segment	Operating Environment	Segment Length (miles)	EB Fatal Crashes 2010-2014	WB Fatal Crashes 2010-2014	EB Incapacitating Injury Crashes	WB Incapacitating Injury Crashes	Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors
64-1	2 or 3 Lane Undivided Highway	28	1	0	1	3	1
64-2	2 or 3 Lane Undivided Highway	21	0	1	2	2	3
64-3	4 or 5 Lane Undivided Highway	3	0	0	0	1	0

Segment	Operating Environment	Fatal + Incapacitating Injury Crashes Involving Trucks	Fatal + Incapacitating Injury Crashes Involving Motorcycles	Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Weighted 5-Year (2011-2015) Average EB AADT	Weighted 5-Year (2011-2015) Average WB AADT	Weighted 5-Year (2011-2015) Average Total AADT
64-1	2 or 3 Lane Undivided Highway	0	0	1	2468	2468	4935
64-2	2 or 3 Lane Undivided Highway	0	1	0	2577	2469	5047
64-3	4 or 5 Lane Undivided Highway	0	0	1	3458	3458	6917

HPMS Data

2010-2014 Weighted Average						2015			2014			2013			2012			2011		
SEGMENT	MP_FROM	MP_TO	WEIGHTED AVERAGE EB AADT	WEIGHTED AVERAGE WB AADT	WEIGHTED AVERAGE AADT	EB AADT	WB AADT	2015 AADT	EB AADT	WB AADT	2014 AADT	EB AADT	WB AADT	2013 AADT	EB AADT	WB AADT	2012 AADT	EB AADT	WB AADT	2011 AADT
64-1	185	213	2484	2484	4968	2442	2441	4883	2297	2297	4593	2802	2802	5605	2734	2734	5468	2146	2146	4292
64-2	213	234	2570	2464	5035	3155	2946	6102	2644	2556	5198	2376	2312	4690	2324	2277	4603	2352	2230	4584
64-3	234	237	3270	3247	6518	3604	3559	7163	3320	3301	6621	3199	3185	6385	3113	3102	6215	3115	3088	6204

Freight Performance Area Data

Segment	Length (miles)	# of closures	Total minutes of closures		Avg Mins/Mile/Year	
			EB	WB	EB	WB
64-1	28	11	37084.8	625.0	264.89	4.46
64-2	21	7	28496.0	121.0	271.39	1.15
64-3	3	2	3468.0	130.0	231.20	8.67

Segment	ITIS Category Description											
	Closures		Incidents/Accidents		Incidents/Crashes		Obstruction Hazards		Winds		Winter Storm Codes	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
64-1	0	0	0	0	0	0	0	0	0	0	0	0
64-2	0	0	0	0	0	0	0	0	0	0	0	0
64-3	0	0	0	0	0	0	0	0	0	0	0	0

See the **Mobility Performance Area Data** section for other Freight Performance Area related data.

Appendix D: Needs Analysis Contributing Factors and Scores

Pavement Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Pavement Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the existing performance score for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Pavement. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template.

To develop an aggregate Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Enter the appropriate segment information into the columns titled "Segment", "Segment Length", "Segment Mileposts" and "Facility Type".

Step 1.2

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Existing Performance Analysis into the appropriate "Performance Score" columns. Copy the performance score for each segment to the appropriate "Performance Score" column. Paste only the "values" and do not overwrite the formatting.

Step 1.3

Indicate if Pavement is an Emphasis Area by selecting "Yes" or "No" in the row immediately below the segment information.

Step 1.4

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the segment information and the initial needs from the Step 1 template to the "Initial Need" column of the Step 2 template.

Step 2.2

Note in the "Hot Spots" column any pavement failure hot spots identified as part of the baseline corridor performance. For each entry, include the milepost limits of the hot spot. Hot spots are identified in the Pavement Index spreadsheet by the red cells in the columns titled "% Pavement Failure". These locations are based on the following criteria:

Interstates: IRI > 105 or Cracking > 15

Non-Interstates: IRI > 142 or Cracking > 15

Every segment that has a % Pavement Failure greater than 0% will have at least one hot spot. Hot spot locations should be described as extending over consecutive miles. For example, if there is a pavement failure location that extends 5 consecutive miles, it should be identified as one hot spot, not 5 separate hot spots.

Step 2.3

Identify recently completed or under construction paving projects in the "Previous Projects" column. Include only projects that were completed after the pavement condition data period (check dates in pavement condition data provided by ADOT) that would supersede the results of the performance system.

Step 2.5

Update the "Final Need" column using the following criteria:

- If "None" but have a hot spot (or hot spots), the Final Need = Low, and note the reason for the change in the "Comments" column (column H).

- If a recent project has superseded the performance rating data, change the Final Need to “None” and note the reason for the change in the “Comments” column.

Example Scales for Level of Need

Performance Thresholds		Initial Need	Description
3.75	Good	None	(>3.57)
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3rd of Fair Perf. (3.38 - 3.57)
3.2	Fair	Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance (3.02-3.38)
	Poor		
	Poor	High	Lower 2/3rd of Poor Performance (<3.02)
	Poor		

Need Scale for Interstates

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index (corridor non-emphasis area)	3.57	3.38	3.38	3.02	3.02
Pavement Index (corridor emphasis area)	3.93	3.57	3.57	3.20	3.20
Pavement Index (segments)	3.57	3.38	3.38	3.02	3.02
Directional PSR	3.57	3.38	3.38	3.02	3.02
%Pavement Failure	10%	15%	15%	25%	25%

Need Scale for Highways (Non-Interstates)

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index (corridor non-emphasis area)	3.30	3.10	3.10	2.70	2.70
Pavement Index (corridor emphasis area)	3.70	3.30	3.30	2.90	2.90
Pavement Index (segments)	3.30	3.10	3.10	2.70	2.70
Directional PSR	3.30	3.10	3.10	2.70	2.70
%Pavement Failure	10%	15%	15%	25%	25%

Step 2.6

Note any programmed projects that could have the potential to mitigate pavement needs in in the “Comments” column. Programmed projects are provided as information and do not impact the need rating. The program information can be found in ADOT’s 5-year construction program. If there are other comments relevant to the needs analysis (such as information from previous reports), they can be entered in the “Comments” column. However, only include information related to needs that have been identified through this process. Do not add or create needs from other sources.

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab. The steps to complete Step 3 include:

Step 3.1

Input the level of historical investment for each segment. This will be determined from the numeric score from the Pavement History Table based on the following thresholds:

- Low = < 4.60
- Medium = 4.60 – 6.60
- High = > 6.60

If the PeCoS data shows a high level of maintenance investment, increase the historical investment rating by one level.

Step 3.2

Note the milepost ranges of pavement failure hot spots into the column titled “Contributing Factors and Comments.”

Step 3.3

Note any other information that may be contributing to the deficiency, or supplemental information, in the “Contributing Factors and Comments” column. This could come from discussions with ADOT District staff, ADOT Materials/Pavement Group, previous reports, or the historical investment data.

Step 3.4

Include any programmed projects from ADOT’s 5-year construction program in the “Contributing Factors and Comments” column.

Bridge Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Bridge Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

<u>Step 1: Initial Needs</u>

The input required to populate the Step 1 template includes transferring the existing performance score for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Bridge. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial level of need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

The steps include:

Step 1.1

Enter the appropriate segment information into the columns titled "Segment", "Segment Length", "Segment Mileposts" and "Number of Bridges."

Step 1.2

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Existing Performance Analysis into the appropriate "Performance Score" columns. Copy the performance score for each segment to the appropriate "Performance Score" column. Paste only the "values" and do not overwrite the formatting.

Step 1.3

Indicate if Bridge is an Emphasis Area by selecting "Yes" or "No" in the row immediately below the segment information.

Step 1.4

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

<u>Step 2: Final Needs</u>

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial needs from the Step 1 template to the "Initial Need" column of the Step 2 template.

Step 2.2

Note in the column titled "Hot Spots" any bridge hot spots identified as part of the baseline corridor performance. For each entry, note the specific location. Hot spots are identified as having any bridge rating of 4 or less, or multiple ratings of 5 in the deck, substructure, or superstructure ratings.

Step 2.3

Identify recently completed or under construction bridge projects in the "Previous Projects" column. Include only projects that were completed after the bridge condition data period (check dates in bridge condition data provided by ADOT) that would supersede the results of the performance system.

Step 2.4

Update the Final Need on each segment based on the following criteria:

- If the Initial Need is "None" and there is at least one hot spot located on the segment, change the Final Need to "Low".
- If a recent project has superseded the performance rating data, the performance data should be adjusted to increase the specific ratings and the resulting need should be reduced to account for the project.
- Note the reason for any change in the "Comments" column.

Step 2.5

Historical bridge rating data was tabulated and graphed to find any bridges that had fluctuations in the ratings. Note in the “Historical Review” column any bridge that was identified as having a potential historical rating concern based on the following criteria:

- Ratings increase or decrease (bar chart) more than 2 times
- Sufficiency rating drops more than 20 points

This is for information only and does not affect the level of need.

Step 2.6

Note the number of functionally obsolete bridges in each segment in the column titled “# Functionally Obsolete Bridges”. This is for information only and does not affect the level of need.

Step 2.7

Identify each bridge “of concern” in the “Comments” column. Note any programmed projects that could have the potential to mitigate bridge needs. Programmed projects are provided as information and do not impact the need rating. The program information can be found in ADOT’s 5-year construction program. If there are other comments relevant to the needs analysis (such as information from previous reports), they can be entered in the “Comments” column. However, only include information related to needs that have been identified through this process. Do not add or create needs from other sources.

Example Scales for Level of Need

Bridge Index Performance Thresholds	Level of Need		Description
6.5	Good	None	All of Good Performance and upper 1/3rd of Fair Performance
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3rd of Fair Performance
5.0	Fair	Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance
	Poor		
	Poor	High	Lower 2/3rd of Poor Performance
	Poor		

Need Scale

Measure	None >=	Low >=	> Medium <		High <=
Bridge Index (corridor non-emphasis area)	6.0	5.5	5.5	4.5	4.5
Bridge Index (corridor emphasis area)	7.0	6.0	6.0	5.0	5.0
Bridge Index (segments)	6.0	5.5	5.5	4.5	4.5
Bridge Sufficiency	70	60	60	40	40
Bridge Rating	6.0	5.0	4.0	4.0	3.0
%Functionally Obsolete Bridges	21.0%	31.0%	31.0%	49.0%	49.0%

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab. The steps to compete Step 3 include:

Step 3.1

Input the bridge name, structure number, and milepost information for each bridge “of concern” resulting from Step 2.

Step 3.2

For bridges that have a current rating of 5 or less, enter the specific rating, or state “No current ratings less than 6”.

Step 3.3

For bridges that were identified for a historical review (step 2.5), state “Could have a repetitive investment issue”. If a bridge was not identified for a historical review, state “This structure was not identified in historical review”.

Step 3.4

Input any programmed projects from ADOT’s 5-year construction program. Note any other information that may be contributing to the deficiency, or supplemental information. This could come from discussions with ADOT District staff, ADOT Bridge Group, or previous reports.

Mobility Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Mobility Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Refined Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

<u>Step 1: Initial Needs</u>

The input required to populate the Step 1 template includes transferring the existing performance score for each segment to the appropriate "Performance Score" columns from Existing Performance Analysis. This includes the primary and secondary measures for Mobility. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" in the Step 1 tab.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scores, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Input the accurate number of segments for your corridor in the column titled 'Segment' and the appropriate segment milepost limits and segment lengths in adjacent columns.

Step 1.2

Select the appropriate 'Environment Type' and 'Facility Operation Type' from the drop-down menus as defined in Existing Performance Analysis.

Step 1.3

Select 'Yes' or 'No' form the drop-down list to not if the Mobility Performance Area is an Emphasis Area for your corridor.

Step 1.4

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Existing Performance Analysis. Copy the performance score for each segment to the appropriate "Performance Score" column.

Step 1.5

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

<u>Step 2: Final Needs</u>

The Initial Need will be carried over to Step 2 The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to the Step 2 template.

Step 2.2

Identify recently completed or under construction projects that would be considered relevant to mobility performance. Include only projects that were constructed after 2015 for which the 2015 HPMS data used for traffic volumes would not include. Any completed or under construction roadway project after 2015 that has the potential to mitigate a mobility issue on a corridor segment should be listed in the template. Such projects should include the construction of new travel lanes or speed limit changes on the main corridor only. Do not include projects involving frontage roads or crossings as they would not impact the corridor level performance.

Step 2.3

Update the Final Need using the following criteria:

- If a recent project has superseded the performance rating data and it is certain the project addressed the deficiency, change the need rating to "None".
- If a recent project has superseded the performance rating data but it is uncertain that a project addressed the need, maintain the current deficiency rating and note the uncertainty as a comment.

Step 2.4

Note any programmed or planned projects that have the potential to mitigate any mobility needy on the segment. Programmed and Planned projects are provided as information and do not impact the deficiency rating. Future projects will be reviewed in the development of solution sets for identified needs and deficiencies. The source of future projects can be found in ADOT's 5-year construction program or other planning documents. Other comments relevant to the needs analysis can be entered.

Example Scales for Level of Need

Performance Thresholds	Initial Need		Description
0.71	Good	None	(<0.77)
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3rd of Fair Perf. (0.77 - 0.83)
0.89	Fair	Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance (0.83-0.95)
	Poor		
	Poor	High	Lower 2/3rd of Poor Performance (>0.95)
	Poor		

Needs Scale

Measure		None <=	Low >=	> Medium <		High <=
Mobility Index (Corridor Emphasis Area)		Weighted calculation for the segment totals in corridor (urban vs. rural)				
Mobility Index (Corridor Non-Emphasis Area)		Weighted calculation for the segment totals in corridor (urban vs. rural)				
Mobility Index (Segment)	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Future Daily V/C	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Existing Peak Hour V/C	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Closure Extent		0.35	0.49	0.49	0.75	0.75
Directional TTI	Uninterrupted	1.21	1.27	1.27	1.39	1.39
	Interrupted	1.53	1.77	1.77	2.23	2.23
Directional PTI	Uninterrupted	1.37	1.43	1.43	1.57	1.57
	Interrupted	4.00	5.00	5.00	7.00	7.00
Bicycle Accommodation		80%	70%	70%	50%	50%

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab. The steps to compete Step 3 include:

Step 3.1

Input data from Mobility Index worksheet and corridor observations in appropriate columns for Roadway Variables.

Step 3.2

Input traffic variable data in appropriate columns as indicated, Buffer Index scores will auto populate.

Step 3.3

Input relevant mobility related infrastructure located within each segment as appropriate

Step 3.4

Input the Closure Extents that have occurred along the study corridor. Road closure information can be detailed out by the reason for the closure as documented in Highway Condition Reporting System (HCRS) data analyzed as part of the baseline corridor performance. Closure reasons include incident/accidents, winter storms, obstruction hazards, and undefined closures. Statewide average percentages for the various closure reasons have been calculated for 2010-2015 on ADOT's designated strategic corridors. Compare these statewide average percentages to the corridor percentages for the various closure reasons to identify higher than average percentages of one or more closure reasons on any given segment. Input the closures as follows and use red text to indicate that the segment percentage exceeds statewide averages:

- Total Number of Closures
- % Incidents/Accidents
- % Obstructions/Hazards
- % Weather Related

Step 3.5

List the non-actionable conditions that are present within each segment by milepost if possible. Non-Actionable conditions are conditions that exist within the environment of each segment that cannot be improved through an engineered solution. For example, the border patrol check point in Segment 3 of I-19 is a non-actionable condition.

Step 3.6

Considering all information input, identify and list the contributing factors to the Final Need score.

Safety Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Safety Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the corridor characteristics and existing performance score for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for safety. As each performance score is input into the template, the Level of Need will populate based on the weighted scoring system for each measure.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Scale" within the Step 1 template.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the corridor characteristics information. This includes segment operating environments and segment length. Also, specify if the safety performance area is an emphasis area as determined in Goals and Objectives. The "Level of Need" is dependent on the input of the operating environment and "Emphasis Area" as the thresholds dynamically update accordingly.

Input the existing (baseline) performance scores for all primary and secondary performance measures from Existing Performance Analysis. Copy the performance score (paste values only) for each segment to the appropriate "Performance Score" column and conditional formatting should color each cell green, yellow, or red based on the corresponding performance thresholds.

Step 1.2

The thresholds for the corridor safety index are based on the segments' operating environments. To ensure that the correct corridor safety index threshold is applied, input the unique segment operating environments that exist with the corridor. Once the input is complete, the average of the Good/Fair and Fair/Poor thresholds for each of the operating environments is calculated and the "Level of Need" thresholds will be derived and applied to the main Step 1 Table.

Step 1.3

Confirm that the following criteria for "Insufficient Data" have been applied and that the resulting Level of Need has been shown as "N/A" where applicable.

- Crash frequency for a segment is less than 5 crashes over the 5-year crash analysis period.
- The change in +/- 1 crash results in the change of need level of 2 levels (i.e., changes from Good to Poor or changes from Poor to Good).
- The average segment crash frequency for the overall corridor (total fatal plus incapacitating injury crash frequency divided by the number of corridor segments) is less than 2 per segment over the 5-year crash analysis period.

Step 1.4

Confirm that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial needs from the Step 1 template to the Step 2 template**.**

Step 2.2

Using the crash concentration (hot spot) map developed as part of the baseline corridor performance, note the direction of travel and approximate milepost limits of each hot spot.

Step 2.3

Identify recently completed or under construction projects that would be considered relevant to safety performance. Include only projects that were not taken into account during the crash data analysis period (2011 – 2015). Any completed or under construction roadway project after 2015 that has the potential to mitigate a safety issue on a corridor segment should be listed in the template. Sources of recent or current project activity can include ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Final Need based on the following criteria:

- If there is a crash hot spot concentration on a "None" segment, upgrade the need rating to "Low."

Step 2.5

Note any programmed projects that could have the potential to mitigate any safety need on the segment. Programmed projects are provided as information and do not impact the need rating. Programmed projects will be reviewed in the development of solution sets for identified needs. The source of the programming information can be found in ADOT's 5-year construction program. Any other relevant issues identified in previous reports should also be reported.

Needs Scale

Measure		None <=	Low <=	< Medium >		High >=	Good/Fair Threshold	Fair/Poor Threshold
Corridor Safety Index (Emphasis Area)		Weighted average based on operating environment type						
Corridor Safety Index (Non-Emphasis Area)		# Weighted average based on operating environment type					N/A	N/A
Safety Index and Directional Safety Index (Segment)	2 or 3 Lane Undivided Highway	0.98	1.02	1.02	1.10	1.10	0.94	1.06
	2 or 3 or 4 Lane Divided Highway	0.92	1.07	1.07	1.38	1.38	0.77	1.23
	4 or 5 Lane Undivided Highway	0.93	1.06	1.06	1.33	1.33	0.8	1.2
	6 Lane Highway	0.85	1.14	1.14	1.73	1.73	0.56	1.44
	Rural 4 Lane Freeway with Daily Volume < 25,000	0.91	1.09	1.09	1.45	1.45	0.73	1.27
	Rural 4 Lane Freeway with Daily Volume > 25,000	0.89	1.1	1.1	1.53	1.53	0.68	1.32
	Urban 4 Lane Freeway	0.93	1.07	1.07	1.35	1.35	0.79	1.21
	Urban or Rural 6 Lane Freeway	0.94	1.06	1.06	1.3	1.3	0.82	1.18
	Urban > 6 Lane Freeway	0.93	1.06	1.06	1.33	1.33	0.8	1.2
% of Fatal + Incap. Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	2 or 3 Lane Undivided Highway	53%	55%	55%	59%	59%	51%	57%
	2 or 3 or 4 Lane Divided Highway	47%	50%	50%	57%	57%	44%	54%
	4 or 5 Lane Undivided Highway	45%	48%	48%	54%	54%	42%	51%
	6 Lane Highway	39%	43%	43%	50%	50%	35%	46%
	Rural 4 Lane Freeway with Daily Volume < 25,000	46%	49%	49%	56%	56%	43%	53%
	Rural 4 Lane Freeway with Daily Volume > 25,000	46%	51%	51%	62%	62%	41%	57%
	Urban 4 Lane Freeway	52%	55%	55%	62%	62%	49%	59%
	Urban or Rural 6 Lane Freeway	42%	50%	50%	65%	65%	34%	57%
	Urban > 6 Lane Freeway	47%	51%	51%	59%	59%	43%	55%
% of Fatal + Incap. Injury Crashes Involving Trucks	2 or 3 Lane Undivided Highway	6%	7%	7%	8%	8%	5%	7%
	2 or 3 or 4 Lane Divided Highway	5%	6%	6%	8%	8%	4%	7%
	4 or 5 Lane Undivided Highway	7%	8%	8%	11%	11%	6%	10%
	6 Lane Highway	3%	6%	6%	12%	12%	0%	9%
	Rural 4 Lane Freeway with Daily Volume < 25,000	14%	15%	15%	18%	18%	13%	17%
	Rural 4 Lane Freeway with Daily Volume > 25,000	9%	11%	11%	15%	15%	7%	13%
	Urban 4 Lane Freeway	8%	9%	9%	12%	12%	7%	11%
	Urban or Rural 6 Lane Freeway	8%	10%	10%	13%	13%	6%	11%
	Urban > 6 Lane Freeway	4%	5%	5%	7%	7%	3%	6%
% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	2 or 3 Lane Undivided Highway	22%	25%	25%	30%	30%	19%	27%
	2 or 3 or 4 Lane Divided Highway	19%	22%	22%	29%	29%	16%	26%
	4 or 5 Lane Undivided Highway	7%	8%	8%	10%	10%	6%	9%
	6 Lane Highway	7%	14%	14%	27%	27%	0%	20%
	Rural 4 Lane Freeway with Daily Volume < 25,000	6%	7%	7%	9%	9%	5%	8%
	Rural 4 Lane Freeway with Daily Volume > 25,000	11%	14%	14%	20%	20%	8%	17%
	Urban 4 Lane Freeway	10%	11%	11%	13%	13%	9%	12%
	Urban or Rural 6 Lane Freeway	9%	11%	11%	15%	15%	7%	13%
	Urban > 6 Lane Freeway	15%	17%	17%	22%	22%	13%	20%

Measure		None <=	Low <=	< Medium >		High >=	Good/Fair Threshold	Fair/Poor Threshold
Corridor Safety Index (Emphasis Area)		Weighted average based on operating environment type						
Corridor Safety Index (Non-Emphasis Area)		# Weighted average based on operating environment type					N/A	N/A
% of Fatal _ Incapacitating Injury Crashes Involving Non-Motorized Travelers	2 or 3 Lane Undivided Highway	3%	4%	4%	5%	5%	2%	4%
	2 or 3 or 4 Lane Divided Highway	3%	4%	4%	5%	5%	2%	4%
	4 or 5 Lane Undivided Highway	6%	7%	7%	9%	9%	5%	8%
	6 Lane Highway	11%	14%	14%	20%	20%	8%	17%
	Rural 4 Lane Freeway with Daily Volume < 25,000	2%	2%	2%	3%	3%	1.7%	2.5%
	Rural 4 Lane Freeway with Daily Volume > 25,000	0%	0%	0%	0%	0%	0%	0%
	Urban 4 Lane Freeway	7%	9%	9%	12%	12%	5%	10%
	Urban or Rural 6 Lane Freeway	3%	5%	5%	9%	9%	1%	7%
	Urban > 6 Lane Freeway	1%	1%	1%	2%	2%	0.5%	1.5%

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab.

Table 3 - Step 3 Template

A separate *Crash Summary Sheet* file contains summaries for 8 crash attributes for the entire corridor, for each corridor segment, and for statewide roadways with similar operating environments (the database of crashes on roadways with similar operating environments was developed in Existing Performance Analysis (the baseline corridor performance)). The crash attribute summaries are consistent with the annual ADOT Publication, *Crash Facts*. The 8 crash attribute summaries consist of the following:

- First Harmful Event (FHET)
- Crash Type (CT)
- Violation or Behavior (VB)
- Lighting Condition (LC)
- Roadway Surface Type (RST)
- First Unit Event (FUE)
- Driver Physical Condition (Impairment)
- Safety Device Usage (Safety Device)

Non-colored tabs in this spreadsheet auto-populate with filtered crash attributes. Each tab is described below:

- **Step_3_Summary** – This tab contains the filtered summary of crashes that exceed statewide thresholds for crashes on roadways with similar operating environments. Data in this tab are copied into the Step 3 template.
- **Statewide** – This tab contains a summary of statewide crashes from roadways with similar operating environments filtered by the 8 crash type summaries listed above. The crash type summaries calculate statewide crash thresholds (% total for fatal plus incapacitating crashes). The crash thresholds were developed to provide a statewide expected proportion of crash attributes against which the corridor segments' crash attributes can be compared. The crash thresholds were developed using the *Probability of Specific Crash Types Exceeding a Threshold Proportion* as shown in the Highway Safety Manual, Volume 1 (2010). The thresholds are automatically calculated within the spreadsheet. The threshold proportion was calculated as follows:

$$p*_i = \frac{\sum N_{Observed,i}}{\sum N_{Observed,i(total)}}$$

Where:

$p*_i$ = Threshold proportion

$\sum N_{Observed,i}$ = Sum of observed target crash frequency within the population

$\sum N_{Observed,i(total)}$ = Sum of total observed crash frequency within the population

A minimum crash sample size of 5 crashes over the 5-year crash analysis period is required for a threshold exceedance to be displayed in the Step 3 template. The probability of exceeding the crash threshold was not calculated to simplify the process.

- **Corridor** – A summary of corridor-wide crashes filtered by the 8 crash attribute summaries listed above.
- **Segment FHET** – A segment-by-segment summary of crashes filtered by first harmful event attributes.
- **Segment CT** – A segment-by-segment summary of crashes filtered by crash type attributes.
- **Segment VB** - A segment-by-segment summary of crashes filtered by violation or behavior attributes.
- **Segment LC** – A segment-by-segment summary of crashes filtered by lighting condition attributes.
- **Segment RST** – A segment-by-segment summary of crashes filtered by roadway surface attributes.
- **Segment FUE** – A segment-by-segment summary of crashes filtered by first unit event attributes.
- **Segment Impairment** – A segment-by-segment summary of crashes filtered by driver physical condition attributes related to impairment.
- **Segment Safety Device** – A segment-by-segment summary of crashes filtered by safety device usage attributes.

The steps to compete Step 3 include:

Step 3.1

Using the Crash_Summary_Sheet.xlsx, go to the "Step_3_Summary" tab. Input the operating environments for each segment in the table.

Step 3.2

Filter data from the ADOT database for the "CORRIDOR_DATA" tab by inserting the following data in the appropriate columns that are highlighted in gray for the "INPUT_CORRIDOR_DATA" tab:

- Incident ID
- Incident Crossing Feature (MP)
- Segment Number (Non-native ADOT data – must be manually assigned based on the location of the crash)
- Operating Environment (Non-native ADOT data – should already be assigned but if for some reason it isn't, it will need to be manually assigned)
- Incident Injury Severity
- Incident First Harmful Description

- Incident Collision Manner
- Incident Lighting Condition Description
- Unit Body Style
- Surface Condition
- First Unit Event Sequence
- Person Safety Equipment
- Personal Violation or Behavior
- Impairment

Note that columns highlighted in yellow perform a calculated input to aggregate specific crash descriptions. For example, crashes can contain various attributes for animal-involved crashes. The crash attributes that involve an animal were combined into a common attribute, such as "ANIMAL". This will allow the summaries to be consistent with the ADOT *Crash Facts*.

The data in the Impairment category contains blank descriptions if it was found that there was "No Apparent Influence" or if it was "Unknown". Using the crash data fields "PersonPhysicalDescription" 0 - 99, fill in the blank columns to reflect if the physical description is described as "No Apparent Influence" or "Unknown". Note that the native physical description data from the ADOT database may need to be combined to a single column.

Step 3.3

Confirm that the crash database is being properly filtered by comparing crash frequencies from the summary tables with the frequencies developed in Existing Performance Analysis. For example, the lookup function will fail if the filter is for "NO IMPROPER ACTION" if the database has the attribute of "NO_IMPROPER_ACTION".

Step 3.4

Copy and paste the Step_3_Summary into the Safety Needs Assessment spreadsheet in the Step 3 tab. Paste values only and remove the summaries with "0%s" for a clean display. Where duplicate values exist, go to the "Calcs" tab in the Crash_Summary_Sheet file to determine which categories have the same %. If there are more crash types with the same % than there is space in the table, select the crash type with the highest difference between the segment % and the statewide average %

Step 3.5

The Step 3 table in the Safety Needs Assessment spreadsheet should be similar to the Step 3 template. In the Segment Crash Summaries row, the top three crash attributes are displayed. Change the font color of the crash attributes that exceed the statewide crash threshold to red for emphasis. The attributes with a red font in the "Calcs" tab have exceeded statewide crash thresholds. Note that corridor-wide values are not compared to statewide values as corridor-wide values are typically a blend of multiple similar operating environments while the statewide values apply to one specific similar operating environment.

Step 3.6

Provide a summary of any observable patterns found within the crash Hot Spots, if any exist in the segments.

Step 3.7

Input any historic projects (going no further back than 2000) that can be related to improving safety. Projects more than five years old may have exceeded their respective design life and could be contributing factors to safety performance needs.

Step 3.8

Input key points from District interviews or any important information from past discussions with District staff that is consistent with needs and crash patterns identified as part of the performance and needs assessment as this may be useful in identifying contributing causes. This information may be obtained from District Maintenance personnel by requesting the mile post locations that may be considered safety issues.

Step 3.9

For segments with one or more of the following characteristics, review crashes of all severity levels (not just fatal and incapacitating injury crashes). Identify likely contributing factors and compare that to the above statewide average comparison findings already calculated for fatal and incapacitating injury crashes. Refine the contributing factors list accordingly.

- Segments with Medium or High need
- Segments with a crash hot spot concentration (but only review crashes at the concentration areas)
- Segments with no apparent predominant contributing factors based on the comparison of fatal and incapacitating crashes to statewide averages if the segment has a Medium or High need.

Step 3.10

Considering all information in Steps 1-3, list the contributing factors using engineering judgment and the information on contributing factors available in Section 6.2 of the 2010 Highway Safety Manual. Additional sources for determining contributing factors may include aerial, "street view", and/or ADOT photologs. Other documents such as Design Concept Reports (DCR) or Road Safety Assessments can provide insight into the study corridor's contributing factors.

Add comments as needed on additional information related to contributing factors that may have been provided by input from ADOT staff.

Freight Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Freight Performance Area. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of need that combines all performance areas. Corridor needs are then identified in Step 5 of the process. The 5-step process is listed below:

- Step 1: Initial Needs
- Step 2: Final Needs
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Needs

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Freight. As each performance score is input into the template, the Initial Need will populate based on the weighted scoring system for each measure.

The Level of Need for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scale" within the Step 1 template.

To develop an aggregated Initial Need for each segment, the primary and secondary measures are combined by summing the weighted score, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Need for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Existing Performance Analysis. Copy the performance score for each segment to the appropriate "Performance Score" column. Select the *Facility Operations* for each segment from the drop-down list and input whether or not the performance area is an emphasis area. The corridor needs assessment scales will be updated automatically.

Step 1.2

Confirm that that the Step 1 template is generating the appropriate "Level of Need" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of need.

Step 2: Final Needs

The Initial Need will be carried over to Step 2. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial need from the Step 1 template to the Step 2 template.

Step 2.2

Note any truck height restriction hot spots (clearance < 16.25') identified as part of the baseline corridor performance. For each entry, note the milepost of the height restriction and if the height restriction can be detoured by ramping around the obstruction. If it is not possible for a truck to ramp around the height restriction, note the existing height as well.

Step 2.3

Identify recently completed or under construction projects that would be considered relevant to freight performance. Include only projects that were not taken into account during the freight data analysis period. Any completed or under construction roadway project after the date of the data that has the potential to mitigate a freight issue on a corridor segment should be listed in the template. Such projects can include the construction of climbing lanes or Dynamic Message Signs (DMS) installation. Sources of recent or current project activity can be ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Final Need using the following criteria:

- If there is at least one truck height restriction hot spot where a truck cannot ramp around on a 'None' segment, increase (i.e., worsen) the need rating to 'Low'.
- If a recent project has superseded the performance rating data and it is certain the project addressed the need, change the need rating to "None".
- If a recent project has superseded the performance rating data but it is uncertain that a project addressed the need, maintain the current need rating and note the uncertainty as a comment.

Step 2.5

Note any programmed projects that could have the potential to mitigate any freight need on the segment. Programmed projects are provided as information and do not impact the need rating. Programmed projects will be reviewed in the development of solution sets for identified needs. The source of the programming information can be found in ADOT's 5-year construction program. If there are other comments relevant to the needs analysis, they can be entered in the right-most column.

Example Scales for Level of Need - Freight Index

Performance Score Thresholds	Performance Level	Initial Performance Level of Need	Description (Non-emphasis Area)
0.74	Good	None	All levels of Good and the top third of Fair (>0.74)
	Good		
	Good		
	Fair		
	Fair	Low	Middle third of Fair (0.70-0.74)
0.67	Fair	Medium	Lower third of Fair and top third of Poor (0.64-0.70)
	Poor		
	Poor	High	Lower two-thirds of Poor (<0.64)
	Poor		

Needs Scale

Measure	None >=	> Low <		> Medium <		High <=
Corridor Freight Index (Emphasis Area)	Dependent on weighted average of interrupted vs. uninterrupted segments					
Corridor Freight Index (Non-Emphasis Area)	Dependent on weighted average of interrupted vs. uninterrupted segments					
Freight Index (Segment)						
Measure	**None >=**	**> Low <**		**> Medium <**		**High <=**
Interrupted	0.28	0.28	0.22	0.22	0.12	0.12
Uninterrupted	0.74	0.74	0.70	0.70	0.64	0.64
Measure	**None <=**	**< Low >**		**< Medium >**		**High >=**
Directional TTI						
Interrupted	1.53	1.53	1.77	1.77	2.23	2.23
Uninterrupted	1.21	1.21	1.27	1.27	1.39	1.39
Directional PTI						
Interrupted	4.00	4.00	5.00	5.00	7.00	7.00
Uninterrupted	1.37	1.367	1.43	1.43	1.57	1.57
Closure Duration						
All Facility Operations	71.07	71.07	97.97	97.97	151.75	151.75
Measure	**None >=**	**> Low <**		**> Medium <**		**High <=**
Bridge Clearance (feet)						
All Bridges	16.33	16.33	16.17	16.17	15.83	15.83

Step 3: Contributing Factors

The Final Need ratings from Step 2 will populate into the Step 3 tab.

The steps to compete Step 3 include:

Step 3.1

Input all roadway variable data that describe each segment into the appropriate columns. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Needs Assessment.

Step 3.2

Input all traffic variables for each segment into the appropriate columns. The Buffer Index will auto populate based on the TPTI and TTTI input in the Step 1 tab. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Needs Assessment.

Step 3.3

Input any freight-related infrastructure that currently exists on the corridor for each segment. The relevant infrastructure can include DMS locations, weigh stations, Ports of Entry (POE), rest areas, parking areas, and climbing lanes. Include the mileposts of the listed infrastructure. This data can be extracted from the most recent Highway Log and the 2015 Climbing and Passing Lane Prioritization Study.

Step 3.4

Input the Closure Extents that have occurred along the study corridor. Road closure information can be detailed out by the reason for the closure as documented in Highway Condition Reporting System (HCRS) data analyzed as part of the baseline corridor performance. Closure reasons include incident/accidents, winter storms, obstruction hazards, and undefined closures. Statewide average percentages for the various closure reasons have been calculated for the analysis period on ADOT's designated strategic corridors. Compare these statewide average percentages to the corridor percentages for the various closure reasons to identify higher than average percentages of one or more closure reasons on any given segment. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Needs Assessment. Input the closures as follows and use red text to indicate that the segment percentage exceeds statewide averages:

- Total Number of Closures
- % Closures (No Reason)
- % Incidents/Accidents
- % Obstructions/Hazards
- % Weather Related

Step 3.5

List the non-actionable conditions that are present within each segment by milepost if possible. Non-Actionable conditions are conditions that exist within the environment of each segment that cannot be improved through an engineered solution. Examples of Non-Actionable conditions can include border patrol check points and other closures/restrictions not controlled by ADOT. Note that this data can be copied from the Mobility Needs Assessment spreadsheet for Needs Assessment.

Step 3.6

Input any programmed and planned projects or issues that have been identified from previous documents or studies that are relevant to the Final Need. Sources for this data include the current Highway Log, the 2015 Climbing and Passing Lane Prioritization Study, and ADOT's 5-year construction program.

Step 3.7

Considering all information in Steps 1-3, identify the contributing factors to the Final Need column. Potential contributing factors to freight performance needs include roadway vertical grade, number of lanes, traffic volume-to-capacity ratios, presence/lack of a climbing lanes, and road closures. Also, identify higher than average percentages of one or more closure reasons on any given segment.

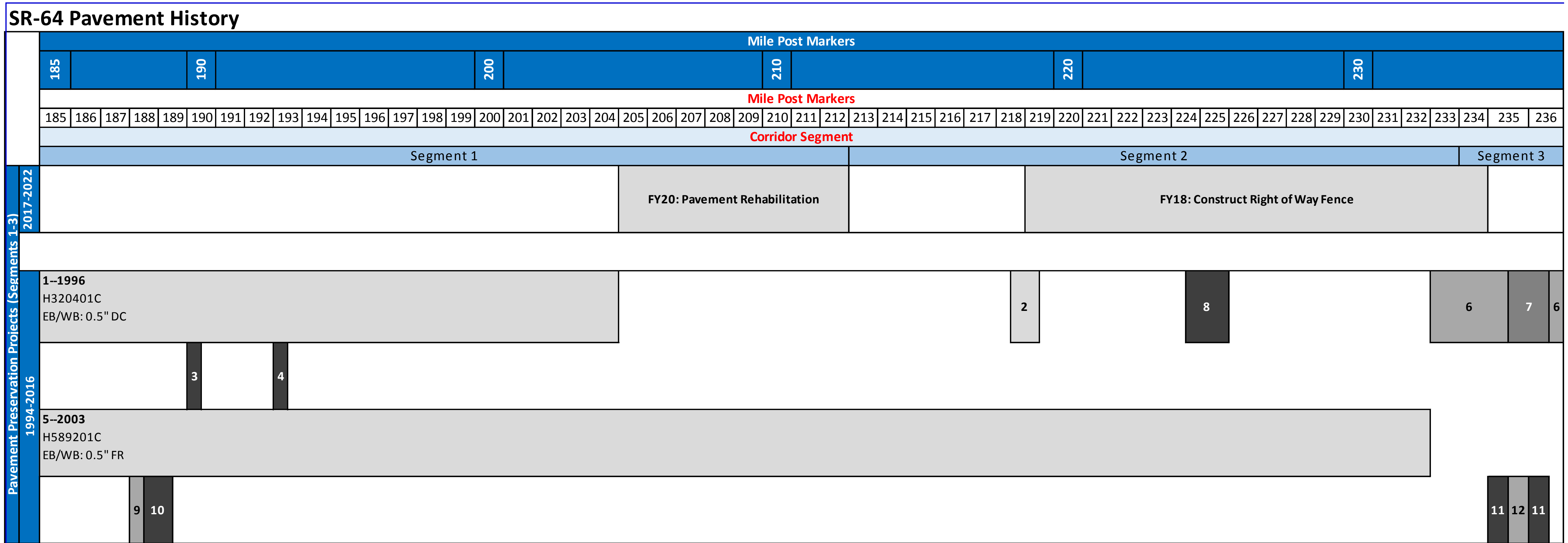
Pavement Performance Area – Need Analysis Step 1

Segment	Segment Length (miles)	Segment Mileposts (MP)	Facility Type	Pavement Index			Directional PSR					% Area Failure			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
							EB	WB		EB	WB				
64-1	28	185-213	Highway	2.88	Fair or Better	Medium	3.09		Fair or Better	Medium	Medium	38.00%	Fair or Better	High	High
64-2	21	213-234	Highway	3.60	Fair or Better	None	3.50		Fair or Better	None	None	0.00%	Fair or Better	None	None
64-3	3	234-237	Highway	3.69	Fair or Better	None	3.52		Fair or Better	None	None	0.00%	Fair or Better	None	None
Emphasis Area?	Yes	Weighted Average		3.22	Good	Medium									

Pavement Performance Area – Need Analysis Step 2

Segment	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Need Adjustments		Final Need	Comments (may include programmed projects or issues from previous reports)
				Hot Spots	Previous Projects (which supersede condition data)		
64-1	28	185-213	High	MP 188-189, MP 198-200, MP 205-212	None	High	**FY20** Pavement Rehabilitation: Pipeline Road to Air Park (ADOT Five-Year Transportation Facilities Construction Program 2018-2022, MP 205-213)
64-2	21	213-234	None	None	None	None	**FY18** Construct Right of Way Fence: MP 219 to Grand Canyon National Park (ADOT Five-Year Transportation Facilities Construction Program 2018-2022, MP 219-235)
64-3	3	234-237	None	None	None	None	**FY18** Construct Right of Way Fence: MP 219 to Grand Canyon National Park (ADOT Five-Year Transportation Facilities Construction Program 2018-2022, MP 219-235)

Pavement History



Pavement Treatment Reference Numbers	Pavement Treatment Reference Numbers
1. **1996 (EB/WB)** H320401C: 0.5" DC	7. **2003 (EB/WB)** H525201C: Remove 2", New 2" AR, 0.5" FR
2. **1999 (EB/WB)** H375601C: 0.5" DC	8. **2006 (EB/WB)** H602701C: 10" AB, 5" AR, 0.5" FR
3. **1999 (EB/WB)** H508601C: 10" AB, 4" AC, 0.5" DC	9. **2008 (EB/WB)** H681301C: Remove 0.5", New 0.5" FR
4. **1999 (EB/WB)** H412701C: 6" AB, 4" AC, 0.5" DC	10. **2008 (EB/WB)** H681301C: 7" AB, 8" AC, 0.5" FR
5. **2003 (EB/WB)** H589201C: 0.5" FR	11. **2012 (EB/WB)** H692701C: 9" AB, 6" AC, 0.5" FC
6. **2003 (EB/WB)** H525201C: 2" AR, 0.5" FR	12. **2012 (EB/WB)** H692701C: Remove 0.5" New 0.5" FC

Legend

- New Paving or Reconstruction
- Mill and Overlay (Adding Structural Thickness)
- Mill and Replace (No Change Structural Thickness)
- Fog Coat or Thin Overlay Treatments
- PCCP Pavement Border
- AC Pavement Border

Value	Level	Segment Number					
		1		2		3	
		Uni-Dir	Bi-Dir	Uni-Dir	Bi-Dir	Uni-Dir	Bi-Dir
1	L1		71%		95%		
1			100%		5%		
1							
1							
3	L2		2%		5%		67%
3							17%
3							
3							
3							
3							
4	L3						33%
4							
4							
4							
6	L4		2%		7%		33%
6			2%				
6			4%				
6							
6							
6							
Sub-Total		0.0	2.2	0.0	1.6	0.0	5.8
Total		**2.2**		**1.6**		**5.8**	

Pavement Historical Investment

Segment	Pavement History Value (bid projects)	Pavement History Score (bid projects)	Pavement History (bid projects)	PeCos ($/mile/yr)	PeCos Score	PeCos	Resulting Historical Investment
64-1	2.20	-0.56	Low	$1,898.49	-0.21	Medium	Low
64-2	1.60	-1.59	Low	$130.45	10.04	Low	Low
64-3	5.80	-1.11	Medium	$38.21	1.64	Low	Medium

Pavement Performance Area – Need Analysis Step 3

Segment	Segment Length (miles)	Segment Mileposts (MP)	Final Need	Bid History Investment	PeCos History Investment	Resulting Historical Investment	Contributing Factors and Comments
64-1	28	185-213	High	Low	Medium	Low	**Hot Spots:** MP 188-189, MP 198-200, MP 205-212 **Programmed Projects:** FY20 Pavement Rehabilitation: Pipeline Road to Air Park (ADOT Five-Year Transportation Facilities Construction Program 2018-2022, MP 205-213)
64-2	21	213-234	None	Low	Low	Low	**Programmed Projects:** FY18 Construct Right of Way Fence: MP 219 to Grand Canyon National Park (ADOT Five-Year Transportation Facilities Construction Program 2018-2022, MP 219-235)
64-3	3	234-237	None	Medium	Low	Medium	**Programmed Projects:** FY18 Construct Right of Way Fence: MP 219 to Grand Canyon National Park (ADOT Five-Year Transportation Facilities Construction Program 2018-2022, MP 219-235)

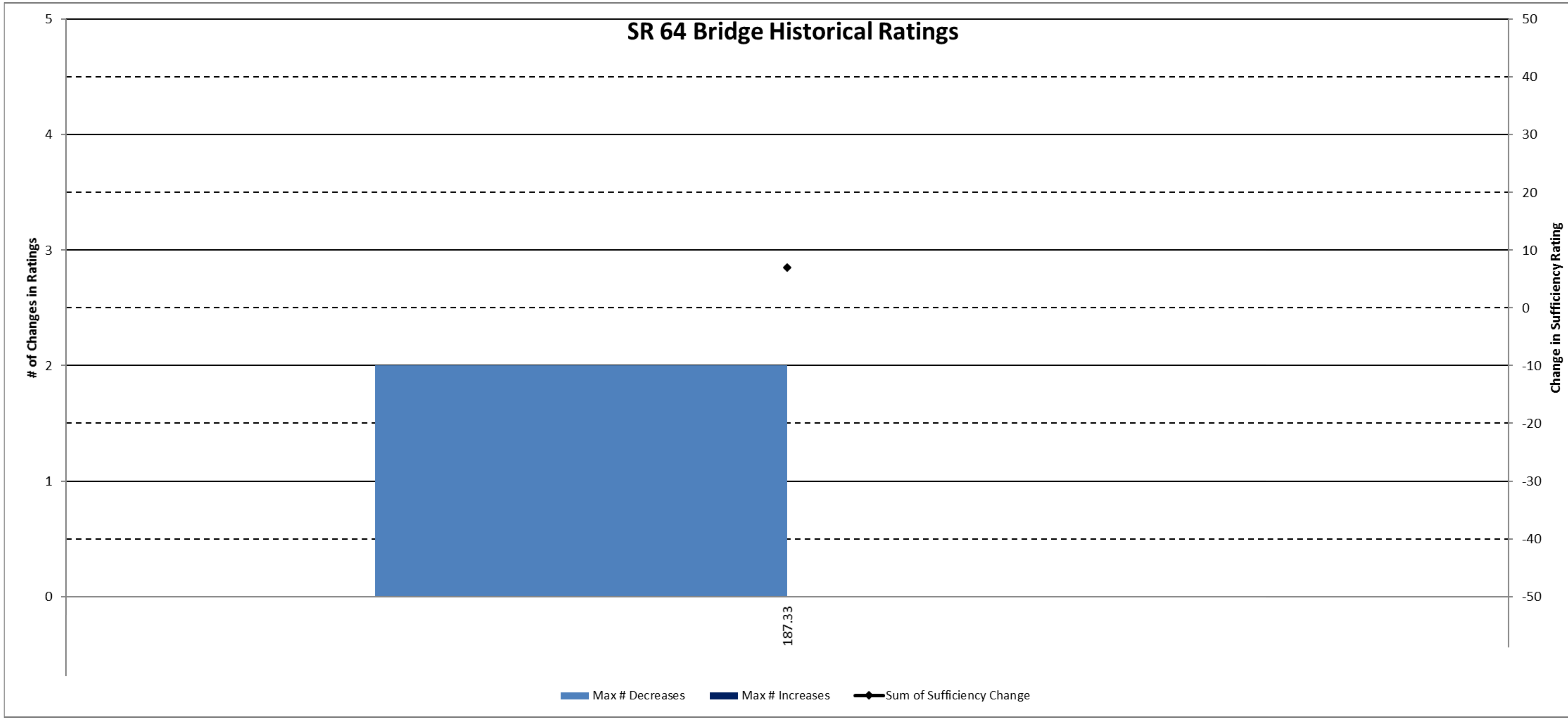
Bridge Performance Area – Need Analysis Step 1

Segment	Segment Length (miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Bridge Index			Lowest Bridge Rating						Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges		Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	
64-1	28	185-213	1	7.00	Fair or Better	None	7	Fair or Better	None	84.60	Fair or Better	None	0.00%	Fair or Better	None	None
64-2	21	213-234	0	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	N/A
64-3	3	234-237	0	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/A	No Bridges	Fair or Better	N/a	N/A
Emphasis Area?	No	Weighted Average		7.00	Fair or Better	None										

Bridge Performance Area – Need Analysis Step 2

Segment	Segment Length (miles)	Segment Mileposts (MP)	Number of Bridges in Segment	Initial Need	Need Adjustments		Final Need	Historical Review	# Functionally Obsolete Bridges	Comments
					Hot Spots (Rating of 4 or multiple 5's)	Previous Projects (which supersede condition data)				
64-1	28	185-213	1	None	None	None	None	None	None	No bridges with current ratings of 4 or 5 and no historical issues
64-2	21	213-234	0	None	None	None	None	None	None	No bridges in segment
64-3	3	234-237	0	None	None	None	None	None	None	No bridges in segment

Bridge Ratings History



_identifies the bridge indicated is of concern from a historical ratings perspective

Maximum # of Decreases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating decreased from 1997 to 2014. (Higher number could indicate a more dramatic decline in the performance of the bridge)

Maximum # of Increases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating increased from 1997 to 2014. (Higher number could indicate a higher level of investment)

Change in Sufficiency Rating: Cumulative change in Sufficiency Rating from 1997 to 2014. (Bigger negative number could indicate a more dramatic decline in the performance of the bridge)

Bridge Performance Area – Need Analysis Step 3

Segment	Segment Length (Miles)	Segment Mileposts (MP)	Number of Bridges in Segment	# Functionally Obsolete Bridges	Final Need	Contributing Factors			Comments
						Bridge	Current Ratings	Historical Review	
64-1	28	185-213	1	0	None	No bridges with current ratings less than 6 and no historical issues			
64-2	21	213-234	0	0	None	No bridges in segment			
64-3	3	234-237	0	0	None	No bridges in segment			

Mobility Performance Area – Need Analysis Step 1

Segment	Segment Mileposts	Segment Length (miles)	Environment Type	Facility Operation	Mobility Index			Future Daily V/C			Existing Peak Hour V/C					Closure Extent (occurrences/year/mile)				
					Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score		Performance Objective	Level of Need		Performance Score		Performance Objective	Level of Need	
											EB	WB		EB	WB	EB	WB		EB	WB
64-1	185-213	28	Rural	Uninterrupted	0.22	Fair or Better	None	0.22	Fair or Better	None	0.21	0.21	Fair or Better	None	None	0.33	0.03	Fair or Better	None	None
64-2	213-234	21	Rural	Uninterrupted	0.28	Fair or Better	None	0.32	Fair or Better	None	0.28	0.26	Fair or Better	None	None	0.28	0.01	Fair or Better	None	None
64-3	234-237	3	Rural	Interrupted	0.55	Fair or Better	None	0.65	Fair or Better	Low	0.35	0.35	Fair or Better	None	None	0.20	0.07	Fair or Better	None	None
Emphasis Area?		Yes	Weighted Average		0.26	Good	None													

Segment	Segment Mileposts	Segment Length (miles)	Environment Type	Facility Operation	Directional TTI (all vehicles)					Directional PTI (all vehicles)					Bicycle Accommodation			Initial Need
					Performance Score		Performance Objective	Level of Need		Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
					EB	WB		EB	WB	NB	WB		EB	WB				
64-1	185-213	28	Rural	Uninterrupted	1.01	1.06	Fair or Better	None	None	1.27	1.59	Fair or Better	None	High	5%	Fair or Better	High	Low
64-2	213-234	21	Rural	Uninterrupted	1.02	1.17	Fair or Better	None	None	2.03	2.57	Fair or Better	High	High	4%	Fair or Better	High	Low
64-3	234-237	3	Rural	Interrupted	1.07	1.16	Fair or Better	None	None	1.00	2.04	Fair or Better	None	None	95%	Fair or Better	None	Low

Mobility Performance Area – Need Analysis Step 2

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Need	Need Adjustments Recently Completed Projects	Final Need	Planned and Programmed Future Projects
64-1	185-213	28	Low	None	Low	Programmed: None Planned: None
64-2	213-234	21	Low	None	Low	Programmed: None Planned: None
64-3	234-237	3	Low	**FY16 H783201C:** TUSAYAN STREETS PH-II, New Sidewalks, Landscape (MP 235.15-236.10) **FY16 H8258:** Grand Canyon Airport/FS Road 328, Construct Shoulder Widening (MP 234.24-237.05)	None	Programmed: None Planned: None

Mobility Performance Area – Need Analysis Step 3

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Roadway Variables								Traffic Variables					Relevant Mobility Related Existing Infrastructure
				Functional Classification	Environmental Type (Urban/Rural)	Terrain	# of Lanes/ Direction	Weighted Average Speed Limit	Aux Lanes	Divided/ Non-Divided	% No Passing	Existing LOS	Future 2035 LOS	% Trucks	EB Buffer Index (PTI-TTI)	WB Buffer Index (PTI-TTI)	
64-1	185-213	28	Low	State Highway	Rural	Level	2	65	No	Non-Divided	40%	A/B	A/B	14%	0.26	0.53	
64-2	213-234	21	Low	State Highway	Rural	Level	2	64	No	Non-Divided	41%	A/B	A/B	16%	1.00	1.40	
64-3	234-237	3	None	State Highway	Rural	Level	2	44	No	Non-Divided	16%	A/B	C	14%	-0.07	0.88	

Mobility Performance Area – Need Analysis Step 3 (continued)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/ Accidents	% Incidents/ Accidents	# Obstructions/ Hazards	% Obstructions/ Hazards	# Weather Related	% Weather Related			
64-1	185-213	28	Low	11	10	91%	0	0%	1	9%		Programmed: None Planned: None	- Candidate for Shoulder Improvements (MP 185 - 234)
64-2	213-234	21	Low	7	6	86%	0	0%	1	14%		Programmed: None Planned: None	- Candidate for Shoulder Improvements (MP 185 - 234)
64-3	234-237	3	None	2	1	50%	0	0%	1	50%		Programmed: None Planned: None	- Candidate for SB Shoulder Improvements

Safety Performance Area – Need Analysis Step 1

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	Safety Index			Directional Safety Index					% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors		
				Performance Score	Performance Objective	Level of Need	EB Performance Score	WB Performance Score	Performance Objective	EB Level of Need	WB Level of Need	Performance Score	Performance Objective	Level of Need
64-1	2 or 3 Lane Undivided Highway	28	185 - 213	0.27	Average or Better	None	0.45	0.09	Average or Better	None	None	*Insufficient Data*	Average or Better	N/A
64-2	2 or 3 Lane Undivided Highway	21	213 - 234	0.36	Average or Better	None	0.08	0.64	Average or Better	None	None	*Insufficient Data*	Average or Better	N/A
64-3	4 or 5 Lane Undivided Highway	3	234 - 237	0.08	Average or Better	None	0.00	0.16	Average or Better	None	None	*Insufficient Data*	Average or Better	N/A
Emphasis Area?		Yes	Weighted Average	0.30	Above Average	None								

Safety Performance Area – Need Analysis Step 1 (continued)

Segment	Operating Environment	Segment Length (miles)	Segment Mileposts (MP)	% of Fatal + Incapacitating Injury Crashes Involving Trucks			% of Fatal + Incapacitating Injury Crashes Involving Motorcycles			% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers			Initial Need
				Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	Performance Score	Performance Objective	Level of Need	
64-1	2 or 3 Lane Undivided Highway	28	185 - 213	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	None
64-2	2 or 3 Lane Undivided Highway	21	213 - 234	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	None
64-3	4 or 5 Lane Undivided Highway	3	234 - 237	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	*Insufficient Data*	Average or Better	N/A	None

Safety Performance Area – Need Analysis Step 2

Segment	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Hot Spots	Relevant Recently Completed or Under Construction Projects (which supersede performance data)*	Final Need	Comments (may include tentatively programmed projects with potential to address need or other relevant issues identified in previous reports)
64-1	28	185 - 213	None	-	None	None	High number of animal related crashes (not F+I) from MP 186-196 (NB), MP 204-210 (NB), MP 11-213 (NB), MP 186-194 (SB), and MP196-199 (SB). Candidate for Shoulder Improvements (MP 185 - 234) **Programmed:** None **Planned:** None
64-2	21	213 - 234	None	-	None	None	High number of animal related crashes (not F+I) from MP 218-234 (NB), MP 219 (SB), MP 222-223 (SB), and MP 224-234 (SB) Candidate for Shoulder Improvements (MP 185 - 234) **Programmed:** None **Planned:** None
64-3	3	234 - 237	None	-	**FY16 H783201C:** TUSAYAN STREETS PH-II, New Sidewalks, Landscape (MP 235.15-236.10) **FY16 H8258:** Grand Canyon Airport/FS Road 328, Construct Shoulder Widening (MP 234.24-237.05)	None	High number of animal related crashes (not F+I) from MP 234-237(NB) and MP 234-237 (SB) **Programmed:** None **Planned:** None

Safety Performance Area – Need Analysis Step 3

Segment Number	64-1	64-2	64-3	Corridor-Wide Crash Characteristics
Segment Length (miles)	28	21	3	
Segment Milepost (MP)	185 - 213	213 - 234	234 - 237	
Final Need	None	None	None	
Segment Crash Overview	1 Crashes were fatal 4 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	1 Crashes were fatal 4 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles	0 Crashes were fatal 1 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	2 Crashes were fatal 9 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles
Segment Crash Summaries (Fatal and Serious Injury Crashes)				
First Harmful Event Type	40% Involve Collision with Motor Vehicle 20% Involve Overturning 20% Involve Collision with Bicyclist	40% Involve Overturning 40% Collision with Animal 20% Involve Collision with Motor Vehicle	N/A - Sample size too small	27% Involve Collision with Motor Vehicle 27% Involve Collision with Motor Vehicle 18% Involve Collision With Animal
Collision Type	40% Involve Single Vehicle 40% Involve Head On 20% Involve Rear End	80% Involve Single Vehicle 20% Involve Left Turn	N/A - Sample size too small	55% Involve Single Vehicle 18% Involve Head On 9% Involve Left Turn
Violation or Behavior	20% Involve No Improper Action 20% Involve Failure to Keep in Proper Lane 20% Involve Other Unsafe Passing	20% Exceeded Lawful Speed 20% Failure to Yield Right-of-Way 20% Failure to Keep in Proper Lane	N/A - Sample size too small	18% Involve No Improper Action 18% Involve No Improper Action 18% Involve No Improper Action
Lighting Conditions	60% Occur in Daylight Conditions 40% Occur in Dark-Unlighted Conditions	60% Occur in Daylight Conditions 20% Occur in Dusk Conditions 20% Occur in Dark-Unlighted Conditions	N/A - Sample size too small	55% Occur in Daylight Conditions 27% Occur in Dark-Unlighted Conditions 9% Occur in Dusk Conditions
Surface Conditions	80% Involve Dry Conditions 20% Involve Snow Conditions	80% Involve Dry Conditions 20% Involve Ice/Frost Conditions	N/A - Sample size too small	82% Involve Dry Conditions 9% Involve Snow Conditions 9% Involve Snow Conditions
First Unit Event	40% Involve a first unit event of Crossed Centerline 40% Motor Vehicle in Transport 20% Involve a first unit event of Ran Off the Road (Right)	40% Involve a first unit event of Collision with Animal 40% Run Off the Road (Right) 20% Involve a first unit event of Motor Vehicle in Transport	N/A - Sample size too small	27% Involve a first unit event of Ran Off the Road (Right) 27% Involve a first unit event of Ran Off the Road (Right) 18% Involve a first unit event of Collision with Animal
Driver Physical Condition	80% No Apparent Influence 20% Under the Influence of Drugs or Alcohol	100% No Apparent Influence	N/A - Sample size too small	91% No Apparent Influence 9% Under the Influence of Drugs or Alcohol 0% Fatigued/Fell Asleep
Safety Device Usage	60% Shoulder And Lap Belt Used 20% None Used 20% Helmet Used	40% Shoulder And Lap Belt Used 40% Air bage Deployed/Shoulder-Lap Belt 20% Helmet Used	N/A - Sample size too small	55% Shoulder And Lap Belt Used 18% Helmet Used 18% Helmet Used

Segment Number	64-1	64-2	64-3	Corridor-Wide Crash Characteristics
Segment Length (miles)	28	21	3	
Segment Milepost (MP)	185 - 213	213 - 234	234 - 237	
Final Need	None	None	None	
Segment Crash Overview	**1** Crashes were fatal **4** Crashes had incapacitating injuries **0** Crashes involve trucks **0** Crashes involve Motorcycles	**1** Crashes were fatal **4** Crashes had incapacitating injuries **0** Crashes involve trucks **1** Crashes involve Motorcycles	**0** Crashes were fatal **1** Crashes had incapacitating injuries **0** Crashes involve trucks **0** Crashes involve Motorcycles	2 Crashes were fatal 9 Crashes had incapacitating injuries 0 Crashes involve trucks 1 Crashes involve Motorcycles
Hot Spot Crash Summaries				
Previously Completed Safety-Related Projects				
District Interviews/Discussions				
Contributing Factors	- Shoulder/ rumble stripe conditions - Traffic control device reflectivity - Clear zone slope and obstructions - High traffic volumes - Driver physical conditions - Shoulder width - Crossover crashes	- Pavement surface conditions - Shoulder/ rumble stripe conditions - Traffic control device reflectivity - Clear zone slope and obstructions - High traffic volumes - Shoulder width		- Pavement surface conditions - Shoulder/ rumble stripe conditions - Traffic control device reflectivity - Clear zone slope and obstructions - High traffic volumes - Shoulder width

Freight Performance Area – Need Analysis Step 1

Segment	Facility Operations	Segment Mileposts (MP)	Segment Length (miles)	Freight Index			Directional TTI (trucks only)					Directional PTI (trucks only)				
				Performance Score	Performance Objective	Level of Need	Performance Score		Performance Objective	Level of Need		Performance Score		Performance Objective	Level of Need	
							EB	WB		EB	WB	EB	WB		EB	WB
64-1	Uninterrupted	185 - 213	28	0.42	Fair or Better	High	1.10	1.19	Fair or Better	None	None	1.54	3.24	Fair or Better	Medium	High
64-2	Uninterrupted	213 - 234	21	0.28	Fair or Better	High	1.14	1.30	Fair or Better	None	Medium	2.46	4.60	Fair or Better	High	High
64-3	Interrupted	234 - 237	3	0.68	Fair or Better	None	1.03	1.32	Fair or Better	None	None	1.00	1.96	Fair or Better	None	None
Emphasis Area?	No	Weighted Average		0.38	Good	High										

Segment	Facility Operations	Segment Mileposts (MP)	Segment Length (miles)	Closure Duration (minutes/mile/year)					Bridge Clearance (feet)			Initial Need
				Performance Score		Performance Objective	Level of Need		Performance Score	Performance Objective	Level of Need	
				EB	WB		EB	WB				
64-1	Uninterrupted	185 - 213	28	264.89	4.46	Fair or Better	High	None	No UP	Fair or Better	None	High
64-2	Uninterrupted	213 - 234	21	271.39	1.15	Fair or Better	High	None	No UP	Fair or Better	None	High
64-3	Interrupted	234 - 237	3	231.20	8.67	Fair or Better	High	None	No UP	Fair or Better	None	Low

Freight Performance Area – Need Analysis Step 2

Segment	Segment Length (miles)	Segment Mileposts (MP)	Initial Need	Vertical Clearance Hot Spots (Vertical Clearance < 16.25' and No Ramps)	Relevant Recently Completed or Under Construction Projects (which supersede performance data)*	Final Need	Comments (may include tentatively programmed projects with potential to address needs or other relevant issues identified in previous reports)
64-1	28	185 - 213	High		None	High	
64-2	21	213 - 234	High		None	High	
64-3	3	234 - 237	Low		**FY16 H783201C:** TUSAYAN STREETS PH-II, New Sidewalks, Landscape (MP 235.15-236.10) **FY16 H8258:** Grand Canyon Airport/FS Road 328, Construct Shoulder Widening (MP 234.24-237.05)	Low	

Freight Performance Area – Need Analysis Step 3

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Roadway Variables								Traffic Variables					Relevant Freight Related Existing Infrastructure
				Functional Classification	Environmental Type (Urban/Rural)	Terrain	# of Lanes/ Direction	Weighted Average Speed Limit	Aux Lanes	Divided/ Non-Divided	% No Passing	Existing LOS	Future 2035 LOS	% Trucks	EB Buffer Index (TPTI-TTTI)	WB Buffer Index (TPTI-TTTI)	
64-1	185 - 213	28	High	State Highway	Rural	Rolling	2	65	No	Non-Divided	30%	A-C	A-C	14%	0.44	2.05	
64-2	213 - 234	21	High	State Highway	Rural	Rolling	2	64	No	Non-Divided	20%	A-C	A-C	52%	1.33	3.31	
64-3	234 - 237	3	Low	State Highway	Rural	Rolling	4	44	No	Non-Divided	0%	A-C	A-C	13%	-0.03	0.63	

Freight Performance Area – Need Analysis Step 3 (continued)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/ Accidents	% Incidents/ Accidents	# Obstructions/ Hazards	% Obstructions/ Hazards	# Weather Related	% Weather Related			
64-1	185-213	28	High	11	10	91%	0	0%	1	9%		Programmed: None Planned: None	- Candidate for Shoulder Improvements (MP 185 - 234)
64-2	213-234	21	High	7	6	86%	0	0%	1	14%		Programmed: None Planned: None	- Candidate for Shoulder Improvements (MP 185 - 234)
64-3	234-237	3	Low	2	1	50%	0	0%	1	50%		Programmed: None Planned: None	- Candidate for SB Shoulder Improvements

Needs Summary Table

Performance Area	Segment Number and Mileposts (MP)		
	64-1	64-2	64-3
	MP 185-213	MP 213-234	MP 234-237
Pavement+	High	None*	None*
Bridge	None*	None*	None*
Mobility+	Low	Low	None*
Safety+	None*	None*	None*
Freight	High	High	Low
Average Need	**1.38**	**0.69**	**0.15**

+ *Identified as an emphasis area for the SR 64 corridor.*

* *A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Level of Need	Average Need Range
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

Appendix E: Life-Cycle Cost Analysis

No LCCA conducted for any Pavement or Bridge candidate solutions on the SR 64 corridor

Appendix F: Crash Modification Factors and Factored Unit Construction Costs

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
REHABILITATION							
Rehabilitate Pavement (AC)	$276,500	Mile	2.20	$610,000	Mill and replace 1"-3" AC pvmt; accounts for 38' width; for one direction of travel on a two-lane roadway; includes pavement, striping, delineators, RPMs, rumble strips	0.70	Combination of rehabilitate pavement (0.92), striping, delineators, RPMs (0.77 for combination), and rumble strips (0.89) = 0.70
Rehabilitate Bridge	$65	SF	2.20	$140	Based on deck area; bridge only - no other costs included	0.95	Assumed - should have a minor effect on crashes at the bridge
GEOMETRIC IMPROVEMENT							
Re-profile Roadway	$974,500	Mile	2.20	$2,140,000	Includes excavation of approximately 3", pavement replacement (AC), striping, delineators, RPMs, rumble strips, for one direction of travel of 2-lane roadway (38' width)	0.70	Assumed - this is similar to rehab pavement. This solution is intended to address vertical clearance at bridge, not profile issue; factor the cost as a ratio of needed depth to 3".
Realign Roadway	$2,960,000	Mile	2.20	$6,510,000	All costs per direction except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.50	Based on Caltrans and NC DOT
Improve Skid Resistance	$675,000	Mile	2.20	$1,490,000	Average cost of pvmt replacement and variable depth paving to increase super-elevation; for one direction of travel on a two-lane roadway; includes pavement, striping, delineators, RPMs, rumble strips	0.66	Combination of avg of 5 values from clearinghouse (0.77) and calculated value from HSM (0.87) for skid resistance; striping, delineators, RPMs (0.77 for combination), and rumble strips (0.89) = 0.66
INFRASTRUCTURE IMPROVEMENT							
Reconstruct to Urban Section	$1,000,000	Mile	2.20	$2,200,000	Includes widening by 16' total (AC = 12'+2'+2') to provide median, curb & gutter along both side of roadway, single curb for median, striping (doesn't include widening for additional travel lane).	0.88	From HSM
Construct Auxiliary Lanes (AC)	$914,000	Mile	2.20	$2,011,000	For addition of aux lane (AC) in one direction of travel; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.78	Average of 4 values from clearinghouse
Construct Climbing Lane (High)	$3,000,000	Mile	2.20	$6,600,000	In one direction; all costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, steep slopes on both sides of road	0.75	From HSM
Construct Climbing Lane (Medium)	$2,250,000	Mile	2.20	$4,950,000	In one direction; all costs except bridges; applicable to areas with medium or large fills and cuts, retaining walls, rock blasting, steep slopes on one side of road	0.75	From HSM

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Construct Climbing Lane (Low)	$1,500,000	Mile	2.20	$3,300,000	In one direction; all costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.75	From HSM
Construct Reversible Lane (Low)	$2,400,000	Lane-Mile	2.20	$5,280,000	All costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.73 for uphill and 0.88 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a conc barrier
Construct Reversible Lane (High)	$4,800,000	Lane-Mile	2.20	$10,560,000	All costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, mountainous terrain	0.73 for uphill and 0.88 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a conc barrier
Construct Passing Lane	$1,500,000	Mile	2.20	$3,300,000	In one direction; all costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.63	Average of 3 values from clearinghouse
Construct Entry/Exit Ramp	$730,000	Each	2.20	$1,610,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, typical earthwork & drainage; does not include any major structures or improvements on crossroad	1.09	Average of 16 values on clearinghouse; for adding a ramp not reconstructing. CMF applied to crashes 0.25 miles upstream/downstream from the gore.
Relocate Entry/Exit Ramp	$765,000	Each	2.20	$1,680,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, typical earthwork, drainage and demolition of existing ramp; does not include any major structures or improvements on crossroad	1.00	Assumed to not add any crashes since the ramp is simply moving and not being added. CMF applied to crashes 0.25 miles upstream/downstream from the gore.
Construct Turn Lanes	$42,500	Each	2.20	$93,500	Includes 14' roadway widening (AC) for one additional turn lane (250' long) on one leg of an intersection; includes AC pavement, curb & gutter, sidewalk, ramps, striping, and minor signal modifications	0.81	Avg of 7 values from HSM; CMF applied to intersection related crashes; this solution also applies when installing a deceleration lane
Modify Entry/Exit Ramp	$445,000	Each	2.20	$979,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting existing ramp to parallel-type configuration	0.21	Average of 4 values from clearinghouse (for exit ramps) and equation from HSM (for entrance ramp). CMF applied to crashes within 1/8 mile upstream/downstream from the gore.
Widen & Modify Entry/Exit Ramp	$619,000	Each	2.20	$1,361,800	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting 1-lane ramp to 2-lane ramp and converting to parallel-type ramp	0.21	Will be same as "Modify Ramp"
Replace Pavement (AC) (with overexcavation)	$1,446,500	Mile	2.20	$3,180,000	Accounts for 38' width; for one direction of travel on a two-lane roadway; includes pavement, overexcavation, striping, delineators, RPMs, rumble strips	0.70	Same as rehab

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Replace Pavement (PCCP) (with overexcavation)	$1,736,500	Mile	2.20	$3,820,000	Accounts for 38' width; for one direction of travel on a two-lane roadway; includes pavement, overexcavation, striping, delineators, RPMs, rumble strips	0.70	Same as rehab
Replace Bridge (Short)	$125	SF	2.20	$280	Based on deck area; bridge only - no other costs included; cost developed generally applies to bridges crossing small washes	0.95	Assumed - should have a minor effect on crashes at the bridge
Replace Bridge (Medium)	$160	SF	2.20	$350	Based on deck area; bridge only - no other costs included; cost developed generally applies to bridges crossing over the mainline freeway, crossroads, or large washes	0.95	Assumed - should have a minor effect on crashes at the bridge
Replace Bridge (Long)	$180	SF	2.20	$400	Based on deck area; bridge only - no other costs included; cost developed generally applies to bridges crossing large rivers or canyons	0.95	Assumed - should have a minor effect on crashes at the bridge
Widen Bridge	$175	SF	2.20	$390	Based on deck area; bridge only - no other costs included	0.90	Assumed - should have a minor effect on crashes at the bridge
Install Pedestrian Bridge	$135	SF	2.20	$300	Includes cost to construct bridge based on linear feet of the bridge. This costs includes and assumes ramps and sidewalks leading to the structure.	0.1 (ped only)	Assumed direct access on both sides of structure
Implement Automated Bridge De-icing	$115	SF	2.20	$250	Includes cost to replace bridge deck and install system	0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
Install Wildlife Crossing Under Roadway	$650,000	Each	2.20	$1,430,000	Includes cost of structure for wildlife crossing under roadway and 1 mile of fencing in each direction that is centered on the wildlife crossing	0.25 (wildlife)	Assumed; CMF applies to wildlife-related crashes within 0.5 miles both upstream and downstream of the wildlife crossing in both directions
Install Wildlife Crossing Over Roadway	$1,140,000	Each	2.20	$2,508,000	Includes cost of structure for wildlife crossing over roadway and 1 mile of fencing in each direction that is centered on the wildlife crossing	0.25 (wildlife)	Assumed; CMF applies to wildlife-related crashes within 0.5 miles both upstream and downstream of the wildlife crossing in both directions
Construct Drainage Structure - Minor	$280,000	Each	2.20	$616,000	Includes 3-36" pipes and roadway reconstruction (approx. 1,000 ft) to install pipes	0.70	Same as rehab; CMF applied to crashes 1/8 mile upstream/downstream of the structure
Construct Drainage Structure - Intermediate	$540,000	Each	2.20	$1,188,000	Includes 5 barrel 8'x6' RCBC and roadway reconstruction (approx. 1,000 ft) to install RCBC	0.70	Same as rehab; CMF applied to crashes 1/8 mile upstream/downstream of the structure
Construct Drainage Structure - Major	$8,000	LF	2.20	$17,600	Includes bridge that is 40' wide and reconstruction of approx. 500' on each approach	0.70	Same as rehab; CMF applied to crashes 1/8 mile upstream/downstream of the structure

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Install Acceleration Lane	$127,500	Each	2.20	$280,500	For addition of an acceleration lane (AC) on one leg of an intersection that is 1,000' long plus a taper; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.85	Average of 6 values from the FHWA Desktop Reference for Crash Reduction Factors
OPERATIONAL IMPROVEMENT							
Implement Variable Speed Limits (Wireless, Overhead)	$718,900	Mile	2.20	$1,580,000	In one direction; includes 1 sign assembly per mile (foundation and structure), wireless communication, detectors	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Ground-mount)	$169,700	Mile	2.20	$373,300	In one direction; includes 2 signs per mile (foundations and posts), wireless communication, detectors	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Solar, Overhead)	$502,300	Mile	2.20	$1,110,000	In one direction; includes 1 sign assembly per mile (foundation and structure), wireless communication, detectors, solar power	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Solar, Ground-mount)	$88,400	Mile	2.20	$194,500	In one direction; includes 2 signs per mile (foundations and posts), wireless communication, detectors, solar power	0.92	From 1 value from clearinghouse
Implement Ramp Metering (Low)	$25,000	Each	2.20	$55,000	For each entry ramp location; urban area with existing ITS backbone infrastructure; includes signals, poles, timer, pull boxes, etc	0.64	From 1 value from clearinghouse; CMF applied to crashes 0.25 miles after gore
Implement Ramp Metering (High)	$150,000	Mile	2.20	$330,000	Area without existing ITS backbone infrastructure; in addition to ramp meters, also includes conduit, fiber optic lines, and power	0.64	From 1 value from clearinghouse
Implement Signal Coordination	$70,000	Mile	2.20	$154,000	Includes conduit, conductors, and controllers for 4 intersections that span a total of approximately 2 miles	0.90	Assumed
Implement Left-Turn Phasing	$7,500	Each	2.20	$16,500	Includes four new signal heads (two in each direction) and associated conductors for one intersection	0.88 (protected) 0.98 (perm/prot or prot/perm)	From HSM; CMF = 0.94 for each protected approach and 0.99 for each perm/prot or prot/perm approach. CMFs of different approaches should be multiplied together. CMF applied to crashes within intersection

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
ROADSIDE DESIGN							
Install Guardrail	$130,000	Mile	2.20	$286,000	One side of road	0.62 (ROR)	0.62 is avg of 2 values from clearinghouse
Install Cable Barrier	$80,000	Mile	2.20	$176,000	In median	0.81	0.81 is average of 5 values from clearinghouse
Widen Shoulder (AC)	$256,000	Mile	2.20	$563,000	Assumes 10' of existing shoulder (combined left and right), includes widening shoulder by a total of 4'; new pavement for 4' width and mill and replace existing 10' width; includes pavement, minor earthwork, striping edge lines, RPMs, high-visibility delineators, safety edge, and rumble strips	0.68 (1-4') 0.64 (>= 4')	0.86 is avg of 5 values from clearing house for widening shoulder 1-4'. 0.76 is calculated from HSM for widening shoulder >= 4'. (Cost needs to be updated if dimension of existing and widened shoulder differs from Description.)
Rehabilitate Shoulder (AC)	$113,000	Mile	2.20	$249,000	One direction of travel (14' total shldr width-4' left and 10' right); includes paving (mill and replace), striping, high-visibility delineators, RPMs, safety edge, and rumble strips for both shoulders	0.72	0.98 is average of 34 values on clearinghouse for shldr rehab/replace; include striping, delineators, RPMs (0.77 combined CMF), and rumble strips (0.89). (Cost needs to be updated if dimension of existing shoulder differs from Description.)
Replace Shoulder (AC)	$364,000	Mile	2.20	$801,000	One direction of travel (14' total shldr width-4' left and 10' right); includes paving (full reconstruction), striping, high-visibility delineators, RPMs, safety edge, and rumble strips for both shoulders	0.72	0.98 is average of 34 values on clearinghouse for shldr rehab/replace; include striping, delineators, RPMs (0.77 combined CMF), and rumble strips (0.89). (Cost needs to be updated if dimension of existing shoulder differs from Description.)
Install Rumble Strip	$5,500	Mile	2.20	$12,000	Both edges - one direction of travel; includes only rumble strip; no shoulder rehab or paving or striping	0.89	Average of 75 values on clearinghouse and consistent with HSM
Install Centerline Rumble Strip	$2,800	Mile	2.20	$6,000	Includes rumble strip only; no pavement rehab or striping	0.85	From HSM
Install Wildlife Fencing	$340,000	Mile	2.20	$748,000	Fencing only plus jump outs for 1 mile (both directions)	0.50 (wildlife)	Assumed
Remove Tree/Vegetation	$200,000	Mile	2.20	$440,000	Intended for removing trees that shade the roadway to allow sunlight to help melt snow and ice (see Increase Clear Zone CMF for general tree/vegetation removal in clear zone)	0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
Increase Clear Zone	$59,000	Mile	2.20	$130,000	In one direction; includes widening the clear zone by 10' to a depth of 3'	0.71	Median of 14 values from FHWA Desktop Reference for Crash Reduction Values

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Install Access Barrier Fence	$15	LF	2.20	$33	8' fencing along residential section of roadway	0.10 (ped only)	Equal to ped overpass
Install Rock-Fall Mitigation - Wire Mesh	$1,320,000	Mile	2.20	$2,904,000	Includes wire mesh and rock stabilization (one direction)	0.75 (debris)	Assumed
Install Rock-Fall Mitigation - Containment Fence & Barrier	$2,112,000	Mile	2.20	$4,646,000	Includes containment fencing, concrete barrier, and rock stabilization (one direction)	0.75 (debris)	Assumed
Install Raised Concrete Barrier in Median	$650,000	Mile	2.20	$1,430,000	Includes concrete barrier with associated striping and reflective markings; excludes lighting in barrier (one direction)	0.90 (Cross-median and head on crashes eliminated completely)	All cross median and head-on fatal or incapacitating injury crashes are eliminated completely; all remaining crashes have 0.90 applied
Formalize Pullout (Small)	$7,500	Each	2.20	$17,000	Includes paving and signage (signs, posts, and foundations) - approximately 4,200 sf	0.97	Assumed - similar to Install Other General Warning Signs; CMF applied to crashes within 0.25 miles after sign
Formalize Pullout (Medium)	$27,500	Each	2.20	$61,000	Includes paving and signage (signs, posts, and foundations) - approximately 22,500 sf	0.97	Assumed - similar to Install Other General Warning Signs; CMF applied to crashes within 0.25 miles after sign
Formalize Pullout (Large)	$80,500	Each	2.20	$177,100	Includes paving and signage (signs, posts, and foundations) - approximately 70,000 sf	0.97	Assumed - similar to Install Other General Warning Signs; CMF applied to crashes within 0.25 miles after sign
INTERSECTION IMPROVEMENTS							
Construct Traffic Signal	$150,000	Each	2.20	$330,000	4-legged intersection; includes poles, foundations, conduit, controller, heads, luminaires, mast arms, etc.	0.95	From HSM; CMF applied to crashes within intersection only
Improve Signal Visibility	$35,000	Each	2.20	$77,000	4-legged intersection; signal head size upgrade, installation of new back-plates, and installation of additional signal heads on new poles.	0.85	Avg of 7 values from clearinghouse; CMF applied to crashes within intersection only
Install Raised Median	$360,000	Mile	2.20	$792,000	Includes removal of 14' wide pavement and construction of curb & gutter; does not include cost to widen roadway to accommodate the median; if the roadway needs to be widened, include cost from New General Purpose Lane	0.83	Avg from HSM
Install Transverse Rumble Strip/Pavement Markings	$3,000	Each	2.20	$7,000	Includes ped markings and rumble strips only across a 30' wide travelway; no pavement rehab or other striping	0.95	Avg of 17 values from clearinghouse; CMF applied to crashes within 0.5 miles after the rumble strips and markings

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Construct Single-Lane Roundabout	$1,500,000	Each	2.20	$3,300,000	Removal of signal at 4-legged intersection; realignment of each leg for approx. 800 feet including paving, curbs, sidewalk, striping, lighting, signing	0.22	From HSM; CMF applied to crashes within intersection only
Construct Double-Lane Roundabout	$1,800,000	Each	2.20	$3,960,000	Removal of signal at 4-legged intersection; realignment of each leg for approx. 800 feet including paving, curbs, sidewalk, striping, lighting, signing	0.40	From HSM; CMF applied to crashes within intersection only
ROADWAY DELINEATION							
Install High-Visibility Edge Line Striping	$10,800	Mile	2.20	$23,800	2 edge lines and lane line - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs. (If implemented separately, CMF will be higher.)
Install High-Visibility Delineators	$6,500	Mile	2.20	$14,300	Both edges - one direction of travel		Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs. (If implemented separately, CMF will be higher.)
Install Raised Pavement Markers	$2,000	Mile	2.20	$4,400	Both edges - one direction of travel		Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs. (If implemented separately, CMF will be higher.)
Install In-Lane Route Markings	$6,000	Each	2.20	$13,200	Installation of a series of three in-lane route markings in one lane	0.95	Assumed; CMF applied to crashes within 1.0 mile before the gore
IMPROVED VISIBILITY							
Cut Side Slopes	$80	LF	2.20	$200	For small grading to correct sight distance issues; not major grading	0.85	Intent of this solution is to improve sight distance. Most CMF's are associated with vehicles traveling on slope. Recommended CMF is based on FDOT and NCDOT but is more conservative.
Install Lighting (connect to existing power)	$270,000	Mile	2.20	$594,000	One side of road only; offset lighting, not high-mast; does not include power supply; includes poles, luminaire, pull boxes, conduit, conductor	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM
Install Lighting (solar powered LED)	$10,000	Pole	2.20	$22,000	Offset lighting, not high-mast; solar power LED; includes poles, luminaire, solar panel	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
DRIVER INFORMATION/WARNING							
Install Dynamic Message Sign (DMS)	$250,000	Each	2.20	$550,000	Includes sign, overhead structure, and foundations; wireless communication; does not include power supply	1.00	Not expected to reduce crashes
Install Dynamic Weather Warning Beacons	$40,000	Each	2.20	$88,000	Assumes solar operation and wireless communication or connection to existing power and communication; ground mounted; includes posts, foundations, solar panel, and dynamic sign	0.80 (weather related)	Avg of 3 values from FHWA Desktop Reference for Crash Reduction Factors; CMF applies to crashes within 0.25 miles after a sign
Install Dynamic Speed Feedback Signs	$25,000	Each	2.20	$55,000	Assumes solar operation and no communication; ground mounted; includes regulatory sign, posts, foundations, solar panel, and dynamic sign	0.94	Average of 2 clearinghouse values; CMF applies to crashes within 0.50 miles after a sign
Install Chevrons	$18,400	Mile	2.20	$40,500	On one side of road - includes signs, posts, and foundations	0.79	Average of 11 clearinghouse values
Install Curve Warning Signs	$2,500	Each	2.20	$5,500	Includes 2 signs, posts, and foundations	0.83	Average of 4 clearinghouse values; CMF applies to crashes within 0.25 miles after a sign
Install Traffic Control Device Warning Signs (e.g., stop sign ahead, signal ahead, etc.)	$2,500	Each	2.20	$5,500	Includes 2 signs, posts, and foundations	0.85	FHWA Desktop Reference for Crash Reduction Factors; CMF applies to crashes within 0.25 miles after a sign
Install Other General Warning Signs (e.g., intersection ahead, wildlife in area, slow vehicles, etc.)	$2,500	Each	2.20	$5,500	Includes 2 signs, posts, and foundations	0.97	Assumed; CMF applies to crashes within 0.25 miles after a sign
Install Wildlife Warning System	$162,000	Each	2.20	$356,400	Includes wildlife detection system at a designated wildlife crossing, flashing warning signs (assumes solar power), advance signing, CCTV (solar and wireless), game fencing for approximately 0.25 miles in each direction - centered on the wildlife crossing, and regular fencing for 1.0 mile in each direction - centered on the wildlife crossing.	0.50 (wildlife)	Assumed; CMF applies to wildlife-related crashes within 0.5 miles both upstream and downstream of the wildlife crossing in both directions
Install Warning Sign with Beacons	$15,000	Each	2.20	$33,000	In both directions; includes warning sign, post, and foundation, and flashing beacons (assumes solar power) at one location	0.75	FHWA Desktop Reference for Crash Reduction Factors for Installing Flashing Beacons as Advance Warning; CMF applies to crashes within 0.25 miles after a sign

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Install Larger Stop Sign with Beacons	$10,000	Each	2.20	$22,000	In one direction; includes large stop sign, post, and foundation, and flashing beacons (assumes solar power) at one location	0.85/0.81	Use 0.85 for adding beacons to an existing sign; 0.81 for installing a larger sign with flashing beacons; CMF applies to intersection related crashes
DATA COLLECTION							
Install Roadside Weather Information System (RWIS)	$60,000	Each	2.20	$132,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	Not expected to reduce crashes
Install Closed Circuit Television (CCTV) Camera	$25,000	Each	2.20	$55,000	Assumes connection to existing ITS backbone or wireless communication; does not include fiber-optic backbone infrastructure; includes pole, camera, etc	1.00	Not expected to reduce crashes
Install Vehicle Detection Stations	$15,000	Each	2.20	$33,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	Not expected to reduce crashes
Install Flood Sensors (Activation)	$15,000	Each	2.20	$33,000	Sensors with activation cabinet to alert through texting (agency)	1.00	Not expected to reduce crashes
Install Flood Sensors (Gates)	$100,000	Each	2.20	$220,000	Sensors with activation cabinet to alert through texting (agency) and beacons (public) plus gates	1.00	Not expected to reduce crashes
WIDEN CORRIDOR							
Construct New General Purpose Lane (PCCP)	$1,740,000	Mile	2.20	$3,830,000	For addition of 1 GP lane (PCCP) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.87
Construct New General Purpose Lane (AC)	$1,200,000	Mile	2.20	$2,640,000	For addition of 1 GP lane (AC) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.88
Convert a 2-Lane undivided highway to a 5-Lane highway	$1,576,000	Mile	2.20	$3,467,200	For expanding a 2-lane undivided highway to a 5-lane highway (4 through lanes with TWLTL), includes standard shoulder widths but no curb, gutter, or sidewalks	0.60	Assumed to be slightly lower than converting from a 4-lane to a 5-lane highway
Install Center Turn Lane	$1,053,000	Mile	2.20	$2,316,600	For adding a center turn lane (i.e., TWLTL); assumes symmetrical widening on both sides of the road; includes standard shoulder widths but no curb, gutter, or sidewalk	0.75	From FHWA Desktop Reference for Crash Reduction Factors, CMF Clearinghouse, and SR 87 CPS comparison

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Construct 4-Lane Divided Highway (Using Existing 2-Lane Road for one direction)	$3,000,000	Mile	2.20	$6,600,000	In both directions; one direction uses existing 2-lane road; other direction assumes addition of 2 new lanes (AC) with standard shoulders; includes all costs except bridges	0.67	Assumed
Construct 4-Lane Divided Highway (No Use of Existing Roads)	$6,000,000	Mile	2.20	$13,200,000	In both directions; assumes addition of 2 new lanes (AC) with standard shoulders in each direction; includes all costs except bridges	0.67	Assumed
Construct Bridge over At-Grade Railroad Crossing	$10,000,000	Each	2.20	$22,000,000	Assumes bridge width of 4 lanes (AC) with standard shoulders; includes abutments and bridge approaches; assumes vertical clearance of 23'4" + 6'8" superstructure	0.72 (All train-related crashes eliminated)	Removes all train-related crashes at at-grade crossing; all other crashes CMF = 0.72
Construct Underpass at At-Grade Railroad Crossing	$15,000,000	Each	2.20	$33,000,000	Assumes underpass width of 4 lanes (AC) with standard shoulders; includes railroad bridge with abutments and underpass approaches; assumes vertical clearance of 16'6" + 6'6" superstructure	0.72 (All train-related crashes eliminated)	Removes all train-related crashes at at-grade crossing; all other crashes CMF = 0.72
Construct High-Occupancy Vehicle (HOV) Lane	$900,000	Mile	2.20	$1,980,000	For addition of 1 HOV lane (AC) in one direction with associated signage and markings; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.95	Similar to general purpose lane
ALTERNATE ROUTE							
Construct Frontage Roads	$2,400,000	Mile	2.20	$5,280,000	For 2-lane AC frontage road; includes all costs except bridges; for generally at-grade facility with minimal walls	0.90	Assumed - similar to new general purpose lane
Construct 2-Lane Undivided Highway	$3,000,000	Mile	2.20	$6,600,000	In both directions; assumes addition of 2 new lanes (AC) with standard shoulders in each direction; includes all costs except bridges	0.90	Assuming new alignment for a bypass
OTHER IMPROVEMENTS							
Install Curb and Gutter	$211,200	Mile	2.20	$465,000	In both directions; curb and gutter	0.89	From CMF Clearinghouse
Install Sidewalks, Curb, and Gutter	$475,200	Mile	2.20	$1,045,000	In both directions; 5' sidewalks, curb, and gutter	0.89 installing sidewalk 0.24 (pedestrian crashes only)	From CMF Clearinghouse Avg of 6 values from FHWA Desktop Reference

SOLUTION	CONSTRUCTION UNIT COST	UNIT	FACTOR^	FACTORED CONSTRUCTION UNIT COST	DESCRIPTION	CMF FOR CORRIDOR PROFILE STUDIES	CMF NOTES
Install Sidewalks	$264,000	Mile	2.20	$581,000	In both directions; 5' sidewalks	0.24 (pedestrian crashes only)	Avg of 6 values from FHWA Desktop Reference
Install Advanced Warning Signal System	$108,000	each	2.20	$238,000	Overhead static sign with flashing beacons, detectors, and radar system. Signs for each mainline approach of the intersection (2)	0.61	FHWA Desktop Reference for CRF
Install Indirect Left Turn Intersection	$1,140,000	each	2.20	$2,500,000	Raised concrete median improvements; intersection improvements; turn lanes	0.80	CMF Clearinghouse
Convert Standard Diamond Interchange to Diverging Diamond Interchange	$2,272,700	each	2.20	$5,000,000	Convert traditional diamond interchange into diverging diamond interchange; assumes re-use of existing bridges	0.67	CMF Clearinghouse
Install Adaptive Signal Control and Signal Coordination	$363,500	mile	2.20	$800,000	Controller upgrades, advanced detection, software configuration, cameras; includes conduit, conductors, and controllers for 4 intersections that span a total of approximately 2 miles for coordination	0.81 (adaptive control) 0.90 (signal coordination)	CMF Clearinghouse
Left-in Only Center Raised Median Improvements	$84,100	each	2.20	$185,000	Left-in only center raised median improvements	0.87	CMF Clearinghouse

^ Factor accounts for traffic control, erosion control, construction surveying and quality control, mobilization, construction engineering, contingencies, indirect cost allocation, and miscellaneous work

Appendix G: Performance Area Risk Factors

Pavement Performance Area

- Elevation
- Mainline Daily Traffic Volume
- Mainline Daily Truck Volume

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000'
0-5	4000'- 9000'
5	> 9000'

Mainline Daily Traffic Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.000039)})$

Score	Condition
0	< 6,000
0-5	6,000 – 160,000
5	>160,000

Mainline Daily Truck Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.00025)})$

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Bridge Performance Area

- Mainline Daily Traffic Volume
- Elevation
- Carries Mainline Traffic
- Detour Length
- Scour Critical Rating
- Vertical Clearance

Mainline Daily Traffic Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.000039)})$

Score	Condition
0	<6,000
0-5	6,000-160,000
5	>160,000

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000'
0-5	4000'- 9000'
5	> 9000'

Carries Mainline Traffic

Score	Condition
0	Does not carry mainline traffic
5	Carries mainline traffic

Detour Length

Divides detour length by 10 and multiplies by 2.5

Score	Condition
0	0 miles
0-5	0-20 miles
5	> 20 miles

Scour Critical Rating

Variance below 8

Score	Condition
0	Rating > 8
0-5	Rating 8 - 3
5	Rating < 3

Vertical Clearance

Variance below 16' x 2.5; (16 –Clearance) x 2.5

Score	Condition
0	>16'
0-5	16'-14'
5	<14'

Mobility Performance Area

- Mainline VMT
- Buffer Index (PTI-TTI)
- Detour Length
- Outside Shoulder Width

Mainline VMT

Exponential equation; score = 5-(5*e(ADT*-0.0000139))

Score	Condition
0	<16,000
0-5	16,000-400,000
5	>400,000

Buffer Index

Buffer Index x 10

Score	Condition
0	Buffer Index = 0.00
0-5	Buffer Index 0.00-0.50
5	Buffer Index > 0.50

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Outside Shoulder Width

Variance below 10', if only 1 lane in each direction

Score	Condition
0	10' or above or >1 lane in each direction
0-5	10'-5' and 1 lane in each direction
5	5' or less and 1 lane in each direction

Safety Performance Area

- Mainline Daily Traffic Volume
- Interrupted Flow
- Elevation
- Outside Shoulder Width
- Vertical Grade

Mainline Daily Traffic Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.000039)}$)

Score	Condition
0	<6,000
0-5	6,000-160,000
5	>160,000

Interrupted Flow

Score	Condition
0	Not interrupted flow
5	Interrupted Flow

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000'
0-5	4000'- 9000'
5	> 9000'

Outside Shoulder Width

Variance below 10'

Score	Condition
0	10' or above
0-5	10' - 5'
5	5' or less

Grade

Variance above 3% x 1.5

Score	Condition
0	< 3%
0-5	3% - 6.33%
5	>6.33%

Freight Performance Area

- Mainline Daily Truck Volume
- Detour Length
- Truck Buffer Index (TPTI-TTTI)
- Outside Shoulder Width

Mainline Daily Truck Volume

Exponential equation; score = 5-(5*e$^{(ADT*-0.00025)}$)

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Truck Buffer Index

Truck Buffer Index x 10

Score	Condition
0	Buffer Index = 0.00
0-5	Buffer Index 0.00-0.50
5	Buffer Index > 0.50

Outside Shoulder Width

Variance below 10', if only 1 lane in each direction

Score	Condition
0	10' or above or >1 lane in each direction
0-5	10'-5' and 1 lane in each direction
5	5' or less and 1 lane in each direction

Solution Number	Mainline Traffic Vol (vpd) (2-way)	Solution Length (miles)	Bridge Detour Length (miles) (N19)	Elevation (ft)	Scour Critical Rating (0-9)	Carries Mainline Traffic (Y/N)	Bridge Vert. Clear (ft)	Mainline Truck Vol (vpd) (2-way)	Detour Length > 10 miles (Y/N)	Truck Buffer Index	Non-Truck Buffer Index	Grade (%)	Interrupted Flow (Y/N)	Outside/ Right Shoulder Width (ft)	1-lane each direction
64.1	4,883	19.5		6,500				684	Y	2.05	0.53	2.1	N	5.25	Y
64.2	6,102	2		6,200				976	Y	3.30	1.40	2	N	5.1	Y

Solution Number	Bridge	Pavement	Mobility	Safety	Freight	Risk Score (0 to 10)				
						Bridge	Pavement	Mobility	Safety	Freight
64.1	N	Y	Y	Y	Y	0.00	2.77	9.21	3.24	7.77
64.2	N	N	Y	Y	Y	0.00	0.00	7.84	3.26	7.99

Appendix H: Candidate Solution Cost Estimates

Candidate Solution #	Location #	Candidate Solution Name	Scope	BMP	EMP	Unit	Quantity	Factored Construction Unit Cost	Preliminary Engineering Cost	Design Cost	Right-of-Way Cost	Construction Cost	Total Cost	Notes
CS64.1	L2	Williams to Valle Freight and Pavement Improvements	Construct Climbing Lane EB	196	198	mi	2	$3,300,000	$198,000	$660,000	$0	$6,600,000	$7,458,000	
			Construct Climbing Lane WB	200	202	mi	2	$3,300,000	$198,000	$660,000	$0	$6,600,000	$7,458,000	
			Construct Climbing Lane EB	203	205	mi	2	$3,300,000	$198,000	$660,000	$0	$6,600,000	$7,458,000	
			Pavement Preservation EB and WB	185.5	205	mi	19.5	$564,000	$329,900	$1,099,000	$0	$10,998,000	$12,427,700	Adjusted width to 36 feet in standard solution cost for SR 64 '
								Solution Total	**$923,900**	**$3,079,800**	**$0**	**$30,798,000**	**$34,801,700**	
CS64.2	L3	Valle Area Freight Improvements	Construct Climbing Lane EB	221	222	mi	1	$3,300,000	$99,000	$330,000	$0	$3,300,000	$3,729,000	
			Construct Climbing Lane WB	223	224	mi	1	$3,300,000	$99,000	$330,000	$0	$3,300,000	$3,729,000	
								Solution Total	**$198,000**	**$660,000**	**$0**	**$6,600,000**	**$7,458,000**	

Appendix I: Performance Effectiveness Scores

Need Reduction

			Solution #	**64.1**	**64.2**
			Description	Williams to Valle Freight and Pavement Improvements	Valle Area Freight Improvements
	LEGEND:		Project Beg MP	185.46	221
	(tan)	- user entered value	Project End MP	205	224
	(white)	- calculated value for reference only	Project Length (miles)	6	2
	(blue)	- calculated value for entry/use in other spreadsheet	Segment Beg MP	185	213
	(orange)	- for input into Performance Effectiveness Score spreadsheet	Segment End MP	213	234
	(red)	- assumed values (do not modify)	Segment Length (miles)	28	21
			Segment #	1	2
			Current # of Lanes (both directions)	2	2
			Project Type (one-way or two-way)	one-way	one-way
			Additional Lanes (one-way)	0.21	1
			Pro-Rated # of Lanes	2.05	2.10
		Notes and Directions	**Description**		
SAFETY	DIRECTIONAL SAFETY	Input current value from performance system (NB/EB)	Orig Segment Directional Safety Index (NB/EB)	0.450	0.080
		Input current value from performance system (NB/EB)	Orig Segment Directional Fatal Crashes (NB/EB)	1	0
		Input current value from performance system (NB/EB)	Orig Segment Directional Incap Crashes (NB/EB)	1	2
		Input current value from performance system (NB/EB)	Original Fatal Crashes in project limits (NB/EB)	0	0
		Input current value from performance system (NB/EB)	Original Incap Crashes in project limits (NB/EB)	1	0
		Input CMF value (NB/EB) - If no CMF enter 1.0	CMF 1 (NB/EB)(lowest CMF)	Calculated in separate worksheet	Calculated in separate worksheet
		Input CMF value (NB/EB) - If no CMF enter 1.0	CMF 2 (NB/EB)		
		Input CMF value (NB/EB) - If no CMF enter 1.1	CMF 3 (NB/EB)		
		Input CMF value (NB/EB) - If no CMF enter 1.2	CMF 4 (NB/EB)		
		Input CMF value (NB/EB) - If no CMF enter 1.0	CMF 5 (NB/EB)		
		Calculated Value (NB/EB)	Total CMF (NB/EB)	See Worksheet	See Worksheet
		Calculated Value (NB/EB)	Fatal Crash reduction (NB/EB)	0.000	0.000
		Calculated Value (NB/EB)	Incap Crash reduction (NB/EB)	0.300	0.000
		Enter in Safety Index spreadsheet to calculate new Safety Index (NB/EB)	Post-Project Segment Directional Fatal Crashes (NB/EB)	1.000	0.000
		Enter in Safety Index spreadsheet to calculate new Safety Index (NB/EB)	Post-Project Segment Directional Incap Crashes (NB/EB)	0.700	2.000
		Input value from updated Safety Index spreadsheet (NB/EB)	Post-Project Segment Directional Safety Index (NB/EB)	0.440	0.080
		Enter in Safety Needs spreadsheet to calculate new segment level Safety Need (NB/EB)	Post-Project Segment Directional Safety Index (NB/EB)	0.440	0.080
		Input current value from performance system (SB/WB)	Orig Segment Directional Safety Index (SB/WB)	0.090	0.640
		Input current value from performance system (SB/WB)	Orig Segment Directional Fatal Crashes (SB/WB)	0	1
		Input current value from performance system (SB/WB)	Orig Segment Directional Incap Crashes (SB/WB)	3	2
		Input current value from performance system (SB/WB)	Original Fatal Crashes in project limits (SB/WB)	0	1
		Input current value from performance system (SB/WB)	Original Incap Crashes in project limits (SB/WB)	1	0
		Input CMF value (SB/WB) - If no CMF enter 1.0	CMF 1 (SB/WB)(lowest CMF)	Calculated in separate worksheet	Calculated in separate worksheet
		Input CMF value (SB/WB) - If no CMF enter 1.0	CMF 2 (SB/WB)		
		Input CMF value (SB/WB) - If no CMF enter 1.1	CMF 3 (SB/WB)		
		Input CMF value (SB/WB) - If no CMF enter 1.2	CMF 4 (SB/WB)		
		Input CMF value (SB/WB) - If no CMF enter 1.0	CMF 5 (SB/WB)		
		Calculated Value (SB/WB)	Total CMF (SB/WB)	See Worksheet	See Worksheet
		Calculated Value (SB/WB)	Fatal Crash reduction (SB/WB)	0.000	0.250
		Calculated Value (SB/WB)	Incap Crash reduction (SB/WB)	0.300	0.000
		Enter in Safety Index spreadsheet to calculate new Safety Index (SB/WB)	Post-Project Segment Directional Fatal Crashes (SB/WB)	0.000	0.750
		Enter in Safety Index spreadsheet to calculate new Safety Index (SB/WB)	Post-Project Segment Directional Incap Crashes (SB/WB)	2.700	2.000
		Input value from updated Safety Index spreadsheet (SB/WB)	Post-Project Segment Directional Safety Index (SB/WB)	0.010	0.500
		Enter in Safety Needs spreadsheet to calculate new segment level Safety Need (SB/WB)	Post-Project Segment Directional Safety Index (SB/WB)	0.010	0.500
	SAFETY INDEX	Calculated Value - verify that it matches current performance system	Current Safety Index	0.270	0.360
		Enter in Safety Needs spreadsheet to calculate new segment level Safety Need	Post-Project Safety Index	0.225	0.290
	Needs	User entered value from Safety Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Safety Need	0.165	0.220
		User entered value from Safety Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Safety Need	0.138	0.178

			Solution #	**64.1**	**64.2**
			Description	Williams to Valle Freight and Pavement Improvements	Valle Area Freight Improvements
	LEGEND:		Project Beg MP	185.46	221
	(tan)	- user entered value	Project End MP	205	224
	(white)	- calculated value for reference only	Project Length (miles)	6	2
	(blue)	- calculated value for entry/use in other spreadsheet	Segment Beg MP	185	213
	(orange)	- for input into Performance Effectiveness Score spreadsheet	Segment End MP	213	234
	(red)	- assumed values (do not modify)	Segment Length (miles)	28	21
			Segment #	1	2
			Current # of Lanes (both directions)	2	2
			Project Type (one-way or two-way)	one-way	one-way
			Additional Lanes (one-way)	0.21	1
			Pro-Rated # of Lanes	2.05	2.10
		Notes and Directions	**Description**		
MOBILITY	MOBILITY INDEX	Input current value from performance system	Original Segment Mobility Index	0.220	0.280
MOBILITY	MOBILITY INDEX	Enter in Mobility Index Spreadsheet to determine new segment level Mobility Index	Post-Project # of Lanes (both directions)	2.05	2.10
MOBILITY	MOBILITY INDEX	Input value from updated Mobility Index spreadsheet	Post-Project Segment Mobility Index	0.20	0.26
MOBILITY	MOBILITY INDEX	Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Mobility Index	0.200	0.260
MOBILITY	FUT V/C	Input current value from performance system	Original Segment Future V/C	0.220	0.320
MOBILITY	FUT V/C	Input value from updated Mobility Index spreadsheet	Post-Project Segment Future V/C	0.200	0.300
MOBILITY	FUT V/C	Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Future V/C	0.200	0.300
MOBILITY	PEAK HOUR V/C	Input current value from performance system (NB/EB)	Original Segment Peak Hour V/C (NB/EB)	0.210	0.280
MOBILITY	PEAK HOUR V/C	Input current value from performance system (SB/WB)	Original Segment Peak Hour V/C (SB/WB)	0.210	0.260
MOBILITY	PEAK HOUR V/C	***If One-Way project**, enter in Mobility Index Spreadsheet to determine new segment level Peak Hour V/C. **If Two-Way project,** disregard	Adjusted total # of Lanes for use in directional peak hr	2.09	2.19
MOBILITY	PEAK HOUR V/C	Input value from updated Mobility Index spreadsheet (NB/EB)	Post-Project Segement Peak Hr V/C (NB/EB)	0.210	0.28
MOBILITY	PEAK HOUR V/C	Input value from updated Mobility Index spreadsheet (SB/WB)	Post-Project Segement Peak Hr V/C (SB/WB)	0.210	0.26
MOBILITY	PEAK HOUR V/C	Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Peak Hr V/C (NB/EB)	0.210	0.280
MOBILITY	PEAK HOUR V/C	Enter in Mobility Needs spreadsheet to update segment level Mobility Need	Post-Project Segment Peak Hr V/C (SB/WB)	0.210	0.260
MOBILITY	TTI AND PTI	Calculated Value (both directions)	Safety Reduction Factor	0.833	0.806
MOBILITY	TTI AND PTI	Calculated Value (both directions)	Safety Reduction	0.167	0.194
MOBILITY	TTI AND PTI	Calculated Value (both directions)	Mobility Reduction Factor	0.909	0.929
MOBILITY	TTI AND PTI	Calculated Value (both directions)	Mobility Reduction	0.091	0.071
MOBILITY	TTI AND PTI	Assumed effect on TTI (% of mobility reduction)	Mobility effect on TTI	0.60	0.60
MOBILITY	TTI AND PTI	Assumed effect on PTI (% of mobility reduction)	Mobility effect on PTI	0.50	0.50
MOBILITY	TTI AND PTI	Assumed effect on TTI (% of safety reduction)	Safety effect on TTI	0.00	0.00
MOBILITY	TTI AND PTI	Assumed effect on PTI (% of safety reduction)	Safety effect on PTI	0.60	0.60
MOBILITY	TTI AND PTI	Input current value from performance system (NB/EB)	Original Directional Segment TTI (NB/EB)	1.010	1.020
MOBILITY	TTI AND PTI	Input current value from performance system (NB/EB)	Original Directional Segment PTI (NB/EB)	1.270	2.030
MOBILITY	TTI AND PTI	Input current value from performance system (SB/WB)	Original Directional Segment TTI (SB/WB)	1.060	1.170
MOBILITY	TTI AND PTI	Input current value from performance system (SB/WB)	Original Directional Segment PTI (SB/WB)	1.590	2.570
MOBILITY	TTI AND PTI	Calculated Value (both directions)	Reduction Factor for Segment TTI	0.055	0.043
MOBILITY	TTI AND PTI	Calculated Value (both directions)	Reduction Factor for Segment PTI	0.145	0.152
MOBILITY	TTI AND PTI	Enter in Mobility Needs spreadsheet to update segment level Mobility Need (NB/EB)	Post-Project Directional Segment TTI (NB/EB)	1.005	1.010
MOBILITY	TTI AND PTI	Enter in Mobility Needs spreadsheet to update segment level Mobility Need (NB/EB)	Post-Project Directional Segment PTI (NB/EB)	1.085	1.721
MOBILITY	TTI AND PTI	Enter in Mobility Needs spreadsheet to update segment level Mobility Need (SB/WB)	Post-Project Directional Segment TTTI (SB/WB)	1.060	1.170
MOBILITY	TTI AND PTI	Enter in Mobility Needs spreadsheet to update segment level Mobility Need (SB/WB)	Post-Project Directional Segment TPTI (SB/WB)	1.590	2.570
MOBILITY	CLOSURE EXTENT	Input current value from performance system (NB/EB)	Orig Segment Directional Closure Extent (NB/EB)	0.330	0.280
MOBILITY	CLOSURE EXTENT	Input current value from performance system (SB/WB)	Orig Segment Directional Closure Extent (SB/WB)	0.030	0.010
MOBILITY	CLOSURE EXTENT	Input value from HCRS	Segment Closures with fatalities/injuries	3	4
MOBILITY	CLOSURE EXTENT	Input value from HCRS	Total Segment Closures	11	7
MOBILITY	CLOSURE EXTENT	Calculated Value (both directions)	% Closures with Fatality/Injury	0.27	0.57
MOBILITY	CLOSURE EXTENT	Calculated Value (both directions)	Closure Reduction	0.045	0.111
MOBILITY	CLOSURE EXTENT	Calculated Value (both directions)	Closure Reduction Factor	0.955	0.889
MOBILITY	CLOSURE EXTENT	Enter in Mobility Needs spreadsheet to update segment level Mobility Need (NB/EB)	Post-Project Segment Directional Closure Extent (NB/EB)	0.315	0.249
MOBILITY	CLOSURE EXTENT	Enter in Mobility Needs spreadsheet to update segment level Mobility Need (SB/WB)	Post-Project Segment Directional Closure Extent (SB/WB)	0.030	0.010
MOBILITY	BICYCLE ACCOM	Input current value from performance system	Orig Segment Bicycle Accomodation %	5.0%	4.0%
MOBILITY	BICYCLE ACCOM	Input current value from performance system	Orig Segment Outside Shoulder width	5	5
MOBILITY	BICYCLE ACCOM	Input value from updated Mobility Index spreadsheet	Post-Project Segment Outside Shoulder width	5	5
MOBILITY	BICYCLE ACCOM	Input value from updated Mobility Index spreadsheet	Post-Project Segment Bicycle Accomodation (%)	5.0%	15.0%
MOBILITY	BICYCLE ACCOM	Enter in Mobiity Needs spreadsheet to calculate new segment level Mobility Need	Post-Project Segment Bicycle Accomodation (%)	5.0%	15.0%
MOBILITY	**Needs**	User entered value from Mobility Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Mobility Need	1.376	2.731
MOBILITY	**Needs**	User entered value from Mobility Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Mobility Need	1.346	2.433

LEGEND:

- user entered value
- calculated value for reference only
- calculated value for entry/use in other spreadsheet
- for input into Performance Effectiveness Score spreadsheet
- assumed values (do not modify)

			Solution #	**64.1**	**64.2**
			Description	Williams to Valle Freight and Pavement Improvements	Valle Area Freight Improvements
			Project Beg MP	185.46	221
			Project End MP	205	224
			Project Length (miles)	6	2
			Segment Beg MP	185	213
			Segment End MP	213	234
			Segment Length (miles)	28	21
			Segment #	1	2
			Current # of Lanes (both directions)	2	2
			Project Type (one-way or two-way)	one-way	one-way
			Additional Lanes (one-way)	0.21	1
			Pro-Rated # of Lanes	2.05	2.10
		Notes and Directions	**Description**		
BRIDGE	BRIDGE INDEX	Input current value from performance system	Original Segment Bridge Index	7.00	No Bridges
		Input current value from performance system	Original lowest rating for specific bridge	7	No Bridges
		Input post-project value (For repair +1, rehab +2, replace=8)	Post-Project lowest rating for specific bridge	7	No Bridges
		Enter in Bridge Index spreadsheet to calculate new Bridge Index	Post-Project lowest rating for specific bridge	7	No Bridges
		Input updated segment value from updated Bridge Index spreadsheet	Post-Project Segment Bridge Index	7	No Bridges
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Bridge Index	7.00	No Bridges
	SUFF RATING	Input current value from performance system	Original Segment Sufficiency Rating	84.60	No Bridges
		Input current value from performance system	Original Sufficiency Rating for specific bridge	84.60	No Bridges
		Input post-project value (For repair +10, rehab +20, replace=98)	Post-Project Sufficiency Rating for specific bridge	84.60	No Bridges
		Enter in Bridge Index spreadsheet to calculate new Bridge Index	Post-Project Sufficiency Rating for specific bridge	84.60	No Bridges
		Input updated segment value from updated Bridge Index spreadsheet	Post-Project Segment Sufficiency Rating	84.60	No Bridges
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Sufficiency Rating	84.60	No Bridges
	BR RTNG	Input current value from performance system	Original Segment Bridge Rating	7	No Bridges
		Input updated segment value from updated Bridge Index spreadsheet	Post-Project Segment Bridge Rating	7	No Bridges
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment Bridge Rating	7	No Bridges
	% FUN OB	Input current value from performance system	Original Segment % Functionally Obsolete	0.00%	No Bridges
		Input updated value from updated Bridge Index spreadsheet (only remove bridge from FO if replace or rehab)	Post-Project Segment % Functionally Obsolete	0.00%	No Bridges
		Enter in Bridge Needs spreadsheet to update segment level Bridge Need	Post-Project Segment % Functionally Obsolete	0.00%	No Bridges
	Needs	User entered value from Bridge Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Bridge Need	0	No Bridges
		User entered value from Bridge Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Bridge Need	0	No Bridges
PAVEMENT	PAVEMENT INDEX	Input current value from performance system	Original Segment Pavement Index	2.88	3.6
		Input current value from performance system	Original Segment IRI in project limits	121.41	94.54
		Input current value from performance system	Original Segment Cracking in project limits	11.33	6.33
		Input post-project value (For rehab, increase to 45; for replace increase to 30)	Post-Project IRI in project limits	45	94.54
		Enter in Pavement Index spreadsheet to calculate new Pavement Index	Post-Project IRI in project limits	45	94.54
		Input post-project value (Lower to 0 for rehab or replace)	Post-Project Cracking in project limits	0	6.33
		Enter in Pavement Index spreadsheet to calculate new Pavement Index	Post-Project Cracking in project limits	0	6.33
		Input updated segment value from updated Pavement Index spreadsheet	Post-Project Segment Pavement Index	3.92	3.6
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment Pavement Index	3.92	3.6
	DIRECTION PSR	Input current value from performance system (NB/EB)	Original Segment Directional PSR (NB/EB)	3.09	3.5
		Input current value from performance system (SB/WB)	Original Segment Directional PSR (SB/WB)	-	-
		Value from above	Original Segment IRI in project limits	121.41	94.54
		Value from above	Post-Project directional IRI in project limits	45	94.54
		Input updated segment value from updated Pavement Index spreadsheet (NB/EB)	Post-Project Segment Directional PSR (NB/EB)	3.86	3.5
		Input updated segment value from updated Pavement Index spreadsheet (SB/WB)	Post-Project Segment Directional PSR (SB/WB)	-	-
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment Directional PSR (NB/EB)	3.86	3.5
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment Directional PSR (SB/WB)	-	-
	% FAIL	Input current value from performance system	Original Segment % Failure	37.9%	0.0%
		Input value from updated Pavement Index spreadsheet	Post-Project Segment % Failure	21.0%	
		Enter in Pavement Needs spreadsheet to update segment level Pavement Need	Post-Project Segment % Failure	21.0%	0.0%
	Needs	User entered value from Pavement Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Original Segment Pavement Need	3.113	0.001
		User entered value from Pavement Needs spreadsheet and for use in Performance Effectiveness spreadsheet	Post-Project Segment Pavement Need	0.420	0.001

CMF Application

SR 64 Corridor Profile Study
CMF Application

=user input

CS64.1 (MP 185.46-205)

							Effective	Crashes in Segment Limits		Crashes in Solution Limits		Post-Solution Crashes		'otal Crash Reductio	
BMP	**EMP**	**CMF1**	**CMF2**	**CMF3**	**CMF4**	**Dir**	**CMF**	**Fatal**	**Incap**	**Fatal**	**Incap**	**Fatal**	**Incap**	**Fatal**	**Incap**
185.5	196.0	0.7	1	1	1	NB/EB	0.700			0	0	0.000	0.000	0.000	0.000
185.5	196.0	0.7	1	1	1	SB/WB	0.700			0	1	0.000	0.700	0.000	0.300
196.0	198.0	0.7	0.75	1	1	NB/EB	0.613			0	0	0.000	0.000	0.000	0.000
196.0	198.0	0.7	1	1	1	SB/WB	0.700			0	0	0.000	0.000	0.000	0.000
198.0	200.0	0.7	1	1	1	NB/EB	0.700			0	1	0.000	0.700	0.000	0.300
198.0	200.0	0.7	1	1	1	SB/WB	0.700			0	0	0.000	0.000	0.000	0.000
200.0	202.0	0.7	1	1	1	NB/EB	0.700			0	0	0.000	0.000	0.000	0.000
200.0	202.0	0.7	0.75	1	1	SB/WB	0.613			0	0	0.000	0.000	0.000	0.000
202.0	203.0	0.7	1	1	1	NB/EB	0.700			0	0	0.000	0.000	0.000	0.000
202.0	203.0	0.7	1	1	1	SB/WB	0.700			0	0	0.000	0.000	0.000	0.000
203.0	205.0	0.7	0.75	1	1	NB/EB	0.613			0	0	0.000	0.000	0.000	0.000
203.0	205.0	0.7	1	1	1	SB/WB	0.700			0	0	0.000	0.000	0.000	0.000
						NB/EB		1	1	0	1	**1.000**	**0.700**	0.000	0.300
						SB/WB		0	3	0	1	**0.000**	**2.700**	0.000	0.300

CS64.2 (MP 221-224)

							Effective	Crashes in Segment Limits		Crashes in Solution Limits		Post-Solution Crashes		'otal Crash Reductio	
BMP	**EMP**	**CMF1**	**CMF2**	**CMF3**	**CMF4**	**Dir**	**CMF**	**Fatal**	**Incap**	**Fatal**	**Incap**	**Fatal**	**Incap**	**Fatal**	**Incap**
221	222	0.75	1	1	1	NB/EB	0.750			0	0	0.000	0.000	0.000	0.000
221	222	1	1	1	1	SB/WB	1.000			0	0	0.000	0.000	0.000	0.000
222	223	1	1	1	1	NB/EB	1.000			0	0	0.000	0.000	0.000	0.000
222	223	1	1	1	1	SB/WB	1.000			0	0	0.000	0.000	0.000	0.000
223	224	1	1	1	1	NB/EB	1.000			0	0	0.000	0.000	0.000	0.000
223	224	0.75	1	1	1	SB/WB	0.750			1	0	0.750	0.000	0.250	0.000
						NB/EB		0	2	0	0	**0.000**	**2.000**	0.000	0.000
						SB/WB		1	2	1	0	**0.750**	**2.000**	0.250	0.000

Performance Area Scoring

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement					Bridge					Safety					Mobility					Freight					Total Risk Factored Performance Area Benefit
				Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	Existing Segment Need	Post-Solution Segment Need	Raw Score	Risk Factor	Factored Score	
64.1	Williams to Valle Freight and Pavement Improvements	185.5 - 205	34.8	3.113	0.420	2.693	2.77	7.460	0.000	0.000	0.000	0.00	0.000	0.165	0.138	0.027	3.24	0.087	1.376	1.346	0.030	9.21	0.276	5.133	5.013	0.120	7.77	0.932	8.756
64.2	Valle Area Freight Improvements	221 - 224	7.5	0.001	0.001	0.000	0.00	0.000	0.000	0.000	0.000	0.00	0.000	0.220	0.178	0.042	3.26	0.137	2.731	2.433	0.298	7.84	2.336	7.199	6.988	0.211	7.99	1.686	4.159

Performance Effectiveness Scoring

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement Emphasis Area						Safety Emphasis Area						Mobility Emphasis Area						Total Factored Benefit	VMT Factor	NPV Factor	Performance Effectiveness Score		miles	2014 ADT	1-way or 2-way	VMT
				Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score									
64.1	Williams to Valle Freight and Pavement Improvements	185.5 - 205	34.8	2.478	0.711	1.767	2.77	1.50	7.342	0.152	0.139	0.013	3.24	1.50	0.063	0.267	0.256	0.011	9.21	1.50	0.152	16.313	1.67	15.3	12.0		6.00	4883	2	29298
64.2	Valle Area Freight Improvements	221 - 224	7.5	2.478	2.478	0.000	0.00	1.50	0.000	0.152	0.137	0.015	3.26	1.50	0.073	0.267	0.259	0.008	7.84	1.50	0.094	4.327	0.78	20.2	9.1		2.00	6102	2	12204

Appendix J: Solution Prioritization Scores

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement		Bridge		Safety		Mobility		Freight		Total Factored Score	Risk Factors					Weighted Risk Factor	Segment Need	Prioritization Score
				Score	%	Score	%	Score	%	Score	%	Score	%		Pavement	Bridge	Safety	Mobility	Freight			
64.1	Williams to Valle Freight and Pavement Improvements	185.5 - 205	34.8	14.801	90.7%	0.000	0.0%	0.151	0.9%	0.428	2.6%	0.932	5.7%	16.313	1.14	1.51	1.78	1.36	1.36	1.164	1.38	**19**
64.2	Valle Area Freight Improvements	221 - 224	7.5	0.000	0.0%	0.000	0.0%	0.210	4.9%	2.430	56.2%	1.686	39.0%	4.327	1.14	1.51	1.78	1.36	1.36	1.380	0.69	**9**

Appendix K: Preliminary Scoping Reports for Prioritized Solutions

PRELIMINARY SCOPING REPORT

GENERAL PROJECT INFORMATION	
Date: December 18, 2017	**ADOT Project Manager:**
Project Name: Williams to Valle Freight and Pavement Improvements	
City/Town: Williams/Valle	**County: Coconino**
COG/MPO: NACOG	**ADOT District: Northcentral**
Primary Route/Street: SR 64	
Beginning Limit: 185.5	
End Limit: 205	
Project Length: 1	
Right-of-Way Ownership(s) (where proposed project construction would occur): *(Check all that apply)* ☐ City/Town; ☐ County; ☒ ADOT ; ☐ Private ; ☐ Federal; ☐ Tribal; ☐ Other:	
Adjacent Land Ownership(s): *(Check all that apply)* ☐ City/Town; ☐ County; ☐ ADOT; ☒ Private; ☐ Federal; ☐ Tribal; ☒ Other: State Trust *http://gis.azland.gov/webapps/parcel/*	

LOCAL PUBLIC AGENCY (LPA) or TRIBAL GOVERNMENT INFORMATION *(If applicable)*	
LPA/Tribal Name:	
LPA/Tribal Contact:	
Email Address:	**Phone Number:**
Administration: ☐ ADOT Administered ☐ Self-Administered ☐ Certification Acceptance	

PROJECT NEED

Freight need: From MP 185-213 on SR 64, there is a High level of need based on the poor performances in TPTI in both directions and long closure durations.

Pavement need: From MP 188-212, there are pavement hot spots that have a high IRI score and have excessive cracking. There are three hot spots: MP 188-189, MP 198-200, and MP 205-212.

PROJECT PURPOSE

What is the Primary Purpose of the Project?	Preservation ☐	Modernization ☒	Expansion ☐

Address identified Freight Need by constructing two eastbound (EB) climbing lanes: one from MP 196-198 and another from MP 203-205. Also, address the Need by constructing one westbound (WB) climbing lane from MP 200-202. Finally, a pavement preservation project will be added from MP 185.5-205 to address the Pavement Hot Spots in the vicinity.

PRELIMINARY SCOPING REPORT

PROJECT RISKS

Check any risks identified that may impact the project's scope, schedule, or budget:

☐ Access / Traffic Control / Detour Issues	☐ Right-of-Way
☐ Constructability / Construction Window Issues	☐ Environmental
☐ Stakeholder Issues	☐ Utilities
☐ Structures & Geotech	☐ Other:

Risk Description: *(If a box is checked above, briefly explain the risk)*

POTENTIAL FUNDING SOURCE(S)				
Anticipated Project Design/Construction Funding Type: *(Check all that apply)*	☐ STBG	☐ TAP	☐ HSIP	☐ State
	☐ Local	☐ Private	☐ Tribal	☐ Other:

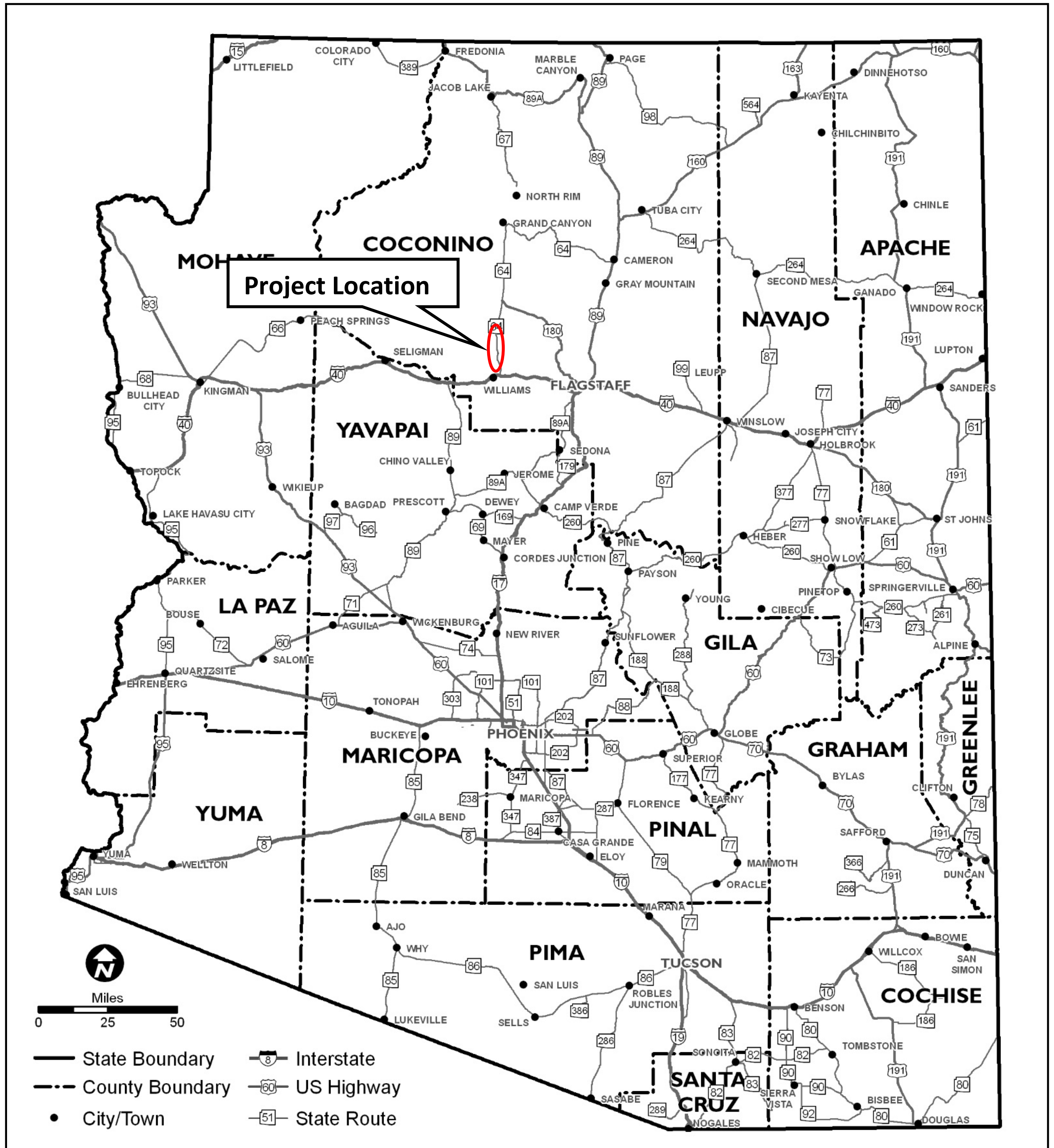
COST ESTIMATE				
Preliminary Engineering $923,900	Design $3,079,800	Right-of-Way $0	Construction $30,798,000	Total $34,801,700

RECOMMENDED PROJECT DELIVERY
Delivery: ☐ Design-Bid-Build ☐ Design-Build ☐ Other:
Design Program Year: FY
Construction Program Year: FY

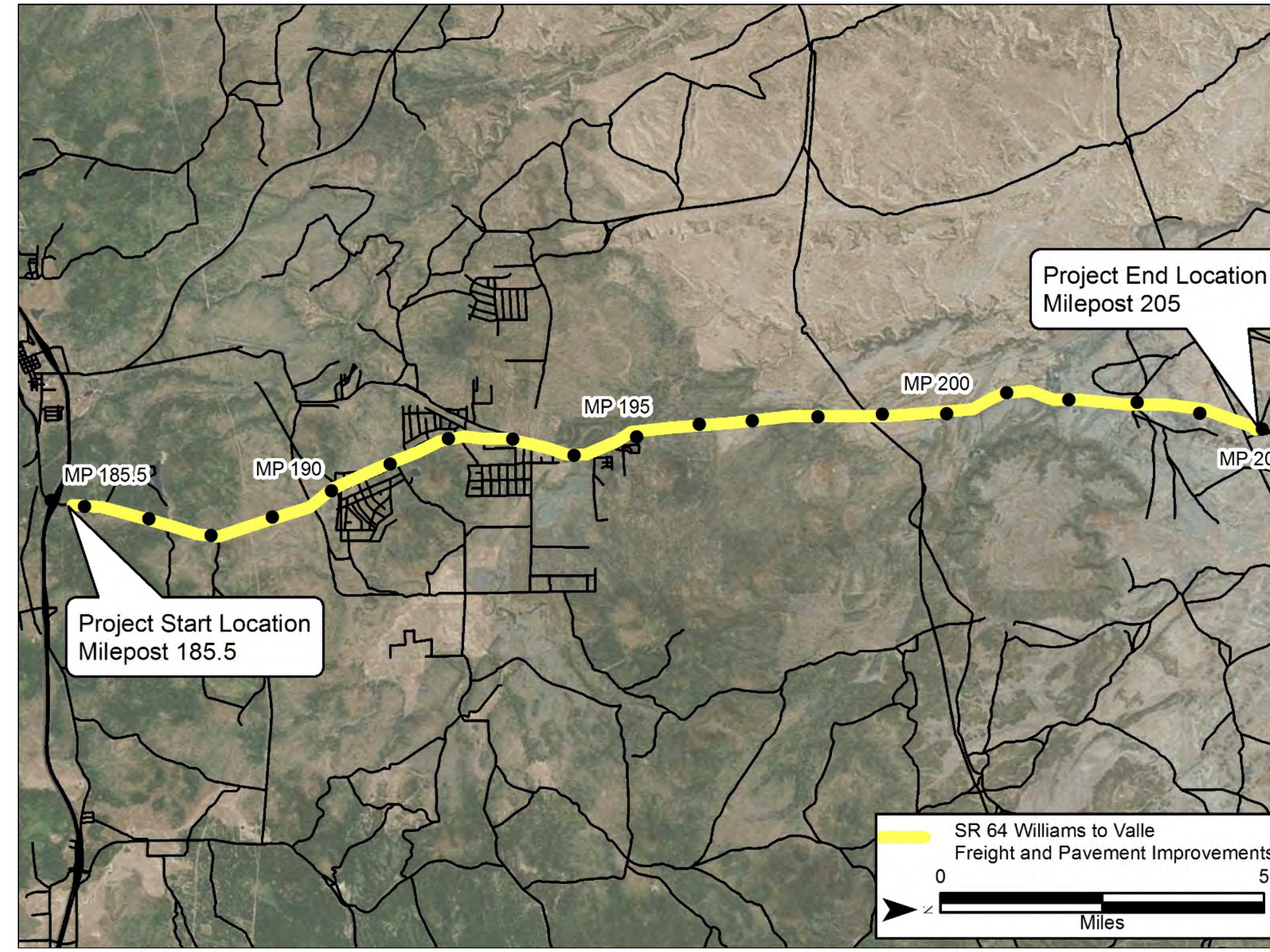
ATTACHMENTS

1) **State Location Map**
2) **Project Vicinity Map**
3) **Project Scope of Work**
4) **Project Schedule**
5) **Itemized Cost Estimate**
6) **Conceptual Design Plans (not to exceed 15% design)**
7) **Final Field Review Report**

ATTACHMENT 1 – STATE LOCATION MAP



ATTACHMENT 2 – PROJECT VICINITY MAP



ATTACHMENT 3 – SCOPE OF WORK

SCOPE OF WORK
(Provide a detailed breakdown of the project's scope of work using bullet format) • Construct two eastbound (EB) climbing lanes: one from MP 196-198 and another from MP 203-205 • Construct one westbound (WB) climbing lane from MP 200-202 • A pavement preservation project will be added from MP 185.5-205 to address the pavement hot spots in the vicinity

1.0 SCOPE ITEMS CONSIDERED, BUT NOT INCLUDED
(Describe scope items considered, but not accepted by the Pre-Scoping Team and why)

The below 23 USC 409 disclaimer is to be included in the Final Pre-Scoping Report and Field Review Report:

Pursuant to 23 USC 409: Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or rail-way-highway crossings, pursuant to sections 130, 144, and 148 [152] of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

PRELIMINARY SCOPING REPORT

GENERAL PROJECT INFORMATION	
Date: December 18, 2017	**ADOT Project Manager:**
Project Name: Valle Area Freight Improvements	
City/Town: Williams/Valle	**County: Coconino**
COG/MPO: NACOG	**ADOT District: Northcentral**
Primary Route/Street: SR 64	
Beginning Limit: 221	
End Limit: 224	
Project Length: 1	
Right-of-Way Ownership(s) (where proposed project construction would occur): *(Check all that apply)* ☐ City/Town; ☐ County; ☒ ADOT ; ☐ Private ; ☐ Federal; ☐ Tribal; ☐ Other:	
Adjacent Land Ownership(s): *(Check all that apply)* ☐ City/Town; ☐ County; ☐ ADOT; ☐ Private; ☐ Federal; ☐ Tribal; ☒ Other: State Trust *http://gis.azland.gov/webapps/parcel/*	

LOCAL PUBLIC AGENCY (LPA) or TRIBAL GOVERNMENT INFORMATION *(If applicable)*	
LPA/Tribal Name:	
LPA/Tribal Contact:	
Email Address:	**Phone Number:**
Administration: ☐ ADOT Administered ☐ Self-Administered ☐ Certification Acceptance	

PROJECT NEED

Freight need: From MP 213-234 on SR 64, there is a High level of need based on the poor performances in TPTI in both directions and a few very long closure durations.

PROJECT PURPOSE

What is the Primary Purpose of the Project?	Preservation ☐	Modernization ☒	Expansion ☐

Address Freight Need by construct an eastbound (EB) climbing lanes from MP 221-222 and constructing a westbound (WB) climbing lane from MP 223-224.

PRELIMINARY SCOPING REPORT

PROJECT RISKS

Check any risks identified that may impact the project's scope, schedule, or budget:

☐ Access / Traffic Control / Detour Issues	☐ Right-of-Way
☐ Constructability / Construction Window Issues	☐ Environmental
☐ Stakeholder Issues	☐ Utilities
☐ Structures & Geotech	☐ Other:

Risk Description: *(If a box is checked above, briefly explain the risk)*

POTENTIAL FUNDING SOURCE(S)

Anticipated Project Design/Construction Funding Type: *(Check all that apply)*	☐ STBG	☐ TAP	☐ HSIP	☐ State
	☐ Local	☐ Private	☐ Tribal	☐ Other:

COST ESTIMATE

Preliminary Engineering	Design	Right-of-Way	Construction	Total
$198,000	$660,000	$0	$6,600,000	$7,458,000

RECOMMENDED PROJECT DELIVERY

Delivery: ☐ Design-Bid-Build ☐ Design-Build ☐ Other:

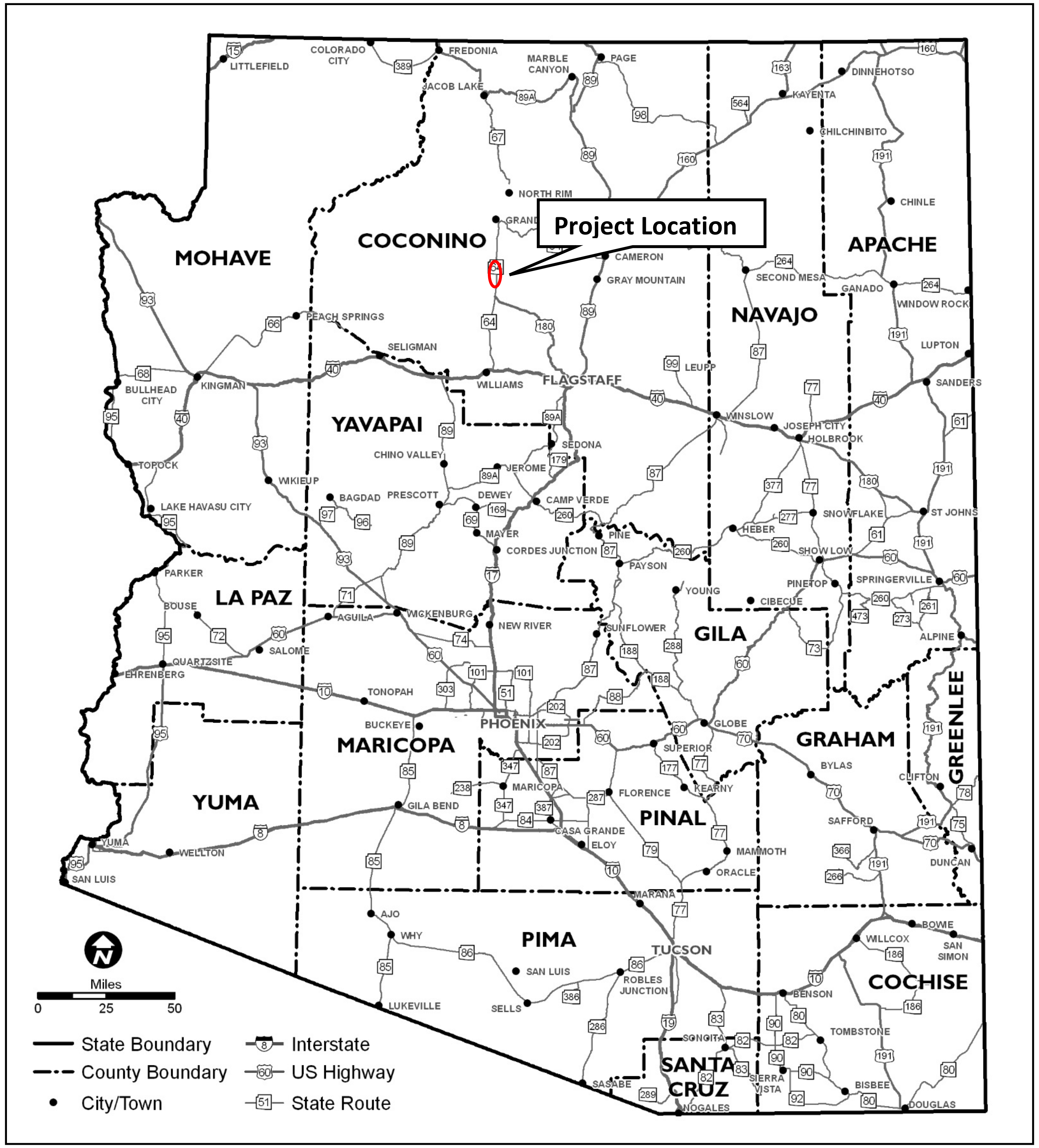
Design Program Year: FY

Construction Program Year: FY

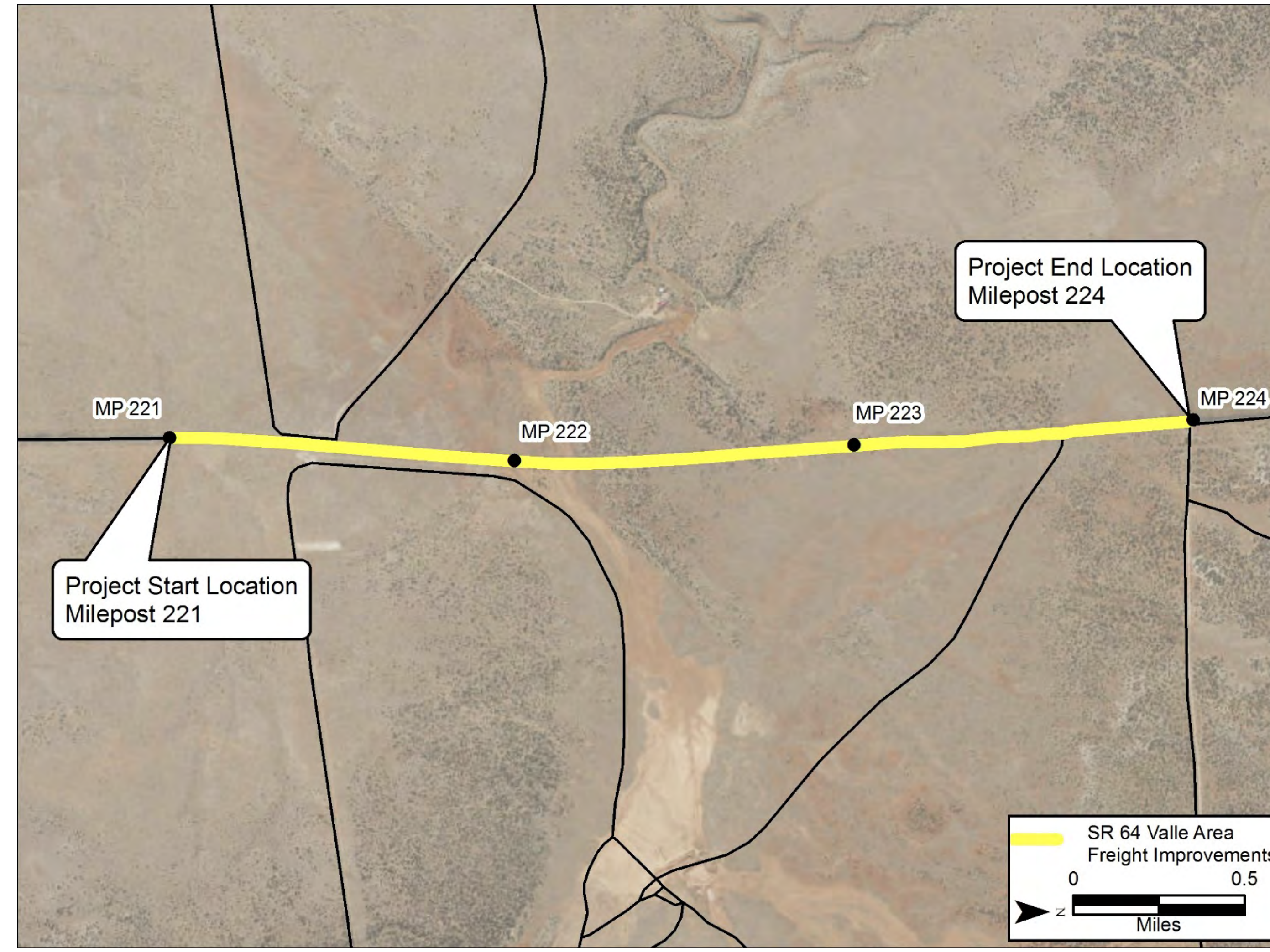
ATTACHMENTS

1) **State Location Map**
2) **Project Vicinity Map**
3) **Project Scope of Work**
4) **Project Schedule**
5) **Itemized Cost Estimate**
6) **Conceptual Design Plans (not to exceed 15% design)**
7) **Final Field Review Report**

ATTACHMENT 1 – STATE LOCATION MAP



ATTACHMENT 2 – PROJECT VICINITY MAP



ATTACHMENT 3 – SCOPE OF WORK

2.0 SCOPE OF WORK
(Provide a detailed breakdown of the project's scope of work using bullet format) • Construct an eastbound (EB) climbing lanes from MP 221-222 • Construct a westbound (WB) climbing lane from MP 223-224

3.0 SCOPE ITEMS CONSIDERED, BUT NOT INCLUDED
(Describe scope items considered, but not accepted by the Pre-Scoping Team and why)

The below 23 USC 409 disclaimer is to be included in the Final Pre-Scoping Report and Field Review Report:

Pursuant to 23 USC 409: Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or rail-way-highway crossings, pursuant to sections 130, 144, and 148 [152] of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.