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ARIZONA U.S.A.

FINAL
DESIGN CONCEPT REPORT
SR 88, MP 222 – MP 229

ADOT Project No. 88 MA 222 F0494 01L
Federal Project No. N/A

Apache Trail Hwy

October 2023

Prepared for:
Arizona Department of Transportation
Multimodal Planning Division
Corridor Planning Group

ADOT

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Glossary of Acronyms and Abbreviations

AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
AB	aggregate base
AC	asphaltic concrete
ADOT	Arizona Department of Transportation
AGFD	Arizona Game & Fish
APE	Area of Potential Effect
CBC	concrete box culvert
CE	Categorical Exclusion
CIP	cast iron pipe
CMP	corrugated metal pipe
DIP	ductile iron pipe
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FY	fiscal year
IGA	intergovernmental agreement
IPaC	Information, Planning, and Conservation system
LOS	level of service
MAG	Maricopa Association of Governments
MASH	Manual for Assessing Safety Hardware
MP	milepost
MOU	Memorandum of Understanding
mph	miles per hour
MSE	mechanically stabilized earth
MUTCD	Manual on Uniform Traffic Control Devices
N/A	not applicable
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
OH	overhead
RCBC	reinforced concrete box culvert
RCP	reinforced concrete pipe
Rd	road
RDG	Roadway Design Guidelines
ROW	right-of-way
SN	structural number
SOI	Secretary of the Interior
SR	State Route
Sta	station
TDMS	Traffic Data Management System
TNF	Tonto National Forest
US	United States
USACE	United States Army Corps of Engineers
UTV	Utility Task/Terrain Vehicle
vph	vehicles per hour
WB	westbound

EXECUTIVE SUMMARY

Project No. 88 MA 222 F0494 01L consists of a study to prepare the design concept for the re-opening of State Route 88 to traffic and improving resilience to future weather events. This project is located within the Arizona Department of Transportation's Southeast District in Maricopa County.

The Arizona Department of Transportation (ADOT), in association with the Tonto National Forest (TNF) and in coordination with the Federal Highway Administration (FHWA) and Maricopa Association of Governments (MAG), has initiated this design concept study and environmental overview to evaluate the feasibility of re-opening the closed section of State Route 88 (SR 88) (Apache Trail) between Milepost 222 and Milepost 229, with considerations for resiliency against events similar to those that closed the road.

The land underlying SR 88 is under the jurisdiction of the U.S. Forest Service - Tonto National Forest. SR 88 is on an easement that is typically 100 feet wide and is maintained by ADOT. The Superstition Wilderness boundary is near the easement boundary in the western section of the study area.

This Design Concept Report presents alternatives to allow ADOT to re-open the roadway and improve resilience against future weather events. The Build alternatives were developed and evaluated for the various elements.

The study evaluates the following potential improvements:

- Cross section improvements for the SR 88 roadway;
- Rockfall mitigation to reduce road closures;
- Slope stabilization and erosion control options to stabilize the SR 88 roadway and adjacent embankments;
- Storm drain improvements;
- Roadside safety devices including concrete barrier along Fish Creek Hill and delineators;
- Additional signing, including speed limit, curve advisory, and narrow roadway sections; and
- Bridge replacement or rehabilitation.

A Recommended Alternative was identified by ADOT and the study team. The Recommended Alternative is a hybrid of the three Build alternatives and is described as follows:

- In general, the roadway will not be widened. However, minor widening to provide a minimum of 15 feet of width will be provided on the Fish Creek Hill section (MP 222.62 to MP 223.61) to accommodate the addition of concrete barrier and a V-ditch.
- New colored cast-in-place concrete barrier will replace the existing guardrail on Fish Creek Hill.
- The existing roadway will be re-graded/repaired. A double chip seal on four inches of crushed aggregate base (AB) will be placed on the roadway. The roadway will match the U.S. Department of Transportation AZ FLAP SR 88(1) project currently under construction from MP 229 to Roosevelt Dam.
- Horizontal and vertical geometry will not be improved.
- The three existing bridges will be repaired and rehabilitated.
- Five new retaining walls are anticipated to avoid encroachment of the roadway improvements into the Superstition Wilderness. Colored concrete may be used, or the new walls, headwalls, and barrier may be painted to blend with the natural surroundings.
- Perform limited rock scaling to remove loose and overhanging rocks near the roadway.
- Identify potential unstable rocks less than 50 feet from the road and stabilize these areas with rock bolts.
- Drainage elements will be cleaned and up-sized to accommodate a larger future design storm and to allow more sediment to easily pass through the system. Outlet protection will be added where downstream erosion is occurring.
- Roadside ditches will be added where flow over the roadway would cause potential damage: one foot deep along Fish Creek Hill on the upslope side and from MP 225.22 (Station 1060+22) (Dry Wash bridge) to MP 225.68 (Station 1069+00) along the left side.
- Additions to the ADOT easement are proposed to provide maintenance access to drainage features.
- Safety improvements, including curve warning signs, speed limit signs, and object markers at bridges, will be added.
- Three new pullout areas are proposed: at MP 227.00, MP 228.21, and MP 228.68.
- Existing pullout areas will be restored.

Additional studies related to offsite drainage improvements will be conducted during final design. The purpose of these studies is to identify methods of reducing the volume and velocity of storm flows approaching SR 88 and reducing sediment transport.

An Environmental Overview (EO) was prepared. Additional studies and an environmental clearance document will be prepared for the project during final design.

The EO is included as Appendix B. A geotechnical letter report is presented in Appendix C. The resiliency study, which was prepared to assess the vulnerability of SR 88 related to wildfire and storm runoff, is included as Appendix D. A Preliminary Drainage Report and an Initial Bridge Study were also prepared; they are presented in separate documents.

The SR 88 study is funded by the state. Design and construction are not included in ADOT's 2024-2028 Five-Year Transportation Facilities Construction Program. The estimated cost of the Recommended Alternative is $33.7 million.

1.0 Introduction

1.1 Foreword

The Arizona Department of Transportation (ADOT) has initiated a design concept study and an environmental overview to evaluate the feasibility of re-opening the closed section of State Route 88 (SR 88) (Apache Trail) between milepost (MP) 222 and MP 229.

SR 88 has been designated as a state historic and scenic road and as a National Forest Scenic Byway. SR 88 runs from U.S. 60 in Apache Junction, Arizona, east to SR 188 near Roosevelt Dam. The section of SR 88 east of Apache Junction is known as the Apache Trail. It was constructed in the early 1900s and is used primarily for recreational purposes.

SR 88 is in the foothills of the Superstition Mountain Range and the surrounding terrain is rugged. The roadway between MP 222 and MP 229 is unpaved. The road is curvy and narrow with steep roadside slopes. The project is entirely within the Tonto National Forest (TNF) and north of the Superstition Wilderness Area. The road has been used by tourists since 1906. SR 88 provides access to recreation areas at Canyon Lake, Tortilla Flat, Apache Lake, Theodore Roosevelt Lake, and Tonto National Monument. The study section of SR 88 is unpaved, with few posted signs and no pavement markings.

Following wildfire and large storm events that caused erosion and a large rockslide, the segment between MP 222 and 229 was closed to traffic in 2019; the segment between MP 227.3 and 229.0 was re-opened in 2022 to provide access to Reavis Trailhead and Forest Road 212.

ADOT will serve as the lead agency, in partnership with the US Forest Service, Federal Highway Administration, Maricopa Association of Governments (MAG), State Historic Preservation Office, and other federal, state, tribal, and local agency stakeholders.

The purpose of this project is to study the feasibility of repairing and re-opening the closed section of SR 88 (Apache Trail) from MP 222 to MP 229, with considerations for resiliency against similar events as those that closed the road. An Environmental Overview (EO) is included as Appendix B. A resiliency study was prepared to assess the vulnerability of SR 88 related to wildfire and storm runoff and is included as Appendix D.

The No Build Alternative and Build alternatives were developed and evaluated for the project. The study will evaluate the following potential improvements:

- Cross section improvements for the SR 88 roadway;
- Rockfall mitigation to reduce road closures;
- Slope stabilization and erosion control options to stabilize the SR 88 roadway and adjacent embankments;
- Storm drain improvements;
- Roadside safety devices including concrete barrier along Fish Creek Hill;
- Additional signing, including speed limit, curve advisory, narrow roadway sections, and delineators; and
- Bridge replacement or rehabilitation.

This project is located in ADOT's Southeast District within Maricopa County in south-central Arizona. Project location and vicinity maps are provided on Figures 1 and 2.

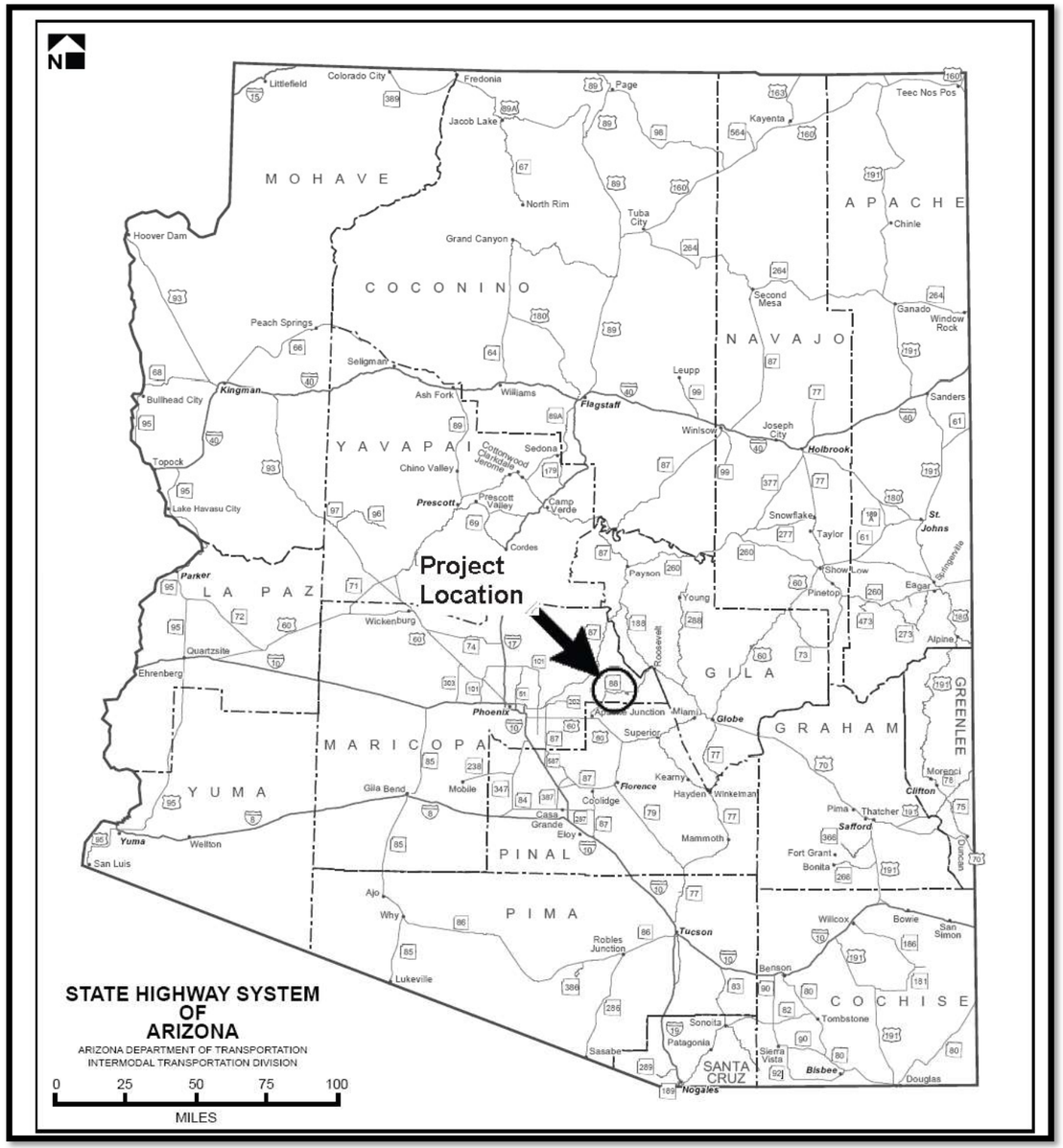


Figure 1 – Project Location Map

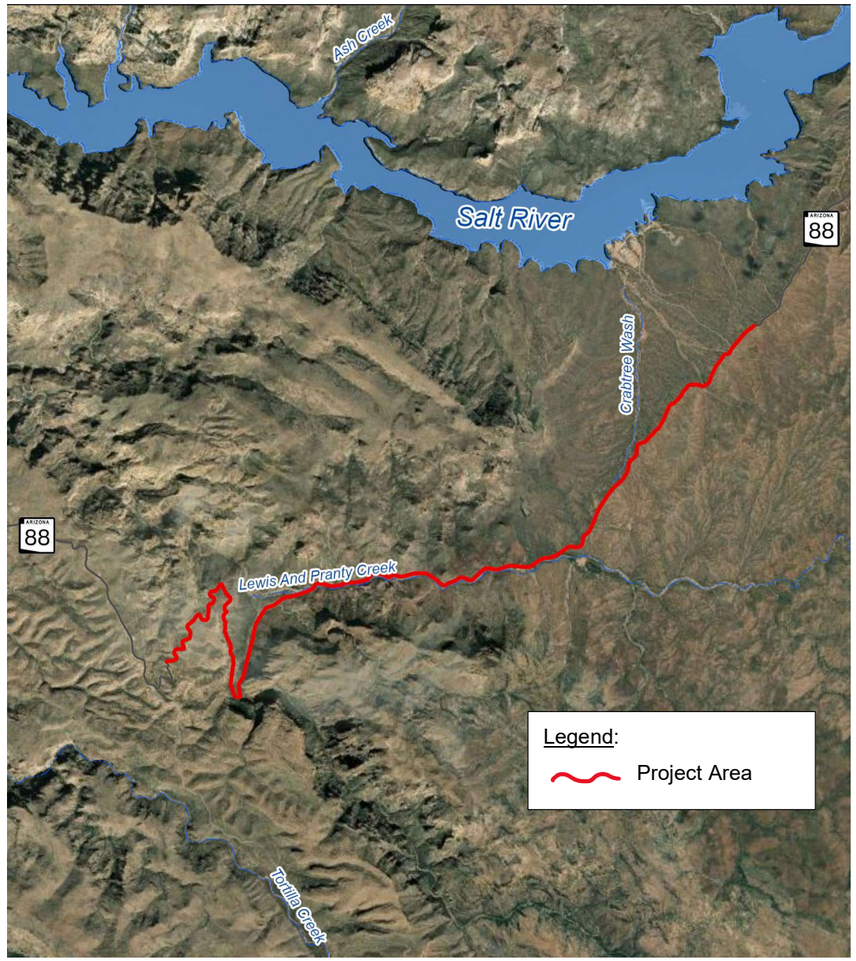


Figure 2 – Vicinity Map

1.2 Need for the Project

The study section of SR 88 is narrow and unpaved. Because of the potential for severe flooding from areas burned in the Woodbury Fire in June 2019, a five-mile section from the Fish Creek Hill Overlook/Rest Area (MP 222) to MP 227.3 is closed for public safety reasons. Rockfall and storm runoff caused extensive roadway damage and erosion, leaving rock debris on the roadway.

The Woodbury Fire consumed almost 124,000 acres of the Tonto National Forest. It was preceded by major storm events in 2004/05 and 2017. In September 2019, approximately six inches of rain fell onto the fire scar and the runoff severely damaged large portions of the road, with the most damage being in the area between Fish Creek Hill Overlook and MP 227 (near Reavis Trailhead Road). The damage included a large rockslide at MP 223.2, making that section of the road impassable. Runoff from future storms on the Woodbury fire burn scar is considered an ongoing risk to the roadway.

While ADOT has a highway easement for SR 88, the underlying landowner is the US Forest Service. ADOT, in cooperation with the U.S. Forest Service and Arizona Game and Fish, currently allows UTVs, equestrians, hikers, and bicyclists to access public lands via SR 88 at Reavis Trailhead Road.

This project is focused on re-opening the road and improving resiliency. The scope does not include capacity improvements.

The SR 88 study is funded by the state, but design and construction are not included in ADOT's 2024-2028 Five-Year Transportation Facilities Construction Program.

1.3 Characteristics of the Corridor

SR 88 was built in the early 1900s as a service road for the construction of Roosevelt Dam. SR 88 is a scenic route between Apache Junction in the far southeastern area of the Phoenix metropolitan area and Roosevelt Dam. SR 88 was designated as a historic road in 1986.

The road was closed in 2019 from MP 222-229. The east end was re-opened in 2022 from MP 227.2 to MP 229 to provide access to the Reavis Trailhead from the east.

SR 88 is a paved two-lane road from Tortilla Flat to MP 220.2. East of MP 220.2, it is unpaved. There are no pedestrian or bicycle facilities within the project limits.

There are scenic vistas at both ends of the project but none within the project segment.

The study segment of SR 88 is characterized by steep grades and tight horizontal curves. The roadway cross section is not wide enough for two vehicles to pass in many areas. An older-style guard rail is present in several areas but is in poor condition and likely does not meet current safety standards.

Because of the age of the road, no original record drawings are available. Table 1 lists several previous projects and studies in the study area, sorted by date.

Table 1 – Previous Projects and Studies

Reference Location	Project Number	Milepost	Date	Description
SR 88 Retaining Walls	Arizona PFH 49-1(1) & ERFO 49-1(2)	222.8, 225.3, 225.5	2010	Apache Trail retaining walls (Central Federal Lands project)
TAG Study by US Forest Service	N/A	N/A	2015	Apache Trail, TNF: Observations, Considerations, and Recommendations from the Interagency Transportation Assistance Group (TAG)
Low Volume State Routes Study	N/A	213.39 to 242.23	2017	ADOT study, includes SR 88 from Tortilla Flat to SR 188
SR 88: Apache Jct to Forest Rd 213	H8112 01C	203.40 to 220.20	2018	Pavement preservation and safety improvement (ADOT project)
Fire Ecology Draft Report	N/A	N/A	2019	By Tonto National Forest
Transportation Asset Mgmt Plan	N/A	N/A	2021	ADOT study, includes SR 88

1.3.1 Roadway Characteristics

SR 88 is a scenic and historic roadway; it is classified as a Rural Major Collector in the ADOT system. There is no posted speed limit.

The existing roadway consists of an aggregate base surface. The traversable roadway width varies from approximately 8-foot width to 32-foot width. A summary of surveyed roadway widths within the project study limits can be found in Table 2.

Table 2 – Existing Roadway Widths

Approximate MP		Approximate Station		Width (ft)		
Beg MP	End MP	Beg Sta	End Sta	Average Width	Min	Max
220	220.5	789+00.00	808+00.00	31.9	23.3	38.2
220.5	221	808+00.00	828+00.00	32.2	21.4	38.1
221	221.5	828+00.00	854+00.00	21.5	14.4	28.2
221.5	222	854+00.00	881+00.00	18.6	13.4	30.4
222	222.5	881+00.00	906+00.00	15.8	10.0	23.5
222.5	223	906+00.00	932+00.00	14.4	9.1	26.2
223	223.5	932+00.00	958+00.00	11.0	7.7	16.3
223.5	224	958+00.00	985+00.00	15.9	8.7	26.1
224	224.5	985+00.00	1008+00.00	12.4	8.1	21.7
224.5	225	1008+00.00	1032+00.00	18.1	8.1	27.0
225	225.5	1032+00.00	1059+00.00	13.4	9.5	20.8
225.5	226	1059+00.00	1086+00.00	14.7	10.9	20.4
226	226.5	1086+00.00	1111+00.00	12.6	9.0	18.2
226.5	227	1111+00.00	1137+00.00	17.1	11.5	26.2
227	227.5	1137+00.00	1163+00.00	20.2	12.8	27.8
227.5	228	1163+00.00	1190+00.00	22.1	14.4	31.9
228	228.5	1190+00.00	1216+00.00	19.5	14.2	22.5
228.5	229	1216+00.00	1243+00.00	19.8	15.9	24.4
229	229.5	1243+00.00	1251+00.00	18.1	16.0	19.6

LEGEND
POOR
FAIR
GOOD

Record drawings for the original roadway construction are not available. The SR 88 horizontal alignment is a best-fit centerline within the ADOT easement. The horizontal curves range from 4°53'02" to 146°54'44" in the project area.

The SR 88 vertical alignment consists of vertical grades that vary from 0% to approximately 10%; the elevation drops from west to east, with an average project elevation of 2500 feet. The existing SR 88 profile is shown on Figure 3.

The existing cross slope varies throughout the project and is not uniform.

The Fish Creek Hill area consists of rock faces steeper than 1:1 on one side of the roadway and non-traversable fill slopes often steeper than 2:1 on the opposite side of the roadway. Fish Creek Hill area also contains sharp horizontal curves with minimal horizontal sight distance approaching the curves. The existing roadway driving surface in the Fish Creek area has experienced substantial erosion which has left non-uniform cross slopes and longitudinal rilling along the roadway.

The existing guardrail and barrier end terminals throughout the project do not meet Manual for Assessing Safety Hardware (MASH) Test Level 2 or NCHRP Report 350 Test Level 2 standards. The existing barrier and end terminals on all three bridges also do not meet MASH Test Level 2 or NCHRP Report 350 Test Level 2 standards.

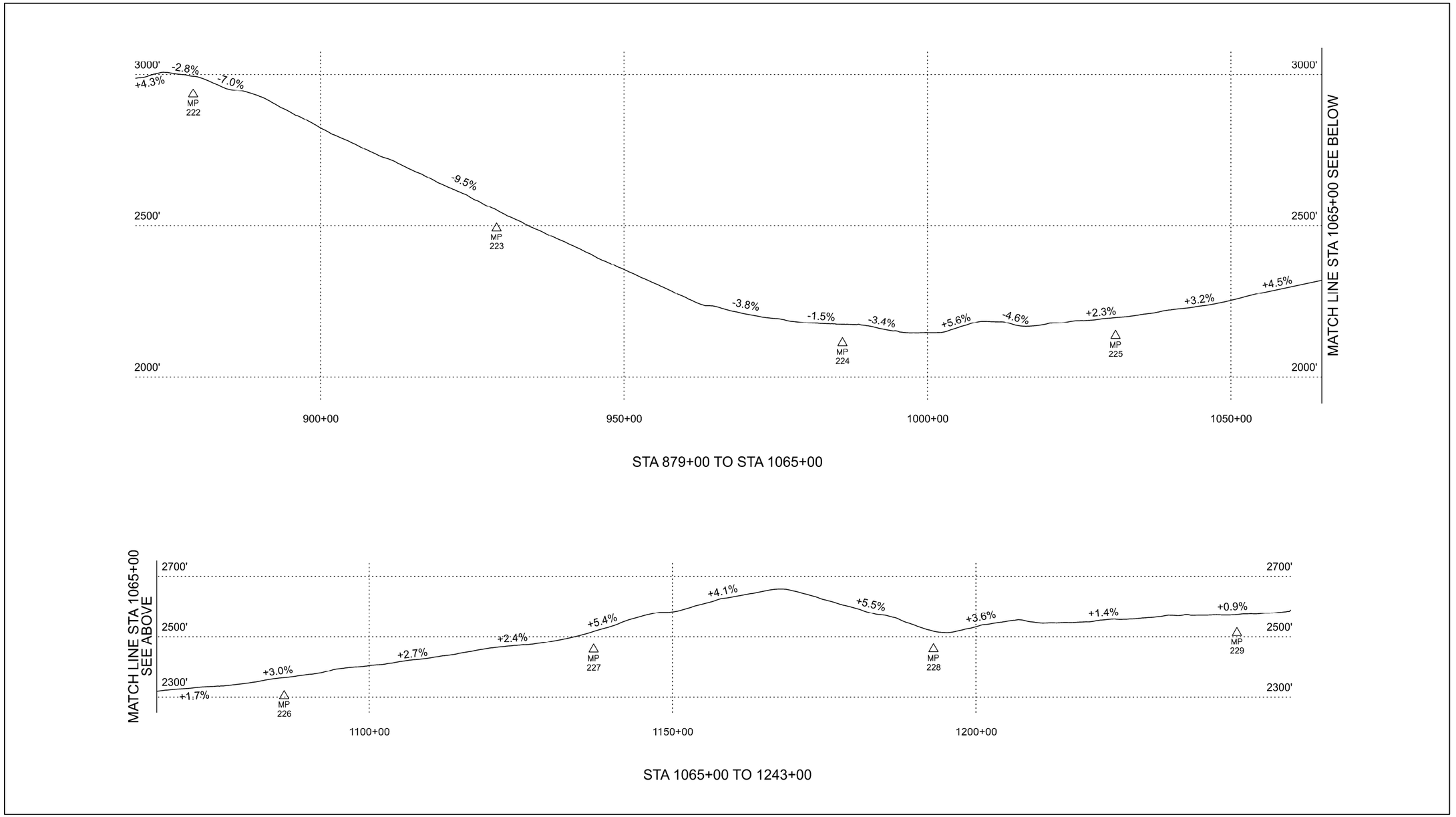


Figure 3 – Existing SR 88 Profile

At approximately MP 222.00 (Station 879+00 to 880+00), the Fish Creek Vista includes restrooms and a parking lot that can accommodate several vehicles.

Existing pullouts are located at approximately MP 222.62 (Sta. 910+00), MP 222.84 (Sta. 921+00), MP 223.58 (Sta. 962+00), MP 223.64 (Sta. 965+00), MP 223.82 (Sta. 975+00), MP 223.96 (Sta. 983+00), MP 224.87 (Sta. 1026+00), MP 224.91 (Sta. 1028+00), MP 225.57 (Sta. 1063+00), MP 225.94 (Sta. 1083+00), MP 227.22 (Sta. 1149+00), MP 227.60 (Sta. 1178+00). MP 227.94 (Sta. 1187+00), and MP 228.63 (Sta. 1223+00).

Existing turnouts are listed below:

- MP 222.00, Station 879+00 (providing access to the Fish Creek Vista)
- MP 224.70, Station 1018+00
- MP 226.63, Station 1118+00 (providing access to an ADOT Maintenance Yard)
- MP 227.25, Station 1151+00 (providing access to several unpaved access paths)
- MP 227.35, Station 1156+00 (providing access to private property)
- MP 227.54, Station 1166+50 (providing access to an unpaved access path)
- MP 227.60, Station 1170+00 (providing access to an unpaved access path)

Existing gates close SR 88 roadway to vehicular traffic at MP 222.02 (Station 880+00) and MP 227.22, (Station 1149+00).

Existing SR 88 roadway driving surface was unpaved and the material has eroded away in many areas, especially Fish Creek Hill area. A mound of material has been built up along the edge of roadway adjacent to fill slopes at several locations to combat erosion.

There is no existing roadway lighting.

The average elevation of the study area is approximately 1,240 feet. The terrain is mountainous to rolling.

1.3.2 Land Use and Recreation

Land within the study area is primarily under the jurisdiction of the US Forest Service, TNF. The Superstition Wilderness boundary is west and south of SR 88 and close to or abutting the SR 88 right-of way from west of MP 222 to the Fish Creek bridge at MP 223.6. East of the Fish Creek bridge, the wilderness boundary shifts away from SR 88.

An ADOT maintenance facility is located on the south side of SR 88 at MP 226.6.

There is one privately owned parcel in the project area with an unpaved turnout connecting to SR 88 at MP 227.25.

SR 88 provides access to recreational facilities including trailheads and the Apache Lake Marina.

1.3.3 Right-of-Way and Access Control

ADOT is responsible for operations and maintenance of SR 88 in the project area. The TNF owns the underlying land. The SR 88 easement is typically 100 feet wide; the easement is slightly narrower than 100 feet near MP 222 (Fish Creek Vista) and is slightly wider than 100 feet at MP 224.3.

SR 88 is not access-controlled.

1.3.4 Utilities

Table 3 lists major existing utilities within the study area. Existing utility locations are also shown on the roll plots in Appendix A.

Existing major utilities within the study area were identified based on information obtained from AZ811. Information was obtained from project mapping and maps obtained from utility companies.

Table 3 – Existing Utility Crossings

Utility / Agency	Utility Description
Arizona Department of Transportation	ADOT culverts, storm drain, electric, fiber optic, irrigation, sewer, telephone, water
Salt River Project	Overhead power transmission lines
TDS Telecom	Buried telecommunication conduit on south/east side of SR 88 from MP 227 to MP 229 and beyond to east

An existing SRP transmission tower is located at MP 222.14 (Sta. 886+00). Maintenance access to the tower is provided from SR 88 which is approximately 22 feet wide at this location.

1.3.5 Drainage - Offsite Drainage Patterns

Offsite flows approach SR 88 from multiple directions with the roadway alignment winding through the steep terrain. The most notable tributary flows originate from the south and flow north to the bridges at Fish Creek Canyon and Lewis and Pranty Creek. These are large watersheds at approximately 14.5 and 29.7 square miles for Lewis and Pranty Creek and Fish Creek, respectively.

The project is surrounded by desert with no development. The watersheds range in elevation from approximately 2,100 feet to over 5,000 feet. There are no Special Flood Hazard Areas (SFHA) within the project limits and no floodplain mitigation or coordination with FEMA will be required.

The roadway corridor is crossed by approximately 80 culverts ranging in size from 18" corrugated metal / reinforced concrete pipes to 15' x 7' reinforced concrete box culverts. There are three bridge crossings. Roadside ditches convey flows along the upstream side of the roadway on the steep decline at the western end of the project to the Fish Creek Crossing and east of the Lewis and Pranty bridge crossing. Twenty-six culverts were analyzed in more detail for this study. Circular culverts with a minimum diameter of 36 inches and all the existing box culvert crossings were included in the analysis.

Offsite drainage features for SR 88 are classified as Drainage Frequency Class III, which are required to convey the 25-year peak discharge. Culverts were also analyzed for future predicted flows determined by a resiliency study for the project. The purpose of the study was to predict future runoff conditions to provide a design that could better mitigate larger storm events and reduce the potential for future closures.

The resiliency analysis looked at two factors that could lead to future runoff increases. The first factor was the potential for future climate hazards to increase. Future climate projections were obtained from the Climate Model Intercomparison Project–Phase 5 Global Climate Models. The models are large-scale models that were downscaled to apply to the study area. The second factor was the potential for increased wildfire risks. The Keetch-Byram Drought Index was utilized. The model results show that an increase in wildfire risks is extremely likely. The increase in wildfires results in associated damages to vegetation and soil, which in turn lead to an increased risk of flash flooding and debris flows. Future weather events will have a substantial impact on drainage, slope stabilization, and wildfire mitigation designs. Specifically, this analysis focuses on changes in runoff events and wildfire risk.

SR 88 will be impacted by projected changes in runoff. The 25-year event was considered since drainage features for ADOT facilities like SR 88 are designed to the 25-year event. Across the study area, average runoff across the suite of climate models is expected to increase. The projected increase in extreme runoff is attributed to the projected increase in frequency and intensity of extreme rainfall events. In 2030, the 25-year event is projected to increase by 55% under Scenario RCP4.5 and 51% under RCP85. In 2050, the 25-year event is projected to increase by 68% under the RCP4.5 scenario and 83% under RCP8.5. For this study, the recommendation was to use the 55% increase for the 2030 event and the 83% increase for the 2050 event. The resiliency study is included in Appendix D.

1.3.6 Existing Structures

Arizona SR 88, stretching 47 miles from US 60 Superstition Freeway to SR 188 near Roosevelt Dam, has 13 bridges on the ADOT/FHWA bridge inventory. Within this project's seven miles between MP 222 and MP 229, three bridges are listed in the ADOT (Southeast District) inventory. For discussion purposes, two bridges back-MP and one bridge ahead-MP, outside the project MP limits are included in Table 4 below:

Table 4 – Existing ADOT Structures

Str. No.	MP	Bridge Name	District	Year Built	Superstructure	Span	Clear Roadway	Sufficiency Rating	Condition
00026	209.62	First Water Creek	C	1924	1-span steel through truss	160'	15'	52.8	Fair
00193	211.05	Boulder Canyon	C	1916	4-span steel through truss	②	15'	67.0	Fair
		(Boulder Creek)							
00027	223.50	Fish Creek	SE	1928①	1-span steel truss	74'	15'	59.9	Fair
00028	224.60	Lewis Pranty Creek	SE	1922①	1-span steel truss	59'	13'	59.3	Fair
00015	225.55	Dry Wash	SE	1928①	1-span steel beam	32'	14'	55.6	Fair
00221	231.7	Davis Wash	SE	1939	3-span conc. slab bridge	3@25'	24'	77.1	Fair
00031	233.50	Pine Creek	SE	1925	2-span conc. filled spandrel arch	2@48'	16'	74.9	Fair

① The Historic Property Inventory Forms report that the Arizona Highway Department undertook Apache Trail reconstruction starting in 1922, and that these three bridges were opened to traffic in 1923.

② The Boulder Canyon Bridge comprises four spans that are repurposed from two other earlier installations. Spans 1/3/4, (about 100 feet long), came from the old Wickenburg Hassayampa River Bridge. Span 2, (about 180 feet long), came from the old LaBarge Creek Bridge.

Fish Creek, Lewis and Pranty Creek, and Dry Wash Bridges are listed in the State of Arizona Historic Bridge Inventory, with State of Arizona Historic Property Inventory Forms (prepared by FRASERdesign, Loveland, Colorado) dated 2004-10-31.

The six tabulated SR 88 bridges, all built in the 1910s-1920s, are among the oldest bridges in the state still in service. All bridges have a clear roadway width around 15 feet and can only accommodate one vehicular lane, with Davis Wash Bridge being the exception at 24 feet. First Water Creek and Boulder Creek (back-MP), and Pine Creek (ahead-MP) prevent passage of wider vehicles from reaching Fish Creek, Lewis and Pranty Creek, and Dry Wash Bridges.

At MP 215.02, between Boulder Creek and Fish Creek, the Ash Creek Bridge – also a 1920s historic bridge – was replaced by the Str. No. 04685 Ash Creek RCBC. The historic one-span 60-foot-long steel truss was replaced with a 241-foot-long two-barrel 10'x10' RCBC in 1961-1962.

Fish Creek, Lewis and Pranty Creek, and Dry Wash Bridges underwent the most recent biennial inspection in 2018. Inspection reports for the periodic inspections in 2020 and 2022 indicate that they were not performed due to the road closure inaccessibility. The next biennial inspection should occur in 2024.

1.3.7 Retaining Walls

SR 88 passes through the foothills of the Superstition Mountain Range. The surrounding terrain is rugged and characterized by steep grades, tight horizontal curves, and steep roadside slopes. Much of the roadway was constructed by cutting into the steep bedrock hillsides. The fill material from these cuts was used as roadway fill on the downhill side of the slopes.

At numerous locations, the excavated bedrock has been used to construct stone retaining walls to provide space for the roadway. These walls range from dressed stacked stone that include patterns to random rubble. Over the past century since their construction, many of the walls remain in service as originally constructed. Numerous walls have been reconstructed, modified to include a parapet/curb, or replaced completely with reinforced concrete retaining walls with a stone veneer to improve the appearance.

1.3.8 Geotechnical

A Geotechnical Assessment Letter was prepared for the project in March 2023. It is appended to this report and summarized in the following sections and in Chapter 4.

1.3.8.1 Geotechnical Conditions and Field Observations

From the Fish Creek Hill Overlook (MP 222) going east, SR 88 was constructed mainly as a winding side-hill cut/fill unpaved road on steeply ascending terrain dropping roughly 700 feet over a distance of approximately 1.5 miles to the single-lane bridge at Fish Creek Canyon. East of the bridge, SR 88 is relatively flat, running along the east bank of Fish Creek to about MP 224.3 where it then mainly hugs the side hills as a cut/fill constructed roadway either to the north or south sides of Lewis and Pranty Creek. At MP 227 and extending east to MP 229 (just west of the Apache Lake Turnoff), the roadway veers from the creek and climbs roughly 50 feet.

The section of roadway from Fish Creek Hill to about MP 222.6 is a moderately ascending section of winding road, with cuts typically varying from 10 to 30 feet and fills which vary from roughly 5 to 15 feet. Considerable erosion of the unpaved surface has occurred within this section where the roadside ditch has either plugged or is undersized to handle the high influx of water which occurred in and subsequent to 2019. Exposed rock immediately adjacent to the roadway from Fish Creek Hill to about MP 222.4 consists of massively bedded sedimentary units of sandstone, siltstone and conglomerates which appear to be predominantly horizontally bedded. This orientation is generally relatively stable and fracture induced rockfall does not appear to be an issue. From MP 222.4 to 222.6, the exposed rock within cuts adjacent to the roadway appears to be moderately to widely fractured volcanic rock. Erosion of the roadway surface appears to be the larger issue within this segment.

Most of the roadway damage is concentrated in the steep section of roadway west of Fish Creek Canyon (approximately MP 222.6 to 223.6). This stretch of road is characterized by a variety of steep overlying rock faces, and rock debris and colluvial slopes which contain loose rock with sizes varying from cobble to large vehicle-size boulders immediately adjoining the road. Higher, near-vertical canyon forming rock walls are set back from the road generally a few hundred feet.

Bedrock within this stretch of road and in the slopes high above the road, consists of volcanic rock, primarily andesite, dacite, and tuff, extending from the west project limits to about MP 223.2. A southeast-to-northwest trending fault separates this volcanic rock from sedimentary sandstone, siltstone, and conglomerate rock. It is apparent from review of aerial photos that faulting has tilted this once horizontally bedded rock unit to a near vertical orientation along the canyon walls. It further appears that the large rock fragments, which closed the road at MP 223.3, detached from the vertically oriented bedding planes.

Other damage in this section includes rock debris flows which have infilled drainages with variably sized rock, often blocking crossroad culverts. This is indicative of large storm flows concentrated into natural drainages. It is evident the roadside ditch on the cut side of the road overtopped at many locations resulting in surface overflows, which often eroded the existing roadbed, outboard fills and in some cases existing rock walls. Erosion on the roadbed exposed the underlying rock cut surface. At some locations, the fills were extensively eroded on the outboard slopes causing significant erosion of the slope and edge of road. Storm induced erosion of exposed colluvial and rock debris slopes also deposited rock onto the road at many locations.

SR 88 follows the east bank of Fish Creek from the bridge to about MP 224.3. This relatively flat section of road sits several feet above the adjacent creek bed. Though some damage was noted along the outboard slope, more significant damage in the form of debris flows are apparent along the east side of the road from uphill water induced erosion. Much of the uphill slope within this stretch consists of highly fractured rock, colluvium and rockfall debris. These loosely held materials, when inundated with water, dislodge and collect as rock and soil debris within the natural drainages. At least four debris flows were observed.

From MP 224.3 to MP 225, the road ascends east adjacent to Lewis and Pranty Creek, crossing to the north side of the creek at the Lewis and Pranty Creek Bridge at about MP 224.9. At the time of the initial site visit in January 2023, the road was not passible just east of the bridge due to a debris flow. Another debris flow impacting the road was noted just east of MP 225. Most of this section is characterized as highly fractured volcanics in nominal 15- to 30-foot-high cuts.

From MP 225 to 226, the road ascends to the east typically with 10- to 15-foot cuts and lesser cuts up to about 40 feet, mainly within fractured volcanics and colluvium. The road was constructed in a side hill cut with fills extending to the creek bed. Rockfall and erosional damage, though present in some areas, is much less compared to the area west of the Fish Creek Hill Bridge. Though the road is typically more than 20 feet wide in most areas, it narrows to about 15 to 17 feet adjacent to a creek side rock wall approximately 220 feet long near MP 225.4. The easternmost single-span, single-lane bridge is located at about MP 225.5. Both this bridge and the Lewis and Pranty Creek Bridge appear to have one abutment founded on rock and the other on alluvial materials (or possibly piles which extend to rock). There were a few areas noted during the initial site visit where hillside generated flows had eroded the roadbed surface, and in several locations the outboard slope caused head cutting back into the slope and roadway surface. Heavy flows within the creek also damaged (eroded) portions of the roadway embankment, oversteepening and in some locations cutting into the roadbed surface.

East of MP 226, the road continues to ascend adjacent to the north side of the creek with cuts transitioning from fractured volcanics to granitics at roughly MP 226.7. At MP 227 the road alignment departs from the creek and heads north towards MP 229 and the road to Apache Lake Marina. Cuts and fills within this area are generally less than 15 feet. Storm-related damage in this section appeared limited to minor erosion that could likely be repaired by ADOT Maintenance.

1.4 Agency and Public Involvement

In addition to ADOT, the primary agency stakeholder is the US Forest Service - Tonto National Forest. Other stakeholders include the Federal Highway Administration, MAG, State Historic Preservation Office, Pinal County, City of Apache Junction, and other federal, state, tribal, and local agency stakeholders.

1.4.1 Website

ADOT has created and maintains a project website: www.https://azdot.gov/projects/southeast-district-projects/state-route-88-apache-trail.

1.4.2 Other Public Involvement

ADOT and its agency partners have attended meetings with legislators and members of the public that are interested in re-opening this segment of SR 88. ADOT met with members of an interest group, Save the Apache Trail, several times. Meetings also included Pinal County, Maricopa County, and Apache Junction.

A public information meeting was held to present the alternatives and preliminary study recommendations on August 16, 2023. The meeting was held at the Multigenerational Center in Apache Junction, Arizona. The meeting format consisted of an open house from 5:30 PM to 6:00 PM, a presentation followed by questions and answers, concluding around 7:30 PM with additional open house time. Study-specific

handouts, boards, and roll plots were available for viewing during the open house. The presentation was made by several members of the study team and included PowerPoint slides focused on the study background, the alternatives considered with the study, and ADOT's Preferred Hybrid Alternative.

The meeting materials, including pre-recorded versions of the presentation in both English and Spanish, were posted to ADOT's project website, along with the Initial DCR.

Comments from the public were welcomed at the meeting and could be submitted during the 30-day comment period ending September 15, 2023. Comments received at the meeting included the following:

- Not in favor of pavement on SR 88
- Re-open the road as soon as possible
- Re-open the road only to off-road vehicles (50" width)
- Preserve the character of the Apache Trail by re-grading, not paving, the roadway

2.0 Traffic and Crash Data

This section presents existing traffic volume data, existing crash data, traffic volume projections for the design year 2040, evaluation of the projected traffic volumes for roadway capacity, and recommendations for safety improvements.

2.1 Crash Analysis

2.1.1 Source Data

Crash data was obtained from ADOT Safety Section along SR 88 for the study area between MP 221 to MP 229. The crash data extends across 10 years starting on January 1, 2008, and ending on December 31, 2017. Due to recent closure of the corridor, crash data was only considered through the end of 2017. There were 34 crashes that occurred along SR 88 within the study segment recorded during the 10-year analysis period. The reported crashes are tabulated below by manner of collision and by severity.

2.1.2 Crash Data

Table 5 presents the number of crashes by manner of collision along SR 88. The data indicates that most of the crashes in the study segment were single vehicle type for a total of 88 percent of the total crashes.

Table 5 – SR 88 Crashes by Manner of Collision

Manner of Collision	SR 88	Percent
Rear End	2	6%
Single Vehicle	30	88%
Sideswipe (Opposite Direction)	2	6%
Total	**34**	**100%**

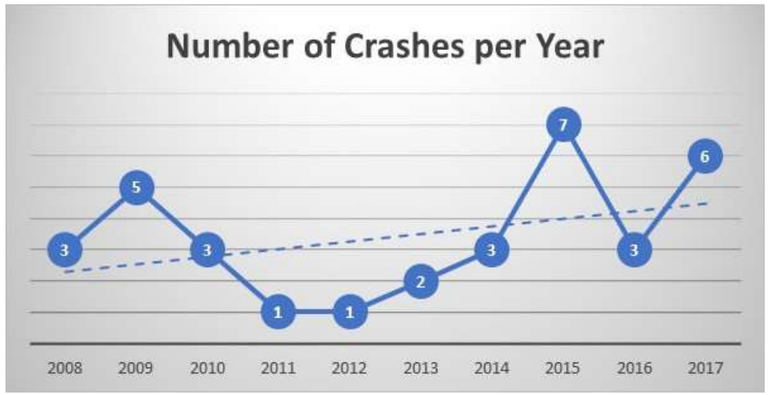
Table 6 shows the number of crashes by severity along SR 88. The data indicates that approximately 71 percent of total crashes along SR 88 were property damage only (no injury) crashes. The data also shows that during the 10-year period, no fatal crashes occurred along SR 88 in the study area. The single vehicle crashes included run off the road crashes, hitting an animal/wild game, equipment failure (tires/brakes), fire/explosion, hitting other fixed object, and overturn rollover.

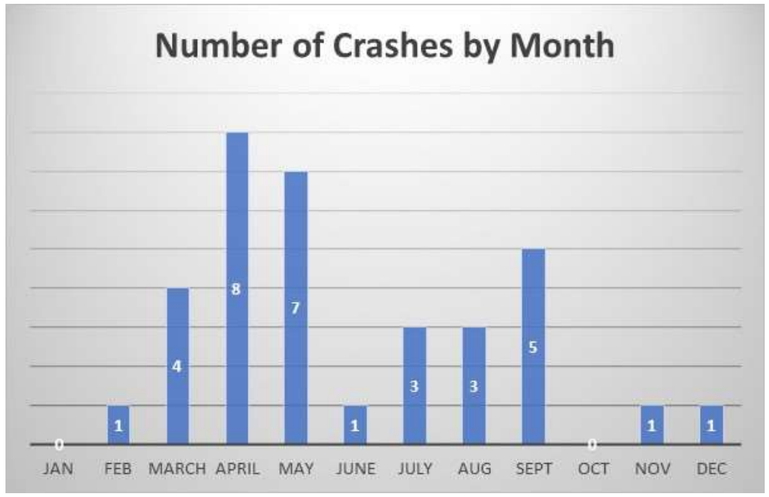
Table 6 – SR 88 Crashes by Severity

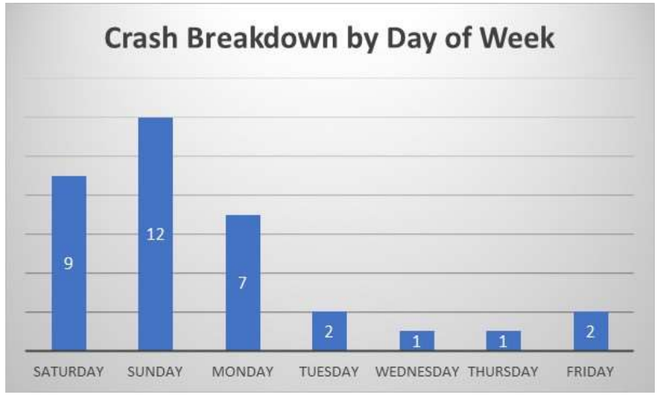
Severity	SR 88	Percent
Property Damage Only (No Injury)	24	71%
Possible Injury	3	9%
Minor Injury	7	20%
Total	**34**	**100%**

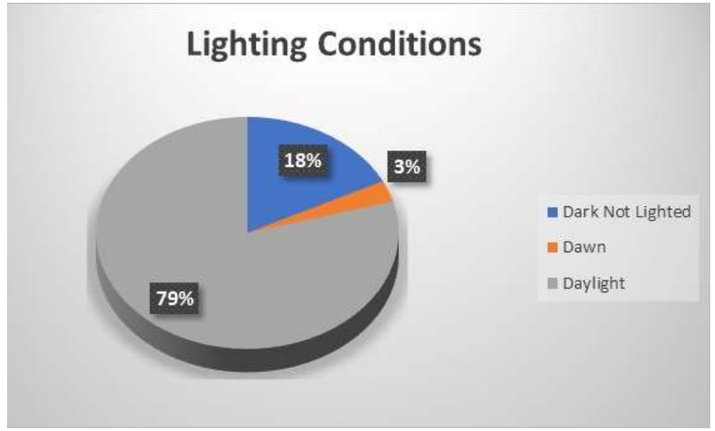
Figure 4 depicts the crash analysis data, sorted by various criteria. The year with the highest number of crashes is 2015, with seven crashes. Overall, the trend for crashes per year is increasing. During the record period, the month with the highest number of crashes is April with eight crashes, with May following close behind with seven crashes. Saturday and Sunday have the highest number of crashes compared to other days of the week with nine and twelve crashes, respectively. For time of day, the highest number of crashes occurred around the PM peak hour with five crashes occurring during the 4 PM hour.

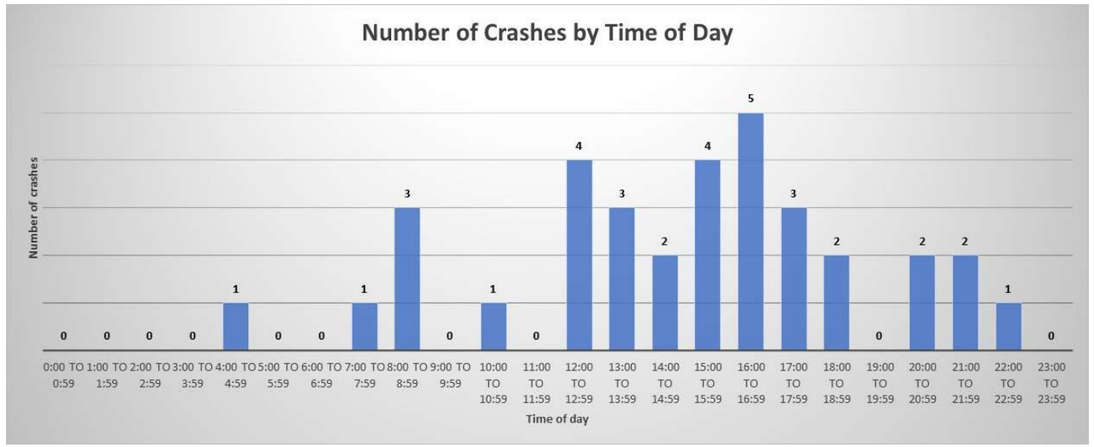
The majority of crashes occurred during daylight lighting conditions (79 percent) while 18 percent occurred under dark not lighted conditions. The surface conditions for 29 of the 34 crashes were dry. The vehicle types most often seen in the crashes were cars or pickup trucks.

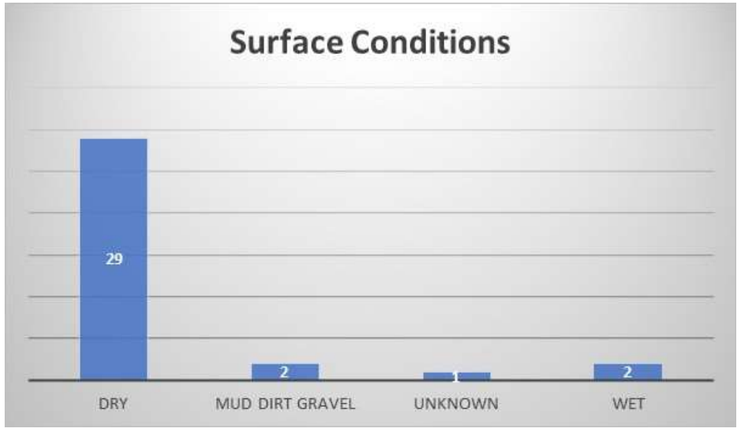


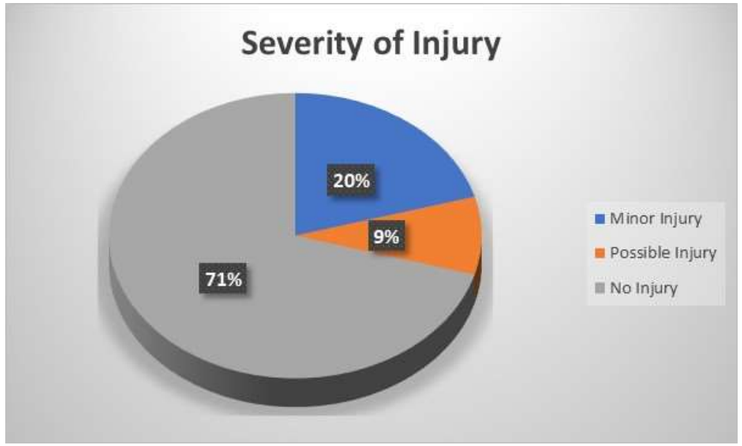












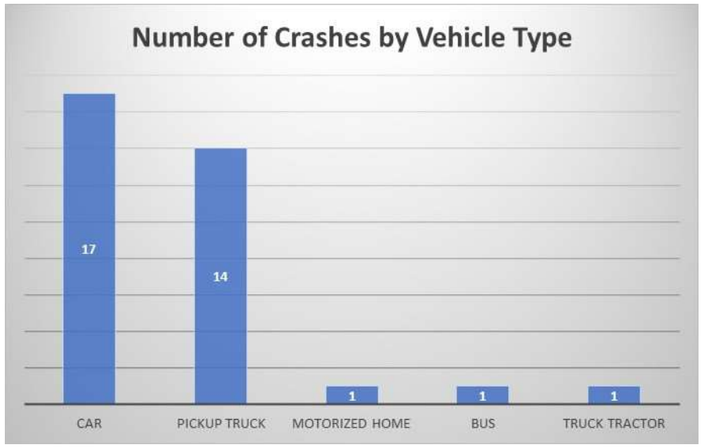


Figure 4 - Crash Diagrams

2.2 Traffic Analysis

2.2.1 Source Data

Existing Annual Average Daily Traffic (AADT) volumes were obtained for the years 1990 through 2021 from the ADOT Transportation Data Management System at MP 228. From 1990 to 2011, traffic volumes were collected, while from 2012 to 2021 the traffic volumes were "grown" based on previous year traffic volumes at MP 228, with the exception of years 2016 and 2018 when traffic volumes were collected. Due to the SR 88 corridor closure between MP 222 and 229, the most recently collected 2018 traffic volumes were primarily utilized in this report. It should be noted the ADOT TDMS collects counts on weekdays; however, this corridor typically experiences higher traffic volumes on the weekends.

2.2.2 Traffic Data

2.2.2.1 Existing Conditions

The study section of SR 88 is unpaved, with a few posted signs and no pavement markings. For safety reasons, the segment between MP 222 and 229 was closed to traffic in 2019. MP 222 through 227.2 remains closed at this time, while MP 227.2 to 229 was recently re-opened.

Collected and grown traffic volumes at MP 228, from 1990 to 2021 from ADOT's TDMS website are shown in Table 7 and Figure 5 shows traffic volume fluctuations graphically for the past 30 years.

Table 7 – AADT Volumes at MP 228

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998
AADT	210	352	300	394	490	527	573	574	592
YEAR	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
AADT	650	602	620	254	261	158	161	245	224
YEAR	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
AADT	182	274	196	142	141*	146*	152*	157*	168
YEAR	**2017**	**2018**	**2019**	**2020**	**2021**				
AADT	170*	229	232*	206*	234*				

* Traffic Volumes were grown based on previous year traffic volumes

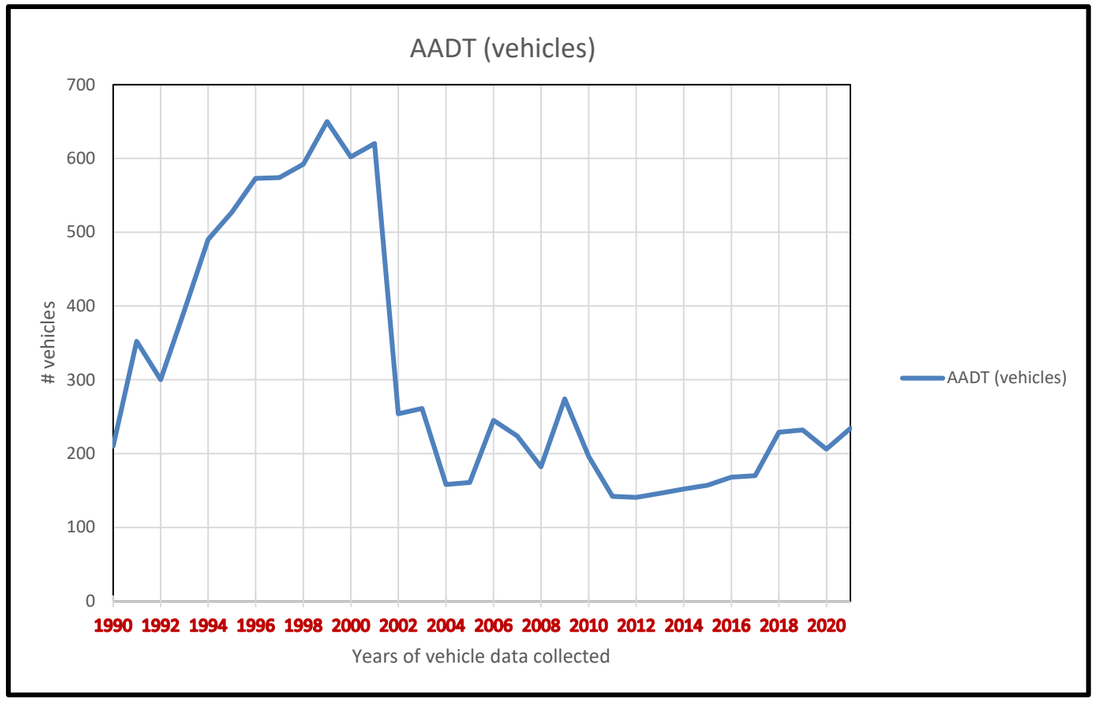


Figure 5 – AADT Volumes by Year at MP 228

In the most recent collected data set in 2018, the Percent Trucks (T) was 6.3%, the Peak Hour Factor (K) was 16%, and the Distribution Factor (D) was 62%. The traffic volumes fluctuated between 141 and 650 vehicles per day over the past 30 years. Traffic volumes in this corridor did not increase or decrease on a straight trajectory. Many environmental, infrastructure, and economic conditions influence the traffic volumes.

The SR 88 corridor between MP 203.4 and MP 220.2 (the section west of the study segment) experienced poor pavement conditions for many years, which likely contributed to the lower traffic volumes in the early 2000s and resulted in lower traffic volumes through 2018 compared to the early 1990s. In 2018, SR 88 was reconstructed and repaved from MP 203.4 to MP 220.2.

Collected and grown traffic volumes at MP 212, from 1990 to 2022 from ADOT's TDMS website are shown in Table 8 and Figure 6 shows traffic volume fluctuations graphically for the past 30 years.

Table 8 – AADT Volumes at MP 212

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998
AADT	1100	1200	1122	1147	1412	1324	1416	1418	1447
YEAR	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
AADT	1519	964	495	550	564	453	462	514	503
YEAR	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
AADT	483	677	867	329	1,293	929	966*	997*	906
YEAR	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**			
AADT	917*	975	1000*	886*	1005*	1169			

* Traffic Volumes were grown based on previous year traffic volumes

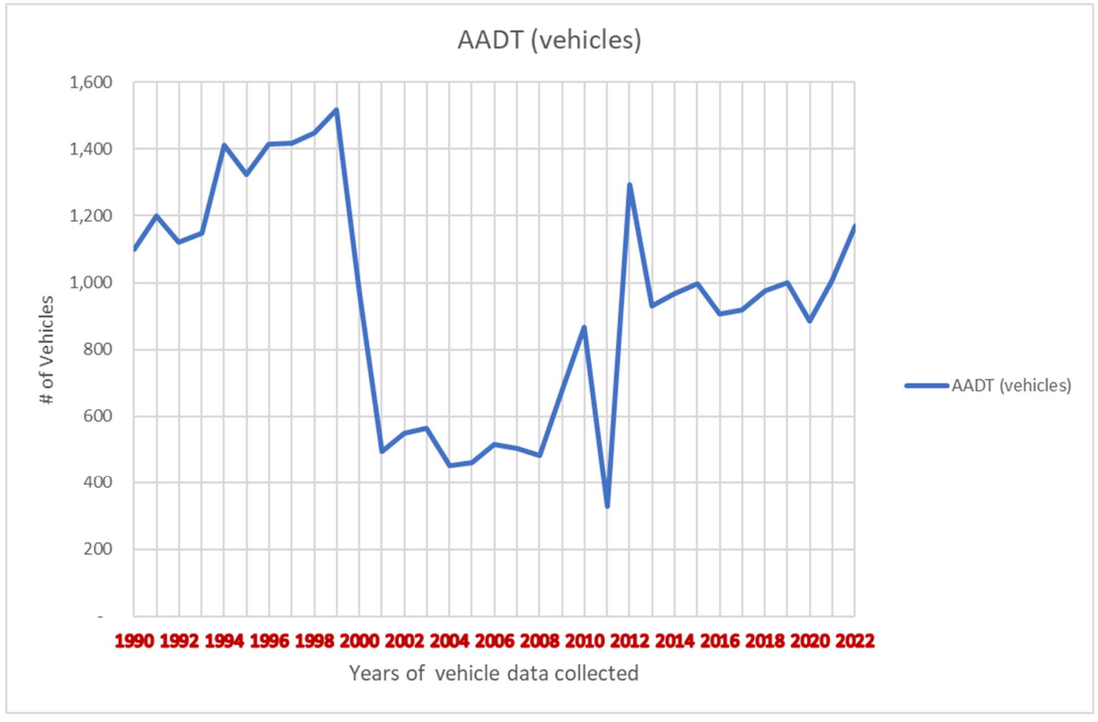


Figure 6 – AADT Volumes at MP 212 Shown Graphically

The traffic volumes fluctuated between 329 and 1,519 vpd in the past 30 years. Traffic volumes in this western section of the corridor did not increase or decrease on a straight trajectory either. Many environmental, infrastructure, and economic conditions influence the traffic volumes. In the most recent collected data set in 2018, the Percent Trucks (T) was 19.2%, the Peak Hour Factor (K) was 8%, and the Distribution Factor (D) was 53%.

Comparing the two data sets, it is clear that the paved section of SR 88 experiences substantially higher traffic volumes than the unpaved section. The paved segment of SR 88 is the entrance to the unpaved section; as a result, when traffic volumes decrease or increase on the paved segment, the volumes tend to follow a similar trend of decrease or increase on the unpaved segment. While the traffic patterns are not identical, they seem to be very similar with the exception of 2011. Comparing Table 7 and Table 8, traffic volumes were always higher in the western section of SR 88. The western paved section of SR 88 also includes Tortilla Flat, a destination that attracts more visitors than the eastern or unpaved segment, which functions as more of a pass-through area. As a result, traffic volumes were always lower in the unpaved section than in the paved section. In addition, the unpaved roadway section was not as comfortable of a ride as the paved section so fewer visitors were utilizing the unpaved section of SR 88.

2.2.2.2 Existing (2023) Conditions

Level of service is commonly used as a qualitative description of a quantitative analysis of the paved roadway facility operations. Since SR 88 is an unpaved roadway, an operational analysis was not conducted to determine existing level of service for the corridor operation.

The most recently collected 2018, the 2021 grown, and the 2040 projected traffic volumes were utilized to develop the 2023 base condition traffic volumes. It is estimated that if the corridor was open to the traveling public today, approximately 250 vpd would utilize the corridor on a weekday based on an exponential growth rate of 3.2% between 2021 and 2040. It is estimated that traffic volumes could increase to 1990's level traffic volumes or approximately 500 to 600 vpd traveling on SR 88 between MP 222 and 229 if roadway conditions are improved and remained unpaved.

2.2.2.3 2040 Traffic Volumes

Since the design year 2050 projected volumes were not available, 2040 traffic volume projections were obtained from ADOT Transportation Data Management System Average Annual Daily Traffic Reports and Projections.

Table 9 – 2040 ADOT Traffic Volume Projections for MP 228

YEAR	AADT	2040 Projected AADT
2018	229	382
2019	232	382
2020	450*	752*
2021	234	427

The 2020 projected traffic volume of 450 vpd shown in Table 9 is unusually high compared to Table 7 traffic volumes at MP 228 collected on the TDM website. That year traffic volumes were unusual and somewhat random and it was difficult to predict reasonable traffic volumes due to the pandemic. As a result, the 2020 traffic volumes shown in Table 9 were not used. The 2018, 2019, and 2021 projected volumes shown in Table 9 seem reasonable and in line with previously observed traffic volumes. If unpaved roadway conditions remain, it is reasonable to expect that traffic volumes could grow to 427 vpd on a weekday by 2040; however, it is possible that the roadway would experience a more significant growth similar to the late 1990s. As mentioned previously, the SR 88 corridor between MP 203.4 and MP 220.2 was recently reconstructed in some areas and repaved, attracting an increased number of visitors. On a weekday in the fall of 2022, between MP 206.00 and 206.99, 945 vpd were observed while on a weekend day, 3,169 vpd were observed traveling in the corridor.

Based on available information, it is reasonable to expect that by 2040 traffic volumes will be approximately 427 vpd or higher if the SR 88 corridor between MP 222 and MP 229 is open to the traveling public and remains unpaved. It is also reasonable to expect that if the SR 88 corridor between MP 222 and MP 229 is paved, traffic volumes could increase to similar levels as traffic volumes west of MP 220.

2.2.3 Traffic Operational Analysis

Traffic operational analysis was not conducted for the alternatives. Traffic volumes between MP 222 and MP 229 have fluctuated through the years and remained relatively low. It is not anticipated that traffic volumes would substantially differ from the previous highs and lows of 1990's and 2000's.

2.3 2040 SR 88 Build Alternatives and Safety Improvement Recommendations

Safety strategies can be employed to improve safety on paved and unpaved scenic roads. National and State standards do not specifically provide signing recommendations for unpaved roadways. The FHWA publication on "*Unpaved Roads: Safety Needs and Treatments*" unpaved.pdf (dot.gov) specifies several recommendations for unpaved roadways while MUTCD and ADOT standards, along with the FHWA publication "*Low-Cost Treatments for Horizontal Curve Safety 2016*" Low-Cost Treatments for Horizontal Curve Safety 2016 (dot.gov), provide guidance on low volume paved road signing and pavement marking.

Traffic and safety recommendations for each alternative are included in Chapter 3.

3.0 Design Concept Alternatives

3.1 Introduction

A No Build alternative and Build alternatives were developed and evaluated for the re-opening and improved resiliency of SR 88 between MP 222 and MP 229.

Public agencies that were involved in the alternatives development and evaluation process include ADOT and TNF.

3.2 Design Concept Alternatives Considered

This study focuses on the reopening of SR 88 to traffic and how to make it more resilient to future weather events. Alternatives were developed to reflect various levels of improvements and various levels of risk of future closures. Environmental evaluation was done at a high level and total impacts may be unknown at this time. Impact mitigation will need to be discussed with TNF and SHPO. For comparison, SR 88 to the west (Tortilla Flat) has geometry similar to this project and is paved. The SR 88 project under construction to the east includes a chip seal surface.

Capacity and geometric improvements were not considered. Alternative concepts were developed for SR 88 based on the features required to meet operational goals and maintenance goals for the potential future conditions. This design concept report evaluates these alternatives, considering factors such as accommodation of two-way traffic, predicted resiliency against future weather events, safety improvements, preliminary environmental impacts, ROW, and cost requirements, and will recommend an alternative for design and construction.

All alternatives retain existing horizontal and vertical roadway geometry.

The alternative evaluation sections are presented as follows:

- No Build Alternative
- Alternative 1: Higher Resilience / Lower Risk of Future Closures
- Alternative 2: Medium Resilience / Medium Risk of Future Closures
- Alternative 3: Lower Resilience / Higher Risk of Future Closures
- Alternative 3A: Lowest Resilience / Highest Risk of Future Closures

The Build Alternatives are detailed in Table 11 on page 15.

3.2.1 No Build Alternative

The No Build alternative assumes that no improvements will be made to SR 88 and that the roadway would remain closed to motor vehicles.

The No Build Alternative would not construct any of the improvements identified in the Build alternatives.

3.2.2 Alternative 1: Higher Resilience / Lower Risk of Future Closures

Alternative 1 would upgrade the SR 88 roadway to a 24-foot-wide paved cross section to allow two-way traffic throughout the study area. The 24-foot roadway would consist of two 10-foot lanes with 2-foot shoulders, meeting AASHTO Low Volume Roads and National Park Service design standards. A two-foot-wide bench would be included behind new guardrail or concrete barrier. The roadway would be paved with asphaltic concrete (AC) to minimize erosion.

Existing guardrail would be removed and new MASH-compliant guardrail and end terminals would be added to meet ADOT Roadway Design Guidelines. New 32-inch cast-in-place colored concrete barrier and end terminals would be placed on the Fish Creek Hill segment (MP 222.62 to 223.61) to reduce maintenance needs. Pinned concrete barrier would be placed at several locations to allow maintenance grading activities and rockfall removal.

W-beam guardrail would be placed throughout the project length as indicated by the ADOT RDG (MP 222.02-222.62, MP 222.50-222.62, and MP 223.63-224.23). MASH TL-2 compliant end terminals should be placed on both ends of every barrier run.

Drainage: Inlets/outlets and culverts would be upsized to accommodate projected 2050 flows as described in Section 1.3.5 of this report and the appended resiliency report. Culverts would be extended and drainage headwalls would be relocated in areas of roadway widening. Downstream erosion protection would be added. Of the 29 culverts analyzed, 16 would need to be upsized. Existing sediment and debris will be removed from currently clogged culverts and at the culvert inlets.

Table 10 – Proposed 2050 Culvert Changes

Culvert Station	Existing Size	Proposed Size	Culvert Station	Existing Size	Proposed Size
948+75	4’ x 7’ RCBC	Add 42” CMP	1106+66	18” CMP	3-42” CMP
957+36	4’ x 7’ RCBC	Add 2-24” CMP	1110+64	48” CMP	2-48” CMP
960+85	6’ x 8’ RCBC	Add 42” CMP	1125+60	8’ x 5’ RCBC	Add 2-36” CMP
1001+80	15’ x 7’ RCBC	Add 24” CMP	1139+64	5’ x 5’ RCBC	Add 48” CMP
1020+07	48” CMP	2-48” CMP	1157+86	36” CMP	5-36” CMP
1021+67	18” CMP	2-48” CMP	1187+96	48” CMP	3-48” CMP
1034+06	36” CMP	2-6’ x 5’ RCBC	1188+63	36” CMP	4-48” CMP
1094+34	6’ x 5’ RCBC	Add 6’ x 5’ RCBC and 24” CMP	1212+49	36” CMP	2-36” CMP

Erosion protection would be added adjacent to the creeks and in areas with slopes steeper than 2H:1V. The protection would likely consist of gabions with isolated zones of riprap.

Rockfall containment measures may include rock bolts in unstable rocks within 50 feet of the road, draped mesh in areas dominated by rock debris slopes, scaling, and rockfall containment ditches. Slope treatments may include debris barriers at major drainages with history of events impacting the roadway.

Since the existing roadway is typically narrower than 24 feet, excavation into the adjacent rock slope or embankment would be required. Recommended maximum rock cut slopes for all alternatives can be found in Table 20 in Chapter 4.

More-specific geotechnical recommendations are presented in the Geotechnical Letter Report (Appendix C).

Table 11 – Alternatives Descriptions

Technical Category	Alternative 1 Higher Resilience/Lower Risk of Future Closures	Alternative 2 Medium Resilience/Medium Risk of Future Closures	Alternative 3 Lower Resilience/Higher Risk of Future Closures	Alternative 3A Re-open SR 88 No Resilience Improvements/ Highest Risk of Future Closures
Roadway Cross Section	• No improvements to roadway curves or grades • Widen roadway to 24 ft to provide two 10-ft travel lanes and two 2-ft shoulders • Add concrete barrier along Fish Creek Hill and add modern guard rail throughout to meet current guidelines • Lay back slopes for sight distance improvements • Add signs and pavement marking.	• No improvements to roadway curves or grades • Widen roadway to 20 ft to provide two 10-ft travel lanes, no shoulders • Stabilize existing shoulders • Add pull-outs • Replace existing guardrail with concrete barrier along Fish Creek Hill • Add reflectors along curves • Add signs throughout	• No improvements to roadway curves or grades • No widening • Remove rockslide that blocks road • Add concrete barrier along Fish Creek Hill • Add reflectors along curves • Add signs throughout	• No improvements to roadway curves or grades • No widening • Add concrete barrier on Fish Creek Hill. • Remove rockslide that blocks road at MP 223.2
Roadway Widening (geotech)				
20'	• N/A	• Would require moderate widening of existing roadway through combination of cut widening, cut slope treatments, and/or fill slopes	• N/A	• N/A
24'	• Would require moderate widening of existing roadway through combination of cut widening, cut slope treatments, and fill slopes	• N/A	• N/A	• N/A
Roadway Surface	• Asphalt pavement	• Stabilized aggregate	• Grade existing dirt road	• Grade existing dirt road
Bridges				
Fish Creek	• Replace with new 1-lane bridge	• Repair/rehab – bridge deck, increase strength, service life	• Necessary repairs only (localized corrosion or damage, paint, curbs)	• None (pending bridge inspection)
Lewis and Pranty Creek	• Replace with new 1-lane bridge	• Since bridge has been overtopped, raise bridge up to two feet	• Necessary repairs only (localized corrosion or damage, paint, curbs)	• None (pending bridge inspection)
Dry Wash	• Replace with new 1-lane bridge	• Repair/rehab – bridge deck, increase strength, service life	• Necessary repairs only (localized corrosion or damage, paint, curbs)	• None (pending bridge inspection)

Technical Category	Alternative 1 Higher Resilience/Lower Risk of Future Closures	Alternative 2 Medium Resilience/Medium Risk of Future Closures	Alternative 3 Lower Resilience/Higher Risk of Future Closures	Alternative 3A Re-open SR 88 No Resilience Improvements/ Highest Risk of Future Closures
Cut Slopes - Upslope				
Rockfall Debris	• Flatten slopes and install debris flow barriers upslope	• Flatten slopes and install isolated debris flow barriers	• Scaling only as needed	• None
Rock Slopes	• Flatten slopes with scaling	• Scaling	• Scaling only as needed	• None
Rockfall				
Rock Bolts	• Identify potentially unstable rocks < 50 feet from the road. Isolated rockfall from high slopes will be evaluated	• Limited to isolated rocks < 20 feet from the road that shouldn't be removed to maintain overall slope stability	• N/A	• None
Retaining Walls	• More prevalent to establish wider roadway section. • Add walls to avoid encroachment into wilderness	• Prevalent to establish wider roadway section. • Add walls to avoid encroachment into wilderness	• Limited use only to reestablish eroded roadway.	• None
Drainage Culverts / Headwalls / Outlet Protection	• Upsize pipes as needed to allow sediment to more easily pass through the system. Include debris flow barriers to retain cobbles and boulders. • Upsize culverts to pass large predicted future storms • Add outlet protection where downstream erosion is occurring • Steepen flatter culverts where possible to improve self-cleaning	• Upsize pipes as needed to allow sediment to more easily pass through the system. • Upsize culverts to pass medium predicted future storms • Add outlet protection where downstream erosion is occurring	• Clean inlets/pipes as needed. Will require ongoing maintenance • Repair/replace damaged culverts • Replace currently undersized culverts (today flows)	• No action
Roadside Ditches	• Add roadside ditches where flow over roadway will cause potential damage • Add crown ditches to direct flows away from rock slopes	• Add roadside ditches where flow over roadway will cause potential damage	• Clean and re-establish existing ditches	• No action

Yellow highlight = Elements of *Preferred Hybrid Alternative* presented to the public in August 2023 and subsequently included in the Recommended Alternative

Bridges: Bridges are costly and increase construction complexity and duration. Historic preservation is deemed to be one key priority. Site accessibility is also an important evaluation factor.

Alternative 1 includes bridge replacement, which is not supportive of historic preservation, but it does provide the highest resilience and lowest risk because the bridges' in-service ages are reset from the century mark back to zero. Bridge replacement introduces higher cost and more complex constructability. There are several good candidate alternatives for bridge replacement at Fish Creek, Lewis and Pranty Creek, and Dry Wash. Among the feasible types/sizes/locations is "in-like-kind" replacement with one-span steel truss, one-span steel truss, and one-span steel beams/stringers, respectively. The bridge type selection process is omitted from this DCR and deferred to Bridge Selection Report development during final design if needed.

The hydraulic analysis revealed that flows at Lewis and Pranty bridge could overtop the bridge for the existing 25-year flows and would overtop the bridge for the 2030 and 2050 25-year flows. The roadway profile and new bridge should be raised to prevent overtopping.

Walls: New retaining walls would be constructed at locations required to establish a wider roadway section and to avoid encroachment into the Superstition Wilderness area.

Traffic/Safety: Alternative 1 includes paving the roadway. Two-way traffic could access the corridor with a width of 24 feet. No changes would be made to horizontal and vertical curves. New bridges would accommodate one lane. Traffic improvements should follow MUTCD and ADOT Signing and Pavement Marking Standard Details. It is anticipated that paving the corridor would increase traffic volumes and would change the mix of vehicle types utilizing SR 88. Vehicle types accessing the corridor and the recreational areas may also include motorcycles, bicycles, heavy duty trucks, and buses. With a new smooth roadway surface, it is reasonable to expect that vehicular speeds and crashes in the corridor would increase. To improve safety, the following improvements are recommended for this alternative:

- Install flexible delineators in areas where guardrail or TCB cannot be installed.
- Consider installing safety edge to assist with controlled recovery for drivers returning to the pavement after straying due to inattention.
- Consider reducing sight obstructions through vegetation maintenance in the corridor.
- Consider geometric improvements such as wider shoulders for recovery and improvements to horizontal curvature.
- Install speed limit signs throughout the corridor.
- Install object markers at the bridge approaches and drainage structures.
- Install "yield to oncoming" traffic signs on the one lane bridge approaches.
- Install advance curve warning and chevron signs in the corridor.
- Consider installing pullouts near bridge approaches, locations where faster vehicles may desire to pass, at areas where visitors may want to stop to take pictures, and at lookout areas. The following minimum criteria are recommended for pullout areas:
  - Minimum width = 8', desirable width = 10'
  - Minimum length = 40', maximum length = 80'
  - Entrance/exit tapers = 5:1
  - Cross slope to match existing roadway cross slope.
- Consider installing high-friction pavement on approaches to sharp curves.
- Install centerline rumble strips.
- Install wider-than-typical 8-inch edge lines.
- Install in-pavement curve marking – advanced curve warning pavement marking

All of the elements listed above are included in the Alternative 1 cost estimate except geometric improvements, safety edges, pullouts, and vegetation maintenance.

Right-of-Way/Easements: Approximately 2.2 acres of new easement would be required from the TNF. This easement area includes one acre for maintenance access to drainage structures. To prevent encroachment into the Superstition Wilderness, approximately 26,000 square feet of retaining walls would be constructed.

3.2.3 Alternative 2: Medium Resilience / Medium Risk of Future Closures

Alternative 2 would upgrade the SR 88 roadway to a 20-foot-wide cross section to allow two-way traffic throughout the study area. The 20-foot roadway would provide two 10-foot lanes with no shoulders. Six inches of stabilized (1% lime-treated) aggregate base would provide a roadway surface that is more stable than the existing dirt road.

Existing guardrail would be replaced with colored 32-inch cast-in-place concrete barrier on the Fish Creek Hill segment (MP 222.62 to 223.61) to reduce maintenance needs. Pinned concrete barrier would be placed at several locations to allow maintenance grading activities and rockfall removal. MASH TL-2 compliant end terminals should be placed on both ends of each concrete barrier run. No other guardrail or barrier would be included.

Drainage: Culverts and drainage inlets/outlets would be upsized to account for projected 2030 flows as described in Section 1.3.5 of this report and in the appended resilience report. Drainage headwalls and culverts would be extended in areas where the roadway is widened. Erosion protection will need to be included downstream. Of the 29 culverts analyzed, 13 would need to be upsized from their current size. Existing sediment and debris will be removed from currently clogged culverts and at the culvert inlets.

Table 12 – Proposed 2030 Culvert Changes

Culvert Station	Existing Size	Proposed Size	Culvert Station	Existing Size	Proposed Size
948+75	4' x 7' RCBC	Add 36" CMP	1110+64	48" CMP	2-48" CMP
957+36	4' x 7' RCBC	Add 24" CMP	1125+60	48" CMP	8' x 6' RCBC
960+85	6' x 8' RCBC	Add 24" CMP	1139+64	5' x 5' RCBC	Add 24" CMP
1021+67	18" CMP	1-48" CMP	1157+86	36" CMP	4-36" CMP
1034+06	36" CMP	2-6' x 5' RCBC	1187+95	48" CMP	3-48" CMP
1094+34	6' x 5' RCBC	Add 2- 48" CMP	1188+63	36" CMP	4-48" CMP
1106+66	18" CMP	3-42" CMP			

Erosion protection would be added adjacent to the creeks. The protection would likely consist of gabions and/or riprap.

Rockfall containment measures may include rock bolts in isolated rocks within 20 feet of the road that shouldn't be removed to maintain overall slope stability, draped mesh in areas dominated by rock debris slopes, and scaling as needed for drainage. Slope treatments may include debris barriers at major drainages with a history of events impacting the roadway.

Since the existing roadway is typically narrower than 20 feet, excavation into the adjacent rock slope or embankment would be required. Recommended maximum rock cut slopes can be found in Table 20.

Bridges: Alternative 2 takes advantage of the opportunity to strike a balance among historic preservation, correction of observed items needing attention, and extension of useful service life. Alternative 2 presents a tier of supplemental enhancement measures above Alternative 3. The additional steps accomplish the following help to raise resilience and lower risks:

- Resolve ADOT Bridge Group concerns about Fracture Critical Members (FCM).
- Improve deck sustainability and live load capacity.
- Reduce inadvertent vehicle/trailer impact damage to truss portal "entrance" components.
- Mitigate approach roadway rutting and debris transport onto the deck.

Alternative 2 bridge action items are presented in Table 13 below:

Table 13 – Alternative 2 Bridge Recommendations

Component	Alternative 2 Action Item	00027 Fish Creek	00028 Lewis & Pranty Creek	00015 Dry Wash
Steel Truss	Strengthen the main steel truss bottom chords	Applicable	Applicable	
Concrete Deck	Deck replacement – remove and replace reinforced concrete deck. Remove and replace curbs.	Applicable	Applicable	Applicable
Approach object markers (black/yellow panels)	Install high visibility object marker concrete-filled steel pipe bollards at 20' intervals to aid drivers with vehicle/trailer guidance toward bridge portals. Reduce inadvertent impact damage to truss portal members. (Recommend 100 feet beyond bridge limits, all quadrants.)	Applicable	Applicable	
Approach Roadway	Install ADOT standard approach slabs. Reduce rutting and debris transport onto the deck. (Recommended 20 feet length.).	Applicable	Applicable	Applicable

Concrete Deck: The deck is the hardest-working bridge component. It comprises steel reinforcement and concrete. Reinforcing steel and concrete material properties and specifications have risen sharply. The details for the existing concrete "floor" show reinforcing steel as 3/8" tie rods, ½" steel rods, and ¾" longitudinal rods. It is likely that these 1920s bridges have smooth round bars. According to the Concrete Reinforcing Steel Institute (CRSI), the first reinforcing bar ("rebar") specification was 1910. ASTM A15 Grade 33 and Grade 50 originated in 1911, and Grade 40 in 1914. It came in plain (round), deformed, and cold-twisted (usually square). Deformed rebar standardization did not occur until 1947. It is estimated that 1920s common concrete compressive strength was around 2500 to 3000 pounds per square inch (psi).

Today's common standard for rebar is ASTM A615 Grade 60 and prestressing steel is A416 Grade 270. Today's common site cast-in-place concrete is around 4,500-5,000 psi and precast concrete is around 9,000-10,000 psi. Thus, for a given thickness, today's cast-in-place reinforced concrete materials can provide roughly 200% of the strength. Today's precast prestressed concrete materials can provide roughly 400% of the strength.

ADOT inspection documents identify Fracture Critical Members of the Fish Creek and Lewis and Pranty Creek bridge trusses. They are listed in Table 14:

Table 14 – Fracture Critical Members of Truss Bridges

FCM members per truss	Fish Creek	Lewis & Pranty Creek
All primary bottom chord members	9	6
Some secondary vertical members	4	3
Some secondary diagonal members	6	2
All transverse floor beams	10	7

It is possible to substantially reduce the risks associated with all FCM primary bottom chord members and transverse floor beam members with the right transverse and longitudinal design and detailing of the deck replacement.

The hydraulic analysis revealed that flows at Lewis Pranty Creek Bridge could overtop the bridge for the existing 25-year flows and would overtop the bridge for the 2030 and 2050 25-year flows. The rehabilitation of the bridge would include strengthening to account for the overtopping.

Walls: New retaining walls will be constructed at locations required to establish a wider roadway section and to avoid encroachment into the Superstition Wilderness area.

Traffic/Safety: Alternative 2 includes a lime-treated aggregate base surface. Two-way traffic can access the corridor with a proposed roadway width of 20 feet. All bridges remain one lane wide. Traffic improvements should follow MUTCD and ADOT Signing and Pavement Marking Standard Details. It is expected that the vehicle types accessing the corridor would remain passenger vehicles, light duty trucks, SUVs, and vehicles pulling boats. Due to the increased stability and improved roadway surface, it is reasonable to expect that vehicular speeds and crashes in the corridor would increase slightly. The following safety improvements are recommended:

- Install flexible delineators in areas where guardrail or TCB cannot be installed.
- Consider reducing sight obstructions through vegetation maintenance in the corridor.
- Install signs at MP 222 and at MP 229 (on each end of the corridor) to warn drivers of two-way traffic and narrow roadway ahead.
- Install speed limit signs throughout the corridor.
- Install object markers at the bridge approaches and drainage structures.
- Install "yield to oncoming" traffic signs on the one lane bridge approaches.
- Install advance curve warning and chevron signs in the corridor.
- Consider installing pullouts near bridge approaches, locations where faster vehicles may desire to pass, and at lookout areas. The following minimum criteria are recommended for pullout areas:
  - Minimum width = 8', desirable width = 10'
  - Minimum length = 40', maximum length = 80'
  - Entrance/exit tapers = 5:1
  - Cross slope to match existing roadway cross slope

All of the elements listed above are included in the Alternative 2 estimate except pullouts and vegetation maintenance.

Right-of-Way/Easements: Approximately 1.5 acres of new easement will be required from the Tonto National Forest. This easement area includes one acre for maintenance access to drainage structures. To prevent encroachment into the Superstition Wilderness, approximately 9,500 square feet of retaining wall will be constructed.

3.2.4 Alternative 3: Lower Resilience / Higher Risk of Future Closures

Alternative 3 assumes that few improvements will be made to SR 88 other than clearing the rockslide from the roadway and other repairs and maintenance needed to re-open the roadway to traffic.

The existing roadway width cross section would remain as-is. The existing dirt road would be re-graded to a uniform cross slope.

Existing guardrail would be replaced with colored 32-inch cast-in-place concrete barrier on the Fish Creek Hill segment (MP 222.62 to 223.61) to reduce maintenance needs. Pinned concrete barrier would be placed at several locations to allow maintenance grading activities and rock-fall removal. MASH TL-2 compliant end terminals should be placed on both ends of each concrete barrier run. No other guardrail or barrier would be installed.

Several areas near Fish Creek Hill have been particularly exposed to erosive slope conditions. This alternative would likely include excavation into the slopes and reestablishing slope stability, possibly with bolting. Scaling and other slope treatments would be performed only as needed.

Drainage: There are seven undersized existing culverts that do not accommodate existing runoff based on current ADOT design criteria for the 25-year storm. Upsizing the undersized culverts would be a priority. Roadside ditches will be reestablished where practicable. Erosion protection will be placed at culverts where significant existing erosion is noted. Existing sediment and debris will be removed from within the culverts and at the culvert inlets.

Table 15 – Upsize Existing Culverts (Alternative 3)

Culvert Station	Existing Size	Proposed Size	Culvert Station	Existing Size	Proposed Size
1021+67	18” CMP	1-48” CMP	1157+86	36” CMP	3-36” CMP
1034+06	36” CMP	8’ x 5’ RCBC	1187+95	48” CMP	2-48” CMP
1106+66	18” CMP	3-36” CMP	1188+63	36” CMP	4-36” CMP
1125+60	48” CMP	6’ x 5’ RCBC			

Erosion protection would be added only in areas over-steepened due to scour from Lewis and Pranty Creek.

Rockfall containment measures may include scaling as needed and ditches only as needed for drainage. Slope treatments would include maintenance to remove debris flows when they happen.

Bridges: Alternative 3 is the second least intrusive and second lowest cost alternative. While it does optimize historic preservation and address reparable conditions reported in the inspection records over the past 5+ years, it does not address some of ADOT Bridge Group’s concerns inherent to steel truss bridges and older bridges designed to lesser live load capacity specifications. Alternative 3 bridge action items are presented in Table 16 below:

Table 16 - Alternative 3 Bridge Recommendations

Component	Alternative 3 Action Item	00027 Fish Creek	00028 Lewis & Pranty Creek	00015 Dry Wash
Concrete Deck	Clean/remove built-up debris. Remove and replace curbs. Prepare surface and apply MMA (methyl methacrylate) crack healer/sealer	Applicable	Applicable	Applicable
Steel Trusses **	Repair coating deficiencies, minor corrosion Repair bent, damaged components	Applicable	Applicable	
Steel Floor Beams **	Repair coating deficiencies, minor corrosion.	Applicable	Applicable	Applicable
Steel Gusset Plates **	Repair coating deficiencies, minor corrosion. Repair bent, damaged components	Applicable	Applicable	
Abutments	Repair concrete deficiency		Applicable	Applicable
Bearings	Clean/remove built-up debris	Applicable	Applicable	
Railing	Remove/replace railing with more robust and higher visibility “rub rail”	Applicable	Applicable	Applicable
Approach object markers (black/yellow panels)	Increase from 1 per quadrant to 2 per quadrant at intervals of 20 feet (near ends of approach slabs).	Applicable	Applicable	Applicable
Approach Roadway	Regrade/rehabilitate to smooth surfaces	Applicable	Applicable	Applicable
Other miscellaneous minor repair items: Check inspection reports from 2016 & 2018. No inspections done in 2020 & 2022	Subject to 2024 biennial inspection.	Applicable	Applicable	Applicable

** Sample examination for lead-based paint has not been performed.

The hydraulic analysis revealed that flows at Lewis and Pranty bridge could overtop the bridge for the existing 25-year flows. The Alternative 3 repairs would do little to strengthen the bridge to resist overtopping.

Walls: No new retaining walls would be constructed with Alternative 3.

Traffic/Safety: Alternative 3 would re-grade the existing unpaved roadway. Two-way traffic will continue to utilize the corridor with the roadway width varying between 8 and 38 feet. Traffic improvements should follow MUTCD and ADOT Signing and Pavement Marking Standard Details. It is anticipated that with the re-grading of the existing unpaved roadway surface, traffic volumes would remain similar to the traffic volumes that accessed the corridor prior to the roadway closure. It is expected that the vehicle types accessing the corridor would remain passenger vehicles, light duty trucks, SUVs, and vehicles pulling boats. The following safety improvements are recommended:

- Install flexible delineators in areas where guardrail or TCB cannot be installed.
- Consider reducing sight obstructions through vegetation maintenance in the corridor.
- Install signs at MP 222 and at MP 229 (on each end of the corridor) to warn drivers of two-way traffic and narrow roadway ahead.
- Install speed limit signs throughout the corridor.

- Install object markers at the bridge approaches and drainage structures.
- Install "yield to oncoming" traffic signs on the one lane bridge approaches.
- Install advance curve warning and chevron signs in the corridor.

Because there is no widening associated with Alternative 3, pullouts were not considered with this alternative. All of the elements listed above are included in the Alternative 3 estimate except vegetation maintenance, which is assumed to be a routine maintenance activity.

Right-of-Way/Easements: Approximately one acre of new easement will be required from the Tonto National Forest for Alternative 3. This easement area is for maintenance access to drainage structures.

3.2.5 Alternative 3A: Lowest Resilience / Highest Risk of Future Closures

Alternative 3A assumes that minimal improvements would be made to SR 88, including clearing the rockslide from the roadway and grading the roadbed to re-open the roadway to traffic.

The existing roadway width cross section would remain as-is. The existing dirt road would be re-graded to a uniform cross slope.

Existing guardrail would be replaced with new colored 32-inch cast-in-place concrete barrier on Fish Creek Hill (MP 222.62 to 223.61) to reduce maintenance needs. Pinned concrete barrier would be placed at several locations to allow maintenance grading activities and rockfall removal. MASH TL-2 compliant end terminals should be placed on both ends of each concrete barrier run. No other guardrail or barrier would be installed. Several areas near Fish Creek Hill have been particularly exposed to erosive slope conditions. This alternative does not include excavation into the slopes or reestablishing slope stability, bolting, rock scaling or other slope treatments.

Drainage: No drainage improvements would be performed including replacement of existing undersized culverts that do not accommodate existing runoff, re-establishment of roadside ditches, placement of erosion protection at culverts where significant existing erosion is noted or removal of existing sediment and debris within the culverts and at the culvert inlets.

No erosion protection measures would be performed. Rockfall containment measures would be performed.

Bridges: Alternative 3A is the least intrusive and lowest cost. It includes no bridge improvements or modifications unless required by bridge inspection.

Walls: No new retaining walls would be constructed with Alternative 3A.

Traffic/Safety: Alternative 3A would re-grade the existing unpaved roadway. Two-way traffic will continue to utilize the corridor with the roadway width varying between 8 feet and 38 feet. It is anticipated that with the re-grading of the existing unpaved roadway surface, traffic volumes would remain similar to the traffic volumes that accessed the corridor prior to the roadway closure. It is expected that the vehicle types accessing the corridor would remain passenger vehicles, light duty trucks, SUVs, and vehicles pulling boats. The addition of concrete barrier on Fish Creek Hill segment (MP 222.62 to 223.61) is the only safety improvement included with Alternative 3A.

Right-of-Way/Easements: Approximately one acre of new easement will be required from the Tonto National Forest for Alternative 3A. This easement area is for maintenance access to drainage structures.

3.3 Alternatives Evaluation

The Build alternatives were evaluated using the following criteria. See Table 17 for a summary of the preliminary build alternatives evaluation.

The alternatives matrix entries show that providing higher resilience and reducing the risk of future closures (Alternative 1) would require the most construction, result in the largest construction footprint, require the most new easement area, and would cost the most, compared to the medium resilience, lower resilience, and no build alternatives. However, the higher resilience alternative would also result in the lowest projected roadway and slope maintenance requirements.

Accommodate Two-Way Traffic Operations: All three alternatives will accommodate projected 2040 traffic volumes. However, only Alternatives 1 and 2 will provide enough width for one full lane in each direction (except at each one-lane bridge).

Predicted Resiliency Against Future Weather Events: All three build alternatives will improve the resiliency of the roadway to future weather events, but to varying levels. Projected maintenance requirements also vary by alternative.

Stormwater Conveyance: This criterion is used to compare the alternatives' capacity to accommodate future predicted rainfall.

Added Safety Improvements: All three alternatives include safety improvements, but to varying levels. Safety improvements include barrier/guardrail, signage, rock stabilization, and rockfall treatments.

Potential Environmental – Historic/NRHP-listed Elements, Biological, and other Resource Risks: The project is in the Tonto National Forest and adjacent to the Superstition Wilderness; the preliminary impacts are identified based on the environmental overview.

Preliminary Impacts to Scenery or Visual Qualities: Preliminary impacts are identified based on the environmental overview.

Estimated Construction Cost: Alternatives 3 and 3A have the lowest estimated construction costs, followed by Alternative 2. Alternative 1 has the highest estimated construction cost.

Utility Conflicts: There are potential impacts to an SRP tower and an underground telecommunications line, depending on the recommended alternative.

Right-of-Way Impacts: ADOT has a 100-foot-wide right-of-way/easement from the Tonto National Forest. Depending on the recommended alternative, this project may require an increase in the easement width in some areas.

Agency and Public Acceptance: This criterion will indicate which alternative is most favorable to the agency and public stakeholders.

Table 17 – Build Alternatives Evaluation Matrix

Criterion	Alternative 1 Higher Resilience/Lower Risk of Future Closures	Alternative 2 Medium Resilience/Medium Risk of Future Closures	Alternative 3 Lower Resilience/Higher Risk of Future Closures	Alternative 3A Re-Open SR 88/No Resilience Improvements	Recommended Alternative
General Description	*New 24' wide asphalt roadway with barrier/guardrail in several locations. Replace existing bridges with new one-lane bridges. Upsize drainage elements to accommodate (83%) larger predicted storms and add V-ditch on Fish Creek Hill.*	*New 20' wide stabilized aggregate roadway with barrier on Fish Creek Hill. Rehab/repair existing bridges. Upsize drainage elements to accommodate (55%) larger predicted storms and add V-ditch on Fish Creek Hill.*	*Re-grade/repair existing roadway. Add barrier on Fish Creek Hill. No improvements to roadway width. Repair existing bridges. Clean and re-establish existing roadside ditches.*	*Re-grade/repair existing roadway. Add barrier to replace damaged guardrail on Fish Creek Hill. No improvements to roadway width. Remove rockslide that blocks road at MP 223.2.*	*Re-grade/repair existing roadway; pave with chip seal. Minor widening on Fish Creek Hill. Rehab/repair existing bridges. Upsize drainage elements to accommodate (55%) larger predicted storms.*
Accommodates Traffic in Both Directions (some constrained segments)	• Paved surface and wider roadway cross section provide improved conditions for larger/towed vehicles • New one-lane bridges restrict passage to one-way traffic	• Improved roadway surface and wider roadway cross section provide improved conditions for larger/towed vehicles • Existing bridge widths restrict passage to one-way traffic	• Existing bridge widths and narrow roadway cross sections restrict passage to one-way traffic in some locations	• Existing bridge widths and narrow roadway cross sections restrict passage to one-way traffic in some locations	• Existing bridge widths and narrow roadway cross sections restrict passage to one-way traffic in some locations
Predicted Resiliency against Future Weather Events	• Highest resiliency • Lower maintenance requirement after storms • Lower risk of road closure	• Moderate resiliency • Reduced maintenance after storms • Medium risk of road closure	• Lower resiliency • No change to existing high maintenance required after storms • Higher risk of road closure	• No resiliency improvements • Higher risk of road closure	• Moderate resiliency • Reduced maintenance after storms • Medium risk of road closure
Stormwater Conveyance	• Cross culverts' capacity increased to convey higher (83%) predicted flows	• Cross culverts' capacity increased to convey higher (55%) predicted flows	• Existing undersized cross culverts upsized to convey current predicted flows	• No changes to existing capacities	• Cross culverts' capacity increased to convey higher (55%) predicted flows
Added Safety Improvements (e.g., Guardrail, Pullouts)	• New barrier on Fish Creek Hill and to meet current guidelines throughout • Add curve warning and speed limit signs, striping, centerline rumble strip • Improvements to rock slopes for lower risk of rockfall	• New barrier on Fish Creek Hill • Add curve warning and speed limit signs • Moderate improvements to rock slopes; moderate risk of rockfall • Some walls on high side of SR 88	• New barrier on Fish Creek Hill • Add curve warning and speed limit signs	• Only damaged guardrail on Fish Creek Hill would be replaced (by barrier). • No other safety improvements	• New barrier on Fish Creek Hill • Add curve warning and speed limit signs • Add rock bolts to potentially unstable rock faces • Rockfall mesh at rockfall debris areas
Potential Environmental– Historic/NRHP-listed Elements, Biological, and other Resource Risks	<u>Biological Resources</u> • Increased vehicle speeds would increase the potential for wildlife-vehicle collisions. • Would result in the greatest impacts to native vegetation and wildlife habitats.	<u>Biological Resources</u> • Increased vehicle speeds would increase the potential for wildlife-vehicle collisions.	<u>Biological Resources</u> • Maintaining existing conditions would not increase the potential for wildlife-vehicle collisions. • Would result in the least impacts to native vegetation and wildlife habitats.	<u>Biological Resources</u> • Maintaining existing conditions would not increase the potential for wildlife-vehicle collisions. • Would result in the least impacts to native vegetation and wildlife habitats.	<u>Biological Resources</u> • Increased vehicle speeds would increase the potential for wildlife-vehicle collisions.

Criterion	Alternative 1 Higher Resilience/Lower Risk of Future Closures	Alternative 2 Medium Resilience/Medium Risk of Future Closures	Alternative 3 Lower Resilience/Higher Risk of Future Closures	Alternative 3A Re-Open SR 88/No Resilience Improvements	Recommended Alternative
Potential Environmental–Historic/NRHP-listed Elements, Biological, and other Resource Risks (cont'd)	<u>Clean Water Act Permitting</u> • Less future disturbance to waters of the US from bridge maintenance activities	<u>Clean Water Act Permitting</u> • Future disturbance to WUS likely to occur from necessary maintenance activities.	<u>Clean Water Act Permitting</u> • Future disturbance to WUS likely to occur from necessary maintenance activities.	<u>Clean Water Act Permitting</u> • Future disturbance to WUS likely to occur from necessary maintenance activities.	<u>Clean Water Act Permitting</u> • Future disturbance to Waters likely to occur from necessary maintenance activities.

	<u>Cultural Resources</u>
	• Replacement of bridges would constitute an adverse effect to 4(f) properties.
	• Fish Creek guardrail: identified as feature of listed bridge.
	• Removal/replacement of contributing features of SR 88 would constitute an adverse effect to a 4(f) property.
		<u>Cultural Resources</u>
		• Dry Wash bridge: replacement of decking and other repairs should follow standards; preservation of steel elements and other features recommended.
		• Fish Creek guardrail: identified as feature of listed bridge.
		• Removal/replacement of contributing features would constitute an adverse effect to a 4(f) property.
			<u>Cultural Resources</u>
			• Avoidance of adverse effects to 4(f) properties is anticipated as long as:
			  ○ Fish Creek guardrail is repaired in a manner consistent with SOI standards.
			  ○ No contributing features of SR 88 are impacted (e.g., culvert repair/replacement).
				<u>Cultural Resources</u>
				• Avoidance of adverse effects to 4(f) properties is anticipated as long as:
				  ○ Fish Creek guardrail is repaired in a manner consistent with SOI standards.
				  ○ No contributing features of SR 88 are impacted (e.g., culvert repair/ replacement).
					<u>Cultural Resources</u>
					• Dry Wash bridge: replacement of decking and other repairs should follow standards; preservation of steel elements and other features recommended.
					• Fish Creek guardrail: identified as feature of listed bridge.
					• Removal/replacement of contributing features SR 88 would constitute an adverse effect to a 4(f) property.

	<u>Recreational Resources/ Socioeconomics/Other Resources</u> • Con: Improvements are expected to result in a longer construction duration and thus greater potential for impacting recreational resources, the public, and businesses, relative to the other alternatives. • Pro: Since this alternative is expected to result in the most resilient roadway, maintenance would be lowest. The likelihood of future roadway closures which could affect recreational resources, the public, and businesses would be lowest relative to Alternatives 2 and 3.	<u>Recreational Resources/ Socioeconomics/Other Resources</u> • Con: Moderate level of improvements are expected to result in a moderately long construction duration and thus a moderate potential for impacting recreational resources, the public, and businesses, relative to the other alternatives. • Pro: Alternative is expected to result in a moderately resilient roadway and thus maintenance would be moderate relative to the other two alternates. The likelihood of future roadway closures which could affect recreational resources, the public, and businesses would be moderate, relative to Alternatives 1 and 3.	<u>Recreational Resources/ Socioeconomics/Other Resources</u> • Pro: Level of improvements are expected to result in the lowest construction duration and thus lower potential for impacting recreational resources, the public, and businesses, relative to the other alternatives. • Con: Alternative expected to result in the lowest resilient roadway and thus maintenance would be highest. The likelihood of future roadway closures which could affect recreational resources, the public, and businesses would be highest, relative to Alternatives 1 and 2.	<u>Recreational Resources/ Socioeconomics/Other Resources</u> • Pro: Level of improvements are expected to result in the lowest construction duration and thus lower potential for impacting recreational resources, the public, and businesses, relative to the other alternatives. • Con: Alternative expected to result in the lowest resilient roadway and thus maintenance would be highest. The likelihood of future roadway closures which could affect recreational resources, the public, and businesses would be highest, relative to the other alternatives.	<u>Recreational Resources/ Socioeconomics/ Other Resources</u> • Con: Moderate level of improvements are expected to result in a moderately long construction duration and thus a moderate potential for impacting recreational resources, the public, and businesses, relative to the other alternatives. • Pro: Alternative is expected to result in a moderately resilient roadway and thus maintenance would be moderate relative to the other two alternates. The likelihood of future roadway closures which could affect recreational resources, the public, and businesses would be moderate, relative to the other alternatives.
	<u>Air Quality</u> • Con: Paved and widened roadway could result in increased traffic volumes which could adversely affect air quality.	<u>Air Quality</u> • Con: Aggregate-base-surfaced roadway could result in increased traffic volumes which could adversely affect air quality.	<u>Air Quality</u> • Con: Gravel roadway would result in higher levels of airborne dust from traveling vehicles (greater than Alternatives 1 and 2).	<u>Air Quality</u> Con: Gravel roadway would result in higher levels of airborne dust from traveling vehicles (greater than Alternatives 1 and 2).	<u>Air Quality</u> • Con: Fog coat and chip sealed surfaced roadway could result in increased traffic volumes relative to a gravel surface, which could adversely affect air quality.

Criterion	Alternative 1 Higher Resilience/Lower Risk of Future Closures	Alternative 2 Medium Resilience/Medium Risk of Future Closures	Alternative 3 Lower Resilience/Higher Risk of Future Closures	Alternative 3A Re-Open SR 88/No Resilience Improvements	Recommended Alternative
	• Pro: Paved roadway would result in reduced airborne dust compared to a gravel or AB surface which would improve air quality.	• Pro: AB roadway would result in moderate airborne dust (greater than Alternative 1, but less than Alternative 3).			• Pro: Fog coat and chip sealed surfaced roadway would result in reduced airborne dust compared to a gravel surface.
Potential Impacts to Scenery or Visual Qualities	• Expected to result in the greatest level of scenic change. Consideration for additional mitigation to reduce scenery impacts: ○ Paint new barrier to blend with surroundings ○ Consider impacts of barrier on drivers' views ○ Where new guardrail, use weathered guardrail or Natina ○ Consider impact of new signs ○ Minimize cut slope inclinations to reduce visual impact	• Expected to result in a moderate scenic change relative to Alternatives 1 and 3. Consideration for additional mitigation to reduce scenery impacts: ○ Paint new barrier to blend with surroundings ○ Consider impacts of barrier on drivers' views ○ Consider impacts of new signs ○ Minimize cut slope inclinations to reduce visual impact	• Expected to result in the lowest scenic change relative to Alternatives 1 and 2. Consideration for additional mitigation to reduce scenery impacts: ○ Paint new barrier to blend with surroundings ○ Consider impacts of barrier on drivers' views ○ Consider impact of new signs	• Expected to result in the lowest scenic change relative to the other alternatives.	• Expected to result in low level of scenic change relative to the other alternatives (similar to Alternative 3). Consideration for additional mitigation to reduce scenery impacts: ○ Paint new barrier to blend with surroundings ○ Consider impacts of barrier on drivers' views ○ Consider impact of new signs
Estimated Construction Costs (PRELIMINARY, 2023 Dollars)	$102 million (highest)	$54.7 million (medium)	$7.4 million (medium-low)	$3.7 million (low)	$33.7 million (medium)
Easement Impacts	• New easement (all from TNF): Relatively high acreage	• New easement (from TNF): Medium acreage	• New easement (from TNF): Low acreage	• New easement (from TNF): Low acreage	• New easement (from TNF): Medium acreage
Agency Acceptance and Public Input	• To be determined	• To be determined	• To be determined	• To be determined	• To be determined

3.4 Recommendations

3.4.1 Introduction

Design concepts were developed to re-open SR 88 to traffic and improve resiliency against future storms.

Public agencies that have been involved in the alternatives development and evaluation process include ADOT, TNF, and FHWA.

3.4.2 Recommendations

The study team identified a Recommended Alternative that is a hybrid of the three main Build Alternatives and was presented to the public and stakeholders in August 2023 as ADOT's Preferred Hybrid Alternative. It would provide the following benefits:

- The roadway would be widened to a minimum of 15 feet on Fish Creek Hill
- The roadway would receive a chip seal surface.
- New colored (or painted) concrete barrier would replace existing guardrail on Fish Creek Hill.
- The existing bridges would be repaired and rehabilitated to extend their service lives.
- Several retaining walls would be constructed to avoid impacts to the wilderness area.
- The drainage facilities would be upsized and increased to accommodate medium-large predicted storms.
- Safety improvements would include new signs, reflectors, and pullouts to allow vehicles to pass in narrow sections.
- Some rockfall improvements would be made.
- The potential for environmental impacts is moderate based on the size of the disturbance area and potential for work outside the ADOT easement on Tonto National Forest Lands.

4.0 Major Design Features of the Recommended Alternative

4.1 Introduction

This chapter will explore the major design features associated with the Recommended Alternative. The Recommended Alternative is detailed on the roll plot in Appendix A.

4.2 Design Controls

SR 88 is classified as a Rural Major Collector. The improvements will match existing horizontal and vertical geometry. The proposed typical section will match existing widths through most of the project length; however, a minimum of 15 feet will be provided on the narrower Fish Creek Hill. A summary of the design criteria is provided in Table 18.

Table 18 – Design Controls for SR 88

DESCRIPTION OF CRITERION	VALUE FOR DESIGN
Design Year:	2050
Design Speed (Existing):	None
Design Vehicle:	Passenger vehicle + Boat
Normal Cross Slope:	Varies
Superelevation:	None
Lane Width:	N/A
Shoulder Width:	None
Maximum Horizontal Curve	Match existing
Maximum Gradient:	Match existing
Slope Standards Standard Cut slope Rock Cut Slope Fill slopes	 2:1 0.75:1 2:1
Clear Zone Width:	N/A
Minimum Vertical Clearance:	N/A

4.3 Roadway Design Elements

4.3.1 Horizontal Alignment

The SR 88 roadway improvements will not modify the existing horizontal alignment.

4.3.2 Vertical Alignment

The SR 88 improvements will match the existing roadway profile.

4.3.3 Lane Widths

SR 88 will be widened to a minimum 15-foot width on Fish Creek Hill. Other sections of the roadway east of Fish Creek Hill are typically wider.

4.3.4 Shoulder Widths

No new shoulders will be provided.

4.3.5 Pullouts

Existing pullout areas will be restored at MP 222.62 (Sta. 910+00), MP 222.84 (Sta. 921+00), MP 223.64 (Sta. 965+00), MP 223.82 (Sta. 975+00), MP 223.96 (Sta. 983+00), MP 224.87 (Sta. 1026+00), MP 224.91 (Sta. 1028+00), MP 225.57 (Sta. 1063+00), MP 225.94 (Sta. 1083+00), MP 227.22 (Sta. 1149+00), MP 227.60 (Sta. 1178+00), MP 227.94 (Sta. 1187+00), and MP 228.63 (Sta. 1223+00).

Three new pullouts are proposed (MP 227.00 (Sta. 1137+00), MP 228.21 (Sta 1201+00), and MP 228.68, (Sta. 1225+00)), and others may be added during final design. The following criteria will be used for a minimum turnout and pullout area:

- Minimum width = 8', desirable width = 10'
- Minimum length = 40', maximum length = 80'
- Entrance/exit tapers = 5:1
- Match existing roadway cross slope

4.4 Access Control

No changes to access-control are planned.

4.5 Right-of-Way

No new easement area is needed for the Recommended Alternative. However, ADOT's Southeast District and TNF have recognized the need to identify permanent easements to allow ADOT to access pipes and concrete box culverts for maintenance. The easement area would be the same for all alternatives. Approximately one acre of new easement is required for maintenance of drainage facilities.

Temporary construction easements may be required based on retaining wall type selected during Final Design.

4.6 Structures

4.6.1 Fish Creek Bridge

The Recommended Alternative for Fish Creek Bridge will balance historic preservation with repairs and rehabilitations of observed deficiencies to increase the useful service life of the existing structure. The

concrete deck will be replaced with modern materials and a thinner deck section. Careful detailing of the deck will allow an increase to live load capacity and reduction of risk associated with fracture critical members. Approach slabs and approach object markers to protect truss portal members will be installed. Outstanding deficiencies reported in inspection records will be addressed.

4.6.2 Lewis Pranty Creek Bridge

Similar to Fish Creek Bridge, the Lewis Pranty Creek Bridge deck will be replaced, approaches improved, and minor deficiencies repaired. As previously mentioned, the Lewis Pranty Creek Bridge could be overtopped by existing 25-year flows and will be overtopped by predicted 2030 and 2050 25-year flows. For the Recommended Alternative, Lewis Pranty Creek Bridge will be raised, at minimum, to pass the predicted 2030 future storms. The ideal time to raise the bridge is while the bridge is closed and the weight of the old deck has been removed.

4.6.3 Dry Wash Bridge

Dry Wash Bridge will have the concrete deck replaced to increase live load capacity and extend the service life of the structure. Approach slabs will be installed and minor corrosion, coating deficiencies, bent, damaged or missing components will be repaired.

4.6.4 Bridge Foundations

From a geotechnical standpoint, none of the bridge foundations appeared to be damaged from recent flooding. However, the support conditions for the Lewis Pranty Creek Bridge and the bridge at MP 225.5 would be in question at the abutments where not supported on rock. Should replacement of these bridges be deemed necessary, test drilling would need to be performed to ascertain the foundation conditions.

4.6.5 Retaining Walls

Existing retaining walls are not expected to be affected by the new construction. The condition and adequacy of existing retaining walls should be evaluated during final design.

Five new walls will be constructed as needed to prevent encroachment of the construction into the Superstition Wilderness.

4.7 Guardrail / Barrier

New 32-inch cast-in-place concrete barrier will be added on the Fish Creek Hill segment. The barrier will be painted or stained, with the color to be determined with input from TNF.

ADOT Maintenance requested that sections of pinned concrete removable barrier be included every 0.25 to 0.5 mile in the area of Fish Creek Hill. The barrier sections would be un-pinned and temporarily removed while ADOT Maintenance removes rocks from the roadway. Precise locations of pinned concrete removable barrier should be coordinated with ADOT Maintenance during final design.

4.8 Drainage Considerations

Culverts and drainage inlets/outlets will be upsized to account for projected 2030 25-year flows. A total of 29 existing structures were analyzed. This included 3 bridges, 10 reinforced concrete box culverts, and 16 CMP/ reinforced concrete pipe (RCP) culverts. Of the 29 culverts analyzed, 13 would need to be upsized from their current size.

Table 19 - Proposed 2030 Culvert Changes

Culvert Station	Existing Size	Proposed Size	Culvert Station	Existing Size	Proposed Size
948+75	4’ x 7’ RCBC	Add 36” CMP	1110+64	48” CMP	2-48” CMP
957+36	4’ x 7’ RCBC	Add 24” CMP	1125+60	48” CMP	8’ x 6’ RCBC
960+85	6’ x 8’ RCBC	Add 24” CMP	1139+64	5’ x 5’ RCBC	Add 24” CMP
1021+67	18” CMP	1-48” CMP	1157+86	36” CMP	4-36” CMP
1034+06	36” CMP	2-6’ x 5’ RCBC	1187+95	48” CMP	3-48” CMP
1094+34	6’ x 5’ RCBC	Add 2-48” CMP	1188+63	36” CMP	4-48” CMP
1106+66	18” CMP	3-42” CMP			

Drainage headwalls and culverts would be extended in areas where the roadway is widened. Erosion protection will need to be included downstream. Existing sediment and debris will be removed from currently clogged culverts and at the culvert inlets.

Roadside ditches will be cleaned out and reestablished in critical areas. These areas include along Fish Creek Hill as well as a section east of Dry Wash Bridge.

During final design, drainage easements will need to be reviewed for compliance with the 100-year event for the chosen 25-year design event.

Additional studies related to offsite drainage improvements may be conducted during final design. The purpose of these studies is to identify methods of reducing the volume and velocity of storm flows approaching SR 88 and reducing sediment transport.

4.9 Floodplain Considerations

There are no Federal Emergency Management Agency (FEMA) designated Special Flood Hazard Areas (SFHA) located within the project limits. The area is classified as Zone D which is:

> “Area of Undetermined Flood Zone”

Coordination with the Federal Emergency Management Agency (FEMA) for floodplain mitigation will not be needed.

4.10 Earthwork

Earthwork quantities in the cost estimates are approximate and should be verified during final design.

4.10.1 Excavation

Roadway excavation for this project is mainly for widening the existing SR 88 roadway to provide a 15-foot-wide roadway (Recommended Alternative) and constructing roadside ditches for drainage and erosion control.

4.10.2 Embankment

Roadway embankment for this project is primarily for widening the existing SR 88 roadway to provide a minimum 15-foot-wide roadway (Recommended Alternative).

4.11 Construction Phasing and Traffic Control

Since most of the project length is closed to traffic, phasing and traffic control will not be an issue. However, where SR 88 is open to traffic from MP 227.2 to MP 229, traffic control will likely be required.

Final construction sequencing/phasing will be determined during final design. Traffic will be managed using detailed traffic control plans and by procedures and guidelines specified in the 2009 Edition of the Manual on Uniform Traffic Control Devices (MUTCD), Revisions 1 and 2, and by the Arizona Supplement to the 2009 Edition of the MUTCD. Traffic control shall be specified by a traffic control plan or procedures and guidelines in the ADOT Traffic Control Design Guidelines.

4.12 Signing and Pavement Marking

Recommended signing improvements include the following:

- Install new signs to warn drivers of two-way traffic and narrow roadway ahead.
- Install speed limit signs throughout the corridor.
- Install object markers at the bridge approaches and drainage structures.
- Install “yield to oncoming” traffic signs on the one lane bridge approaches.
- Install advance curve warning and chevron signs in the corridor.

No pavement marking is anticipated for the Recommended Alternative because the roadway section will vary in width. Numerous segments of the project length are less than 20 feet in width, i.e., not wide enough for two full lanes.

4.13 Utilities

Utility companies with facilities in the vicinity were contacted and their facility maps were requested. The information provided is shown on the roll plots in Appendix A.

4.13.1 Preliminary Utility Conflicts and Proposed Relocations

Based on record drawings and utility plans supplied by utility companies, minor utility conflicts with SRP, TDS Telecom, and ADOT facilities may be anticipated. Utility relocations or adjustments may be necessary. Prior rights information has not been researched.

During final design, each city and utility company will receive and review the preliminary design plans for this project. Utility conflicts will be resolved with cooperation from the affected companies. Construction plans for the relocations and/or adjustments to the utilities will be developed by the responsible parties.

4.14 Preliminary Geotechnical Recommendations

4.14.1 Pavement Structural Section

The pavement section for the project will be a double chip seal on aggregate base. Additional recommendations include a prime coat applied to the base prior to placement of chip seal and a fog seal applied to the final pavement surface. The pavement section was selected by ADOT to match the SR 88 project to the east (MP 229 to Roosevelt Dam).

The pavement recommendations may be further evaluated in final design.

4.14.2 Cut and Fill Slope Recommendations

Roadway widening with the Recommended Alternative considered the need to excavate into existing slopes or to widen to the fill side with fills or retaining walls. Rock slope stability has been considered with the knowledge that safety improvements could include slope flattening as appropriate, rock bolting, and draped mesh, in combination with improved drainage measures. Table 20 provides preliminary recommended minimum cut slopes based on project mileposts and roadway stationing.

The potential for slope improvements shown in Table 20 is based on observation of the existing geologic conditions, which dictate the viability of either changing the existing slope ratios and/or shifting the existing slopes back into the hillsides to create more roadway width. Typically, blasting or other means of breaking sound rock would be required where intact, competent volcanics or sedimentary rock exists. In general, these slopes can be maintained relatively steep (no more than ½H:1V). Rock bolting should be considered as an allowance to address securing rocks with unfavorable jointing which becomes exposed within the face of newly exposed cut surfaces.

Highly fractured rock and colluvium, where present, can be maintained relatively steep though some flattening (up to 1H:1V) with scaling might be preferred to lessen future maintenance. Similarly, rockfall debris slopes could be flattened from 1/2H:1V to 1H:1V for similar reasons. Rockfall mesh can be considered, particularly if steeper slopes are preferred. If mesh is used, it should blend with the surrounding environment.

Table 20 – Preliminary Slope Recommendations

Milepost	Distance (mile)	Material	Preliminary Recommended Slope (H:V)
222.00-222.40	0.40	Sedimentary rock - horizontal bedding	¼:1
222.40-222.53	0.13	Moderate to widely fractured volcanic rock	½:1
222.60-222.92	0.32	Widely to closely fractured volcanic rock	½:1
222.92-223.00	0.08	Widely to closely fractured volcanic rock	1:1
223.00-223.06	0.06	Moderate to widely fractured volcanic rock	½:1
223.06-223.09	0.03	Tuff – varied volcanics overlain by rock debris	¾:1
223.09-223.15	0.06	Widely to massive fractured volcanics (competent tuff)	¼:1
223.15-223.27	0.12	Colluvium and rockfall debris	1:1
223.27-23.36	0.09	Widely to closely fractured volcanic rock	¼:1
223.36-223.38	0.02	Colluvium and rockfall debris	1:1
223.38-223.40	0.01	Medium to thickly bedded sedimentary rock	¼:1

Milepost	Distance (mile)	Material	Preliminary Recommended Slope (H:V)
223.40-223.44	0.04	Colluvium and rockfall debris	1:1
223.44-223.49	0.05	Medium to thickly bedded sedimentary rock	¼:1
223.49-223.61	0.12	Colluvium and rockfall debris	1:1
223.61-223.63	0.02	Medium to thickly bedded sedimentary rock	¼:1
223.63-224.20	0.57	Highly fractured volcanics and rockfall debris	¾:1
224.20-225.00	0.80	Highly fractured volcanics and some colluvium	1:1
225.00-226.00	1.00	Highly fractured volcanics and colluvium	½:1 (volcanics) 1:1 (colluvium)
226.00-227.00	1.00	Volcanics and granite rock (generally small cuts)	¾:1
227.00-229.00	2.00	Mainly old alluvium	1:1

4.15 Funding / Agreements

Interagency agreements may be required. Acquisition of new right-of-way or easement from the USFS will likely affect the level of environmental investigation and documentation.

4.16 Schedule

Final design, easement/right-of-way acquisition, utility relocation (if required), and construction are not programmed.

5.0 Itemized Estimate of Probable Costs

5.1 Recommended Alternative

The probable cost of the Recommended Alternative is estimated at $33.7 million. The estimated costs are based upon unit prices from ADOT's Construction Cost Data Base. In addition, cost data from adjacent and similar construction projects was used for comparison purposes. The detailed estimate of probable costs for the Recommended Alternative is shown on the following page.

The following assumptions were used for the cost estimate:

Right-of-Way

New right-of-way acquisition or easement is estimated at $1 per acre.

The easement quantity includes new easements for maintenance access at pipes and box culverts. The easement sizes were based on dimensions of 20 feet from the pipe ends and 50 feet each side for pipes and 50 feet from each box culvert end and 100 feet each side for box culverts in order to maneuver and park equipment to clean and maintain the culverts.

Structures

- Bridge costs do not include substructure costs. Unit prices have been adjusted to account for the remote location, access limitations, and constructability restrictions.
- Retaining wall costs are based on cast-in-place concrete cantilever retaining walls.

Drainage:

- Riprap quantities are estimated based on total number of structures being changed.
- Some box culvert quantities are based on estimated concrete and rebar because of nonstandard box culvert sizes.
- Smaller culverts were not analyzed hydraulically and will need to be reviewed in final design.
- Box culvert costs do not include earthwork. Unit prices were adjusted accordingly.
- Additional studies related to offsite drainage improvements may be conducted during final design. The purpose of these studies is to identify methods of reducing the volume and velocity of storm flows approaching SR 88 and reducing sediment transport. Offsite improvements are not included in the current estimate.

Traffic:

Traffic- and safety-related quantities for the Recommended Alternative include new signs to warn drivers of two-way traffic and narrow roadway ahead, speed limit signs, object markers, flexible delineators, 'yield to oncoming' traffic signs at bridge approaches, and advance curve warning signs and chevrons.

The costs of the new pullouts are reflected in the earthwork and paving quantities.

Utility Mitigation / Protection:

The need for utility relocations or mitigation is not known at this time.

Environmental Studies / Mitigation:

The cost estimate includes line items for environmental studies and for environmental mitigation, the extent of which are unknown.

Cost Inflation:

The construction cost estimates are presented in 2023 dollars. Because of recent increases in construction costs, the estimated costs for the Recommended Alternative, inflated at 4% per year, are presented in the table below:

Current Year	Increase Cost Per Year with 4% Inflation		
2023	2024	2025	2026
$33,700,000	$35,050,000	$36,450,000	$37,910,000

Table 21 – Estimate of Probable Construction Cost – SR 88 Recommended Alternative

Item No.		Item Description	Unit	Quantity	Unit Price	Total Price
2020071		REMOVE GUARD RAIL	L.FT.	4,916	$ 5.00	$ 24,580
2030301		ROADWAY EXCAVATION	CU.YD.	170	$ 15.00	$ 2,550
2030302		ROCK EXCAVATION (BOULDER REMOVAL)	CU.YD.	900	$ 200.00	$ 180,000
2030305		ROCK EXCAVATION	CU.YD.	18,760	$ 200.00	$ 3,752,000
2031031		GRADER ROAD	SQ.YD.		$ 11.00	$ -
3030022		AGGREGATE BASE, CLASS 2	CU.YD.	8,486	$ 60.00	$ 509,160
3030102		AGGREGATE BASE (LIME TREATED BASE) (1%)	CU.YD.		$ 61.00	$ -
4040111		BITUMINOUS TACK COAT	TON		$ 600.00	$ -
4040116		APPLY BITUMINOUS TACK COAT	HOUR		$ 200.00	$ -
4040125		FOG COAT	TON	33	$ 2,500.00	$ 82,500
4040159		COVER MATERIAL	SQ.YD.	76,371	$ 4.00	$ 305,484
4040165		BLOTTER MATERIAL	SQ.YD.	76,371	$ 0.50	$ 38,186
4040282		ASPHALT BINDER (PG 76-16)	TON		$ 800.00	$ -
4040286		ASPHALT BINDER (PG 64-28 TR+)	TON	157	$ 1,200.00	$ 188,400
4160004		ASPHALTIC CONCRETE (3/4" MIX) (END PRODUCT) (SPECIAL MIX)	TON		$ 60.00	$ -
4160031		MINERAL ADMIXTURE	TON		$ 90.00	$ -
5010007		PIPE, CORRUGATED METAL, 18"	L.FT.	4	$ 150.00	$ 600
5010011		PIPE, CORRUGATED METAL, 24"	L.FT.	141	$ 200.00	$ 28,200
5010017		PIPE, CORRUGATED METAL, 30"	L.FT.	8	$ 210.00	$ 1,680
5010025		PIPE, CORRUGATED METAL, 36"	L.FT.	250	$ 280.00	$ 70,000
5010030		PIPE, CORRUGATED METAL, 42"	L.FT.	85	$ 320.00	$ 27,200
5010035		PIPE, CORRUGATED METAL, 48"	L.FT.	405	$ 340.00	$ 137,700
5010045		PIPE, CORRUGATED METAL, 60"	L.FT.	-	$ 420.00	$ -
5010055		PIPE, CORRUGATED METAL, 72"	L.FT.	-	$ 460.00	$ -
5030183		DROP INLET (PIPES 48" AND LESS)	EACH	3	$ 7,500.00	$ 22,500
5030184		DROP INLET (PIPES 60" AND GREATER)	EACH	-	$ 22,000.00	$ -
6016089		HEADWALL (FOR PIPES)	EACH	40	$ 5,000.00	$ 200,000
608X001		SIGNAGE	L. SUM	1	$ 317,000.00	$ 317,000
7041501		PAVEMENT MARKING	L. SUM	1	$ -	$ -
9050005		GUARD RAIL, W-BEAM, SINGLE FACE (MASH)	L.FT.	-	$ 50.00	$ -
9100001		CONCRETE BARRIER (C-10.50) (PAINTED)	L.FT.	5,338	$ 100.00	$ 533,800
9100007		CONCRETE HALF BARRIER TRANSITION (20-FT)	EACH	4	$ 20,000.00	$ 80,000
9130001		RIPRAP DUMPED	CU.YD.	900	$ 105.00	$ 94,500
9130030		RIPRAP (GABIONS) (NEW)	CU.YD.	400	$ 125.00	$ 50,000
9140153		RETAINING WALL (REINFORCED CONCRETE CANTILEVER)	SQ.FT.	3,290	$ 175.00	$ 575,750
9240078		MISCELLANEOUS WORK (EXISTING PIPE CLEANOUT)	L.SUM	1	$ 50,000.00	$ 50,000
9240079		MISCELLANEOUS WORK (EXISTING RCBC CLEANOUT)	L.SUM	1	$ 30,000.00	$ 30,000
9240111		MISCELLANEOUS WORK (ROCK BOLTS)	L.FT.	1,200	$ 750.00	$ 900,000
9240112		MISCELLANEOUS WORK (HIGH SLOPE ROCK BOLTS)	L.FT.	800	$ 5,000.00	$ 4,000,000
9240114		MISCELLANEOUS WORK (ROCK SCALER)	HOUR	2,500	$ 160.00	$ 400,000
9240117		MISCELLANEOUS WORK (DEBRIS FLOW BARRIER)	SQ.FT.	-	$ 125.00	$ -
9240118		MISCELLANEOUS WORK (ROCKFALL NETTING)	SQ.FT.	25,000	$ 60.00	$ 1,500,000
6018103	a	REINFORCED CONCRETE BOX CULVERT (4 X 7 EXTEND U/S 10' WITH WINGWALLS)	L. FT.	1	$ 26,630.00	$ 26,630
6018103	b	REINFORCED CONCRETE BOX CULVERT (4 X 7 EXTEND U/S 5' WITH WINGWALLS)	L.SUM	1	$ 21,420.00	$ 21,420
6018103	c	REINFORCED CONCRETE BOX CULVERT (NEW 2-6 X 5 X 28' WITH WINGWALL/APRON)	L. FT.	1	$ 93,270.00	$ 93,270
6018103	d	REINFORCED CONCRETE BOX CULVERT (6 X 7 EXTEND U/S 6' WITH WINGWALLS)	L. FT.	1	$ 26,400.00	$ 26,400
6018103	e	REINFORCED CONCRETE BOX CULVERT (6 X 8 EXTEND U/S 8' WITH WINGWALLS)	L. FT.	1	$ 31,080.00	$ 31,080
6018103	f	REINFORCED CONCRETE BOX CULVERT (NEW 8 X 5 X 28' WITH WINGWALLS/APRON)	L. FT.	-	$ 77,840.00	$ -
6018103	g	REINFORCED CONCRETE BOX CULVERT (NEW 8 X 5 X 28' WITH WINGWALLS/APRON)	L.SUM	-	$ 77,840.00	$ -
6018103	h	REINFORCED CONCRETE BOX CULVERT (10 X 6)	L. FT.	-	$ 24,720.00	$ -
6018103	i	REINFORCED CONCRETE BOX CULVERT (2-10 X 7 NEW 25' WITH WINGWALLS/APRON)	L. FT.	-	$ 121,250.00	$ -
6018103	j	REINFORCED CONCRETE BOX CULVERT (10 X 10)	L. FT.	-	$ 60,560.00	$ -
6018103	k	REINFORCED CONCRETE BOX CULVERT (12 X 6 EXTEND 4' U/S WITH WINGWALLS)	L. FT.	1	$ 26,880.00	$ 26,880
6018103	l	REINFORCED CONCRETE BOX CULVERT (12 X 8)	L. FT.	-	$ 159,600.00	$ -
6018103	m	REINFORCED CONCRETE BOX CULVERT (15 X 7)	L. FT.	-	$ 72,810.00	$ -
2020003	n	REMOVE BRIDGE (FISH CREEK) (NO. 0027)	L.SUM	-	$ 150,000.00	$ -
2020003	o	REMOVE BRIDGE (LEWIS AND PRANTY CREEK) (NO. 0028)	L.SUM	-	$ 110,000.00	$ -
2020003	p	REMOVE BRIDGE (DRY WASH) (NO. 0015)	L.SUM	-	$ 75,000.00	$ -
9240051	q	MISCELLANEOUS WORK (NEW/REPAIR BRIDGE AT FISH CREEK) NO. 0027)	L.SUM	1	$ 250,000.00	$ 250,000
9240051	r	MISCELLANEOUS WORK (NEW/REPAIR BRIDGE AT LEWIS AND PRANTY CREEK) (NO. 28)	L.SUM	1	$ 200,000.00	$ 200,000
9240051	s	MISCELLANEOUS WORK (NEW/REPAIR BRIDGE AT DRY WASH) (NO. 0015)	L.SUM	1	$ 185,000.00	$ 185,000
					SUBTOTAL	$ 14,962,470

MISCELLANEOUS WORK (20%)		COST	20.00%	$	2,992,500
Subtotal 1				**$**	**17,954,970**
FURNISH WATER (1%)		COST	1.00%	$	179,600
MAINTENANCE AND PROTECTION OF TRAFFIC (6%)		COST	6.00%	$	1,077,300
EROSION CONTROL AND POLLUTION PREVENTION (4%)		COST	4.00%	$	718,200
CONTRACTOR QUALITY CONTROL (2%)		COST	2.00%	$	359,100
CONSTRUCTION SURVEYING AND LAYOUT (2%)		COST	2.00%	$	359,100
Subtotal 2				**$**	**20,648,270**
MOBILIZATION (10%)		COST	10.00%	$	2,064,900
Subtotal 3				**$**	**22,713,170**
CONTINGENCIES			5.00%	$	1,135,700
CONSTRUCTION ENGINEERING			15.00%	$	3,407,000
PUBLIC RELATIONS	20,000		1	$	20,000
Subtotal 4				**$**	**27,275,870**
FINAL DESIGN COSTS (10%)		COST	10.00%	$	2,727,600
ENVIRONMENTAL STUDIES (NEPA)		L. SUM	$ 200,000.00	$	200,000
ENVIRONMENTAL MITIGATION (ESTIMATED)		L. SUM	$ 200,000.00	$	200,000
RIGHT OF WAY	2.00	ACRE	$ 1	$	2
Subtotal 5				**$**	**30,403,472**
INDIRECT COST ALLOCATION (10.7% FY24)			10.70%	$	3,253,200
			TOTAL PROJECT COST:	**$**	**33,700,000**

APPENDICES

Appendix A

Recommended Alternative

Roadway and Drainage Roll Plot

Appendix B

Environmental Overview

Appendix C

Geotechnical Letter Report

Appendix D

Resiliency/Vulnerability Assessment Report