CENTRAL ARIZONA GOVERNMENTS

STRATEGIC TRANSPORTATION SAFETY PLAN

SAFETY REVIEW MEMORANDUM

September 15, 2016

ENGINEERING ENFORCEMENT EDUCATION EMERGENCY RESPONSE

PREPARED FOR

CAG

PREPARED BY

CAMBRIDGE SYSTEMATICS

WITH

WILSON & COMPANY

GORDLEY GROUP

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Introduction

Using a network screening process earlier in the study, an analysis of intersections, segments, and bicycle and pedestrians was completed to identify an expansive list of sites in the Central Arizona Governments (CAG) planning area with the potential for safety improvements. This list was narrowed to ten using a site prioritization process (see *Technical Memorandum: Intersection and Segment Priorities* for further information) and input from the multidisciplinary safety committee (MDSC). **Figure 1** shows the locations of all the sites chosen for field review. The intersections and segments evaluated are as follows:

- Intersections:
  - US-60 at Radanovich at Globe Food Mart in Globe, AZ,
  - State Route 87 / Beeline Highway and State Route 260 / Longhorn Road in Payson, AZ,
  - State Route 260 and Manazita / Granite Dells Road in Payson, AZ,
  - SR 260 and Valley Road at Highline Drive near Payson, AZ,
  - Broad Street and Oak Street in Globe, AZ,
  - State Route 87 and Bonita in Payson, AZ.
- Segments:
  - SR 87 from Gila / Maricopa County Boundary to Indian Road / Green Valley Parkway,
  - SR 77 from Gila / Pinal County Boundary to US-70,
  - SR 79 from SR 77 to Deep Well Ranch Road,
  - US-60 from Gila / Pinal County Boundary to Globe Urban.

For each of the locations, information in the memorandum includes:

- Site characteristics – description of physical transportation attributes at the site,
- Crash characteristics – description of crash severity, first harmful event, and collision manner,
- Low, Moderate, High Cost recommendations – a listing of possible countermeasures to be implemented at each site,
- Appendices - separate documentation which includes the crash map, crash diagram, and further details on the crash characteristics for each site.

The recommendations for each site will be further refined using a benefit-cost analysis. Eventually, the results from this memorandum can be used to complete applications for highway safety improvement program (HSIP) funding.

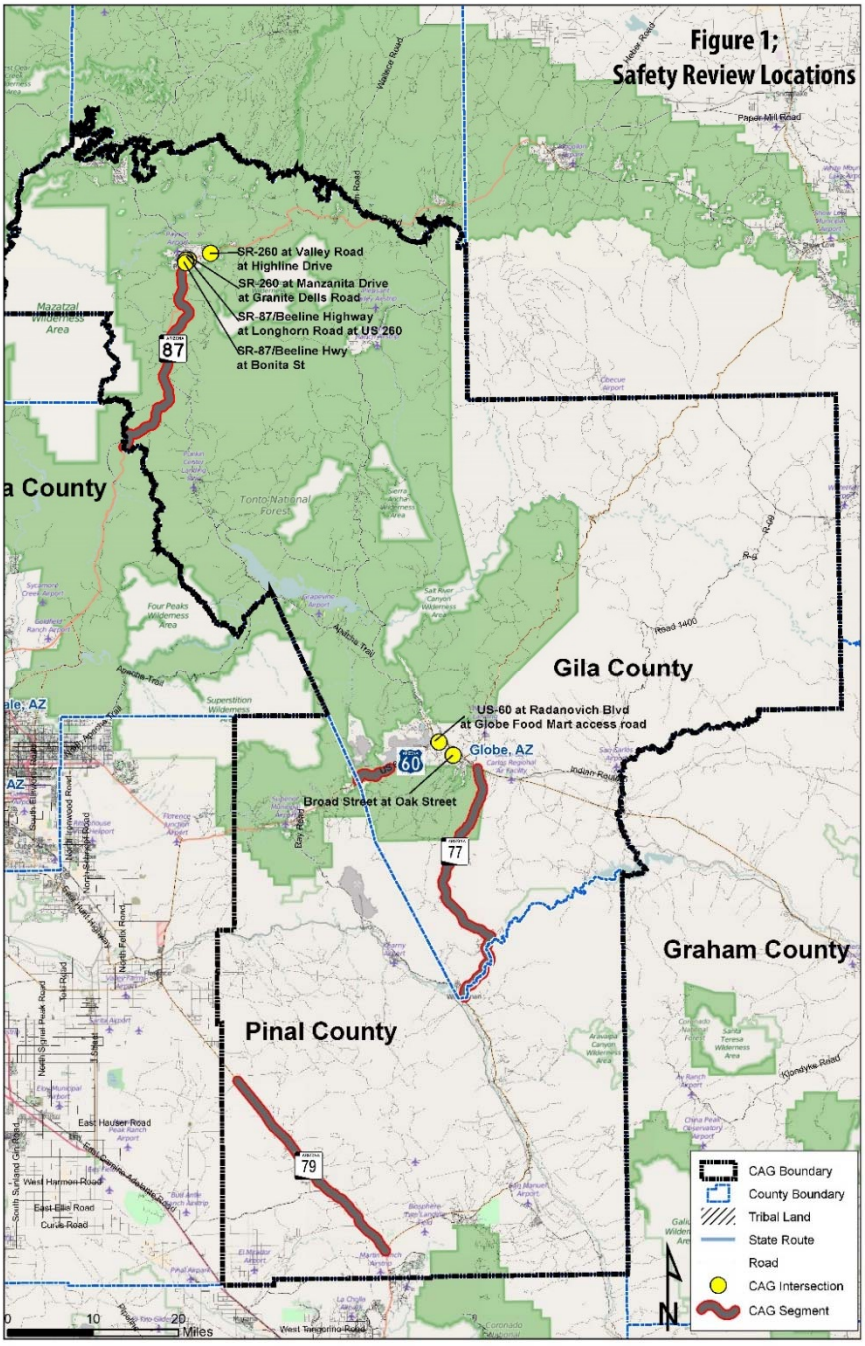

Figure 1: Safety Review Locations

Intersection 1: US-60 at Radanovich at Globe Food Mart

Located in Globe, AZ the intersection of US-60 / Radanovich at Globe Food Mart is ranked first according to the intersection network screening. **Appendix A** contains all supporting documentation for this intersection including a crash map, **Figure A-1;** a crash diagram, **Figure A-2;** and the physical characteristics of the intersection, **Figure A-3.**

Figure 2: US 60 & Radanovich Location Map

Intersection Characteristics

The northern leg of the intersection provides access directly into the Globe Food Mart area, which includes a grocery store, a bank, and a gas station. The southern leg, Radanovich Boulevard, leads to a housing area with a speed limit of 20 mph. The mainline, running east to west, has two thru lanes and a left-turn lane in each direction. The left turn movement is a permissive left and there is no separate left turn phase. A westbound right turn lane, only providing access to adjacent land uses, begins on the west side of the intersection. There is video-detection

for the traffic signal at all four approaches to the intersection. Overhead lighting is present on all legs of the intersection and the signal heads all have backplates.

Existing pedestrian facilities include crosswalks, non-directional ramps, pedestrian countdown heads, and pedestrian buttons. Only the sidewalks on the south side and northwest quadrant provide connectivity. The traffic makeup at the intersection consists primarily of passenger vehicles with some commercial vehicles. There were pedestrians present, but no bicyclists were seen.

Crash Characteristics

Of the 27 total crashes, one was fatal and two were serious injuries. **Table 1.1** shows crash severity at the intersection. Crashes at this intersection occur primarily during daylight hours, but approximately 15% were during dusk and 15% during dark lighted conditions. Three crashes occurred during sleet/hail/ snow conditions. **Table 1.2** shows the breakdown by first harmful event. The most common was motor vehicle in transport but it should be noted that the fatality was a pedestrian. The most common collision manner, shown in **Table 1.3**, is rear-end, consistent with what is expected at an intersection.

Table 1.1: Crashes By Severity	
Fatal	1
Serious Injury	2
Minor Injury	5
Property Damage Only (PDO)	19
Total	**27**

Table 1.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Motor Vehicle in Transport	0	2	5	18	**25**
Pedestrian	1	0	0	0	**1**
Curb	0	0	0	1	**1**
Total	**1**	**2**	**5**	**18**	**27**

Table 1.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	0	0	0	1	**1**
Angle	0	0	0	6	**6**
Left Turn	0	0	2	1	**3**
Rear End	0	2	2	8	**12**
Sideswipe (Same Direction)	0	0	0	3	**3**
Other	1	0	1	0	**2**
Total	**1**	**2**	**5**	**19**	**27**

Recommendations

Recommendations are presented in two categories: low cost / quick implementation and moderate cost / moderate implementation.

Low Cost Solutions

1. **Re-Stripe Intersection** – The intersection has striping but it's fading and needs to be restriped. Stop bars and crosswalks were faded most significantly.
2. **Add Reflective Tape to Backplates** – Adding reflective tape around the outside of the signal heads on the backplate will help the signals be seen more clearly. This should help with visibility during dusk and dark conditions.
3. **Initiate a Pedestrian Lead Time** – This allows the pedestrian to advance into the intersection, where vehicles can see the pedestrian better.

Figure 3: Faded Striping & View of Signal Heads

4. **Install Flashing Yellow Arrow** – It has been shown that the Flashing Yellow Arrow, for permissive left hand turns, is easier to understand for drivers. This should be implemented and will help reduce left turn and angle crashes.
5. **Protected Left Turn Phasing** – Protected left turn phasing for the current permissive lefts would eliminate conflicts with through traffic.

6. **Add Detectable Warnings** – Detectable warnings were not present at any of the ramps. These will help pedestrians with disabilities better evaluate the edge of the roadway.
7. **Asphalt Next to Gutter Lip** –On the southeast corner, a mass of asphalt is causing a trip hazard. Removing this will eliminate the trip hazard for the pedestrian.
8. **Sidewalk Repair & Extension** – The sidewalk on the northeast corner, entering the grocery store, is crumbling and also ends at the end of the curb return. Fixing this will allow pedestrians to use the sidewalk.

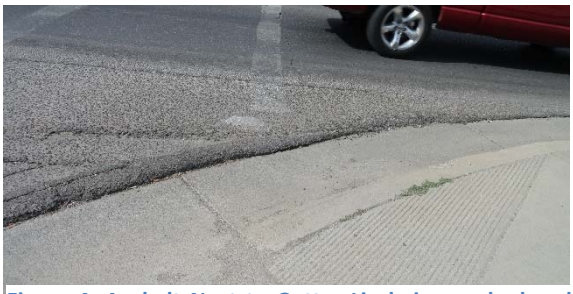

Figure 4: Asphalt Next to Gutter Lip being pushed and causing a trip hazard.

Moderate Cost Solutions

9. **Update Pedestrian Push Buttons** – The pedestrian push buttons are dated, according to design standards. Adding audio to the push button will keep pedestrians safe at the intersection.
10. **Install Directional Pedestrian Ramps** – Installing pedestrian ramps will help pedestrians with disabilities navigate the intersection. It will also allow drivers to see which direction the pedestrian intends to travel.
11. **Install Pedestrian Lighting** – Pedestrian lighting increases the visibility of pedestrians.

Figure 5: Sidewalk deterioration and ending looking towards Globe Food Mart.

Treatment #	Total Cost	B/C	CMF	Notes
1. Restripe Intersection	$14,940.00	N/A	N/A	Standard
2. Add Reflective Tape to Backplates	$1,725.00	143.6	0.97	N/A
3. Initiate a pedestrian lead time	$100.00	3895.2	0.63	N/A
4. Install Flashing Yellow Arrow	$4,000.00	0	0.89	B/C is 0 as there are no fatal/serious injury crashes related but it was included as there were PDO crashes that could be mitigated by this countermeasure.
5. Protected Left Turn Phasing	$4,000.00	0	0.94	B/C is 0 as there are no fatal/serious injury crashes related but it was included as there were PDO crashes that could be mitigated by this countermeasure.
6. Add Detectable Warnings	Included in Ramps	N/A	N/A	ADA, included in price of ramps.
7. Remove Trip hazard-Asphalt next to gutter lip	$80.00	N/A	N/A	ADA
8. Sidewalk Repair and Extension	$2,831.42	N/A	N/A	ADA
9. Update Pedestrian Push Buttons	$8,320.00	N/A	N/A	ADA
10. Install Directional Pedestrian Ramps	$2,500.00	N/A	N/A	ADA
11. Install Pedestrian Lighting	$55,580.00	118.7	0.41	N/A
Recommendation: 1,2,3, 8, 9, 10*	$27,585.00	176.4	0.61	N/A

*Calculated combined CMF using treatments 2 & 3

Intersection 2: State Route 87 / Beeline Highway & State Route 260 / Longhorn Road

Located in Payson, AZ the intersection of State Route 87 / Beeline Highway and State Route 260 / Longhorn Road is a signalized intersection in an urban area. The intersection is ranked second overall from the intersection network screen process. **Appendix B** contains all supporting documentation for this intersection including a crash map, **Figure B-1;** a crash diagram, **Figure B-2;** and the physical characteristics of the intersection, Figure B-3.

Figure 6: SR 87 & SR 260 Location Map

Intersection Characteristics

The intersection has a lot of vehicle traffic and is surrounded by commercial businesses. The traffic primarily includes large vehicles towing campers and large trucks. Bicyclists and pedestrians, using both the roadway and sidewalk, were present. The pedestrian facilities present at this intersection include, ramps, countdown

pedestrian heads, push buttons, and crosswalks. There are no bicycle facilities at the intersection or along the roadways leading to the intersection.

To control vehicular traffic, protected left turn phasing is present on all approaches. For the northbound right-turn, a turn lane is provided with a right-turn signal to indicate if the vehicle must stop. When the pedestrian push button is activated the signal for the right turning vehicles changes to red prior to the pedestrian walk sign appearing. This turn also had an acceleration lane after the turn. Leading up to the intersection, the southbound, northbound, and westbound approaches are divided; making all driveway access points right-in-right-out only in the vicinity of the intersection. Striping at the intersection is in fair condition except for the crosswalks where the lines are beginning to fade. Signing at the intersection started well in advance of the signal, with overhead signs to indicate lane direction.

Crash Characteristics

Of the 78 total crashes at this intersection, only one was classified as serious injury, which also involved a pedestrian. **Table 2.1** shows crash severity at the intersection. The intersection experiences 43% of its crashes during dark-unknown lighting conditions. **Table 2.2** shows the breakdown by first harmful event. The most common crash type is motor vehicle in transport but there have been four crashes involving pedestrians and pedalcyclists. The most common collision manner, shown in **Table 2.3**, is rear-end and the second most common is sideswipe (same direction), followed by left turn.

Table 2.1: Crashes By Severity Level	
Fatal	0
Serious Injury	1
Minor Injury	19
Property Damage Only (PDO)	58
Total	**78**

Table 2.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Motor Vehicle in Transport	0	0	17	55	**72**
Pedestrian	0	1	0	1	**2**
Pedalcycle	0	0	2	0	**2**
Other Post, Pole, or Support	0	0	0	1	**1**
Total	**0**	**1**	**19**	**58**	**78**

Table 2.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	0	0	0	1	**1**
Angle	0	0	2	7	**9**
Left Turn	0	0	6	8	**14**
Rear End	0	0	9	23	**32**
Sideswipe (Same Direction)	0	0	1	16	**17**
Sideswipe (Opposite Direction)	0	0	0	1	**1**
Other	0	1	1	2	**4**
Total	**0**	**1**	**19**	**58**	**78**

Recommendations

Recommendations are presented in three categories: low cost / quick implementation, moderate cost / moderate implementation timeline, high cost / long range implementation.

Low Cost Solutions

1. **Restripe Intersection Crosswalks**– The intersection has crosswalk striping but it is fading.
2. **Update Signing** – The signing prior to the intersection is button copy. This is an old style of sheeting that is no longer reflective. Replacing with new retro-reflective sheeting will help the signs stand out during dark hours.

Figure 7: Overhead Signs

3. **Add Reflective Backplate to Signal Heads** – Reflective backplates will allow the signal heads to be seen better during the day and night.
4. **Trim Trees / Bushes** –Bushes and trees are obstructing the view of the route marking signs in the northwest quadrant. Seeing these signs will help drivers determine which direction they should go.
5. **Update Pedestrian Signing** – There is a pedestrian crossing sign that could be updated to newer design standards, from the yellow sign to the florescent yellow green pedestrian sign.
6. **Provide Dashed Striping for Left Turns** – Currently there are dashed lines for the left turns on all but the northbound approach. Providing dashed lines on the northbound left may help people navigate the left turn and help to eliminate sideswipe crashes.
7. **Add a Leading Pedestrian Interval to Signal Phasing -** Vehicles often do not notice pedestrians trying to cross the street when a green light is given. Adding pedestrian intervals to the signal timing gives pedestrians a head start into the intersection before the related vehicle green time. This puts the pedestrian into the crosswalk before vehicles begin their through or turn movements.

Figure 8: Signal heads on southwest quadrant.

Moderate Cost Solutions

8. **Update Pedestrian Facilities** – Detectable warnings should be installed on all pedestrian ramps except for the two crossing the northbound through and left turn movement as there are already detectable warnings in place.
9. **Check Overhead Lighting Level** – Since more than 40% of the crashes occurred during dark hours, checking the lighting near the intersection would ensure there is an appropriate amount and correct intensity, which may help to reduce crashes.

Figure 9: Pedestrian ramp going from the southeast quadrant to the northeast quadrant.

High Cost Solutions

10. **Provide Pedestrian Lighting** – Since this intersection has pedestrian and pedalcyclists activity, pedestrian lighting would improve visibility for and of those road users.
11. **Extend Raised Median on South Leg and Channelized Left to Del Taco** – The median extends approximately 15 feet beyond the entrance and exit to the shopping

area and fast food restaurants. By extending the median south, past the entrance to the Del Taco, it eliminates the possibility a vehicle would try to take a left out of the shopping center. Adding the channelized left would still provide an entrance into Del Taco while still preventing people from making a left turn maneuver from the shopping center.

Treatment #	Total Cost	B/C	CMF	Notes
1. Restripe Crosswalks	$13,644.00	8.4	0.63	ADA
2. Update Signing	$3,120.00	21.2	0.85	Change signs to be MUTCD compliant
3. Add Reflective Tape to Backplates	$1,725.00	8.7	0.97	N/A
4. Trim Trees/Bushes	$2,000.00	192.3	0.27	N/A
5. Update Pedestrian Signing	$240.00	N/A	N/A	MUTCD Compliance
6. Provide Dashed Striping for left turns.	$2,520.00	N/A	N/A	Standard
7. Add a leading pedestrian interval to signal phasing	$100.00	268.6	0.63	N/A
8. Update Pedestrian Facilities	$9,360.00	N/A	N/A	ADA
9. Check Overhead Lighting Levels	$1,000.00	N/A	N/A	If overhead lighting levels found to be insufficient, installing appropriate lighting may help to reduce crashes.
10. Provide Pedestrian Lighting	$55,580.00	8.1	0.41	N/A
11. Extend Raised Median on South leg and Channelized left to Del Taco	$3,787.88	64.2	0.61	N/A
Recommendation: 1, 2, 3, 4, 7*	$20,589.00	79.5	0.22	

*Calculated combined CMF using treatments 1 & 7.

Intersection 3: State Route 260 and Manzanita / Granite Dells Road

Located in Payson, AZ the intersection of State Route 260 & Manzanita / Granite Dells Road is a signalized intersection in an urban area. The intersection is ranked third overall from the intersection network screen process. **Appendix C** contains all supporting documentation for this intersection including a crash map, **Figure C-1**; a crash diagram, **Figure C-2;** and the physical characteristics of the intersection, **Figure C-3**.

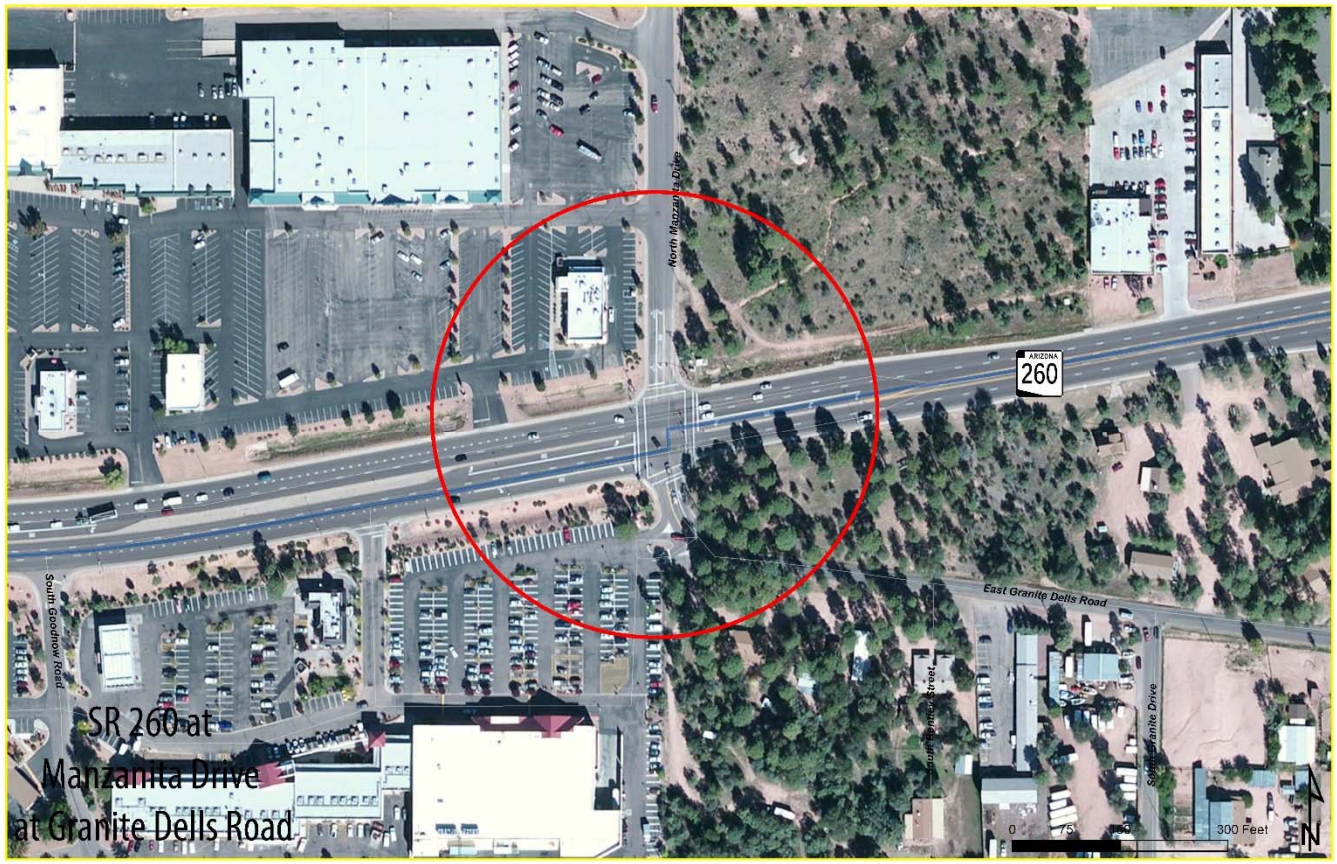

Figure 10: SR 260 & Manzanita Location Map

Intersection Characteristics

The traffic at this intersection is primarily passenger vehicle on Manzanita / Granite Dells Road, and has some large trucks on SR 260. The speed limit is 25 mph on Manzanita and 45 mph on SR 260. On the west side of the intersection, land use is classified as commercial. The east side of the intersection is still undeveloped. Left turn phasing is permissive for the side street and protected permissive for SR 260. Pedestrian facilities include ramps

on all four quadrants, and pedestrian countdown heads. During the site review, two pedestrians were observed using sidewalks at the intersection. The geometrics of this intersection are not typical - the northbound approach comes in off of a curve leading to a slight skew and the thru lane does not line up with the receiving lane. The skewed intersection angle also makes driver interpretation of vehicle speeds and distances more difficult. On Manzanita Drive the entrance to the supermarket is within 40 feet of the intersection.

Crash Characteristics

Of the 27 total crashes at this intersection, two were classified as serious injury. **Table 3.1** shows crashes by severity. All but one crash occurred during daylight hours, but four crashes occurred during inclement weather. **Table 3.2** shows the breakdown by first harmful event. The most common crash type is motor vehicle in transport. The most common collision manner, shown in **Table 3.3**, is left turn and rear end, followed by angle.

Table 3.1: Crashes By Severity	
Fatal	0
Serious Injury	2
Minor Injury	4
Property Damage Only (PDO)	21
Total	**27**

Table 3.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Motor Vehicle in Transport	0	2	4	18	**24**
Traffic Signal Support	0	0	0	1	**1**
Utility Pole / Light Support	0	0	0	1	**1**
Other Fixed Object	0	0	0	1	**1**
Total	**0**	**2**	**4**	**21**	**27**

Table 3.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	0	0	0	3	**3**
Angle	0	1	1	2	**4**
Left Turn	0	0	2	7	**9**
Rear End	0	1	1	7	**9**
Sideswipe (Same Direction)	0	0	0	1	**1**
Sideswipe (Opposite Direction)	0	0	0	1	**1**
Total	**0**	**2**	**4**	**21**	**27**

Recommendations

Recommendations are presented in three categories: low cost / quick implementation, moderate cost / moderate implementation timeline, high cost / long range implementation.

Low Cost Solutions

1. **Restripe Intersection Crosswalks** – The intersection currently has crosswalk striping, but it is fading.
2. **Add Reflective Backplate to Signal Heads** – Reflective backplates will allow the signal heads to be seen better both day and night.
3. **Add a Leading Pedestrian Interval to Signal Phasing -** Vehicles often do not notice pedestrians trying to cross the street when a green light is given. Adding leading pedestrian interval to the signal timing gives pedestrians a head start into the intersection before the related vehicle green time. This puts the pedestrian into the crosswalk before vehicles begin their through or turn movements.
4. **Cut Back Vegetation** –Cutting back the vegetation near the exit from the grocery store, on the south leg, will help with sight distance at this intersection and eliminate potential conflicts.
5. **Fix Sidewalk Edge Drop-Off** – On the sides of the sidewalk on the southwest quadrant, the edge drops roughly 2 inches, having this fixed will prevent pedestrians from falling off the edge.

Figure 11: Sidewalk edge drop-off

Moderate Cost Solutions

6. **Update Pedestrian Facilities** – Only two of the crossings have detectable warnings at the ends of the ramps. Adding detectable warnings at all ramps will help pedestrians with disabilities know where the roadway is located.
7. **Install Flashing Yellow Arrows** – Installing Flashing Yellow Arrows, in place of the green ball for permissive left turn movements, is shown to be easier to understand for drivers.
8. **Install Protected Only Left Turn Phasing** – Installing protected only left turns on the north and southbound approaches would increase the safety by eliminating conflict points.
9. **Provide Pedestrian Lighting** –Pedestrian lighting would improve visibility for pedestrian and pedalcyclists and other road users.
10. **Install Red Light Running Cameras** –This may help with the reduction in angle and left turn crashes.

Figure 12: Pedestrian ramp going from the southeast quadrant to the northeast quadrant.

11. Connect Sidewalk – The sidewalk currently ends at the curb return on Granite Dells Road on the west side of the intersection. Pedestrians were observed either walking through the dirt or on the roadway. Connecting the sidewalk will eliminate conflicts between pedestrians and vehicles making it safer for both modes of transport.

Figure 13: Sidewalk end on southwest quadrant.

High Cost Solutions

12. **Move Grocery Store Drive** – Moving the grocery store driveway, on the south leg, further south would allow for better sight distance and help eliminate conflict.
13. **Realign SR 260 Roadway** – Realigning the roadway to come in at 90 degrees will help with drivers turning decisions.
14. **Realign Granite Dells Road** – Realigning Granite Dells Road and eliminating the curve would help with the sight distance problems.

Figure 14: View from grocery store entrance.

Treatment #	Total Cost	B/C	CMF	Notes
1. Restripe Intersection Crosswalks	$12,600.00	N/A	N/A	Standard practice indicates that crosswalks should be visible for road users.
2. Add Reflective Tape to Backplates	$1,725.00	17.4	0.97	N/A
3. Add Leading Pedestrian Interval to Signal Phasing	$100.00	0	0.63	B/C is 0 due to no fatal/serious injury crashes occurring at this intersection but lesser severity crashes mitigated by this countermeasure did occur.
4. Cut Back Vegetation	$3,000.00	34.9	0.27	N/A
5. Fix Sidewalk Edge Drop Off	$158.40	N/A	N/A	ADA
6. Update Pedestrian Facilities (Total)	$20,820.00	N/A	N/A	ADA
Update Pedestrian Facilities-ped buttons and heads	$8,320.00	N/A	N/A	ADA
Update Pedestrian Facilities-ped ramps	$12,500.00	N/A	N/A	ADA
7. Install Flashing Yellow Arrows (3 section)	$2,000.00	28.9	0.89	N/A
8. Install Protected/Permissive Phasing (4 section)	$2,000.00	42.1	0.84	N/A
9. Install Protected Only Left Turn Phasing	$4,000.00	9.4	0.94	N/A
10. Provide Pedestrian Lighting	$55,580.00	0	0.41	B/C is 0 due to no fatal/serious injury crashes occurring at this intersection but lesser severity crashes mitigated by this countermeasure did occur.
11. Install Red Light Running Cameras	$119,200.00	1.5	0.76	N/A
12. Connect Sidewalk	$1,267.80	N/A	N/A	ADA
13. Move Grocery Store Driveway	$375,000.00	N/A	N/A	Removing driveways from a signals functional area allows for fewer conflict points near the intersection. It is common practice to limit those driveways within the functional areas so as to increase the safety.
14. Realign SR 260 Roadway	$750,000.00	N/A	N/A	Standard practice indicates having a true 90 degree intersection is the safest design.
15. Realign Granite Dells Roadway	$375,000.00	N/A	N/A	Standard practice indicates having a true 90 degree

Treatment #	Total Cost	B/C	CMF	Notes
				intersection is the safest design.
Recommendation: 1, 2, 7, 8*	$18,325.00	22.3	0.73	

*Calculated combined CMF using treatments 2, 7, & 8.
*See Appendix K for detailed information on benefit cost analysis.

Intersection 4: SR 260 & Valley Road at Highline Drive

Located just east of the Payson, AZ city limit, the intersection of SR 260 & Valley Road at Highline Drive is a two-way stop controlled intersection. This intersection was ranked fourth on the intersection network screening process. **Appendix D** contains all supporting documentation for the intersection including a crash map, **Figure D-1**; a crash diagram, **Figure D-2;** and the physical layout of the intersection, **Figure D-3**.

Figure 15: SR 260 & Valley Road / Highline Drive

Intersection Characteristics

The intersection has two offset side streets, Valley Road and Highline Drive. SR 260 has both vertical and horizontal curves at, or near, the intersection and a speed limit of 55 mph. SR 260 has two lanes in each direction as well as left-turn lanes, to turn onto the side streets. It also has a right turn lane to turn onto Highline Drive. Highline Drive leads into a residential area. Valley Road has residential housing, a lodge, and an RV park. On Valley Road, there is a cattle gate and fences prior to the intersection with SR 260. The southbound approach to the intersection from Valley Road is uphill. Fixed objects near the intersection include guardrail, signs, an embankment, and trees. There is a dynamic messaging sign board just east of SR 260 and Highline Drive. Prior to the intersections, there are side street name signs. This intersection does not have any pedestrian or bicycle facilities and it does not have any street lighting.

Crash Characteristics

Of the 18 total crashes at the intersection, one was fatal. **Table 4.1** shows crashes by severity. The intersection experiences 33% or its crashes during dark, not-lighted conditions, and 6% during dark-lighted, conditions. Another 6% of the crashes occur during dawn. Only two of the eighteen crashes occurred during inclement weather (caused by sleet / hail). **Table 4.2** shows the breakdown by first harmful event. The most common crash type is animal wild-game followed by motor vehicle in transport. The most common collision manner, shown in **Table 4.3**, is single vehicle.

Table 4.1: Crashes By Severity Level	
Fatal	1
Serious Injury	0
Minor Injury	3
Property Damage Only (PDO)	14
Total	**18**

Table 4.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Ran Off Road Right	0	0	1	1	**1**
Motor Vehicle in Transport	0	0	1	5	**6**
Animal Wild – Game	1	0	1	6	**8**
Guardrail End	0	0	1	0	**1**
Fence	0	0	0	2	**2**
Total	**1**	**0**	**3**	**14**	**18**

Table 4.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	0	0	2	9	**11**
Angle	0	0	0	1	**1**
Left Turn	0	0	0	1	**1**
Rear End	0	0	1	1	**2**
Head-On	0	0	0	1	**1**
Sideswipe (Opposite Direction)	0	0	0	1	**1**
Other	1	0	0	0	**1**
Total	**1**	**0**	**3**	**14**	**18**

Recommendations

Recommendations are presented in three categories: low cost / quick implementation, moderate cost / moderate implementation timeline, high cost / long range implementation.

Low Cost Solutions

1. **Add Sign Post Delineators** – Adding post delineators on the front of the STOP sign post and on the sides will help with visibility of the STOP sign for both Valley Road and Highline Drive.

2. **Increase STOP sign size** – Increasing the STOP sign size on Valley Road and Highline Drive will help them be more prominent for the side streets.
3. **Install Side Road Warning Signs with Distance Plaque** – A side road warning sign, with a distance plaque, would provide information to the drivers on the SR 260, warning them that another driver may be trying to stop or turning onto the roadway.
4. **Install Proper Signing for No Thru Road** – Valley Road does not have any signing indicating that traffic cannot continue going straight. Installing a double arrow board, with proper object markers, will help the drivers see they must turn.

Figure 16: Incline on Valley Road.

5. **Cut Back Vegetation** – The vegetation, especially near Highline Drive, can obstruct motorists' sightline. By cutting this back further, sight distance will be increased for both the side street driver as well as the mainline driver.
6. **Modify Cattle Fencing** – Currently there is a cattle gate and cattle fencing but it is incomplete. Installing cattle fencing, up to the side of the cattle grate from the existing cattle fencing approximately 10 feet away, will protect the road from livestock.
7. **Install Safety Edge** – The north side of SR 260 is starting to erode. There were run-off the road crashes in this area. In coordination with a reconstruction project, safety edge could be added to eliminate the abrupt road edge making it easier for drivers to maneuver back onto the roadway if they leave the road.


Figure 17: Cattle Guard

Moderate Cost Solutions

8. **Add intersection lighting** – Thirty three percent of crashes occurred during dark hours so overhead street lighting would help.
9. **Wild Animal Fencing** – Wild animals are one of the main crash causes, so installing fencing can help eliminate crossings.
10. **Install transverse rumbles** – Installing transverse rumbles prior to the stop sign will alert the drivers on the side streets to the upcoming stop.

Figure 18: Looking east from Highland Drive.

High Cost Solutions

11. **Cut Back Embankment** – Coming from Highland Drive, the embankment creates a sight distance constraint. Cutting it back would increase the sight distance at the intersection for left turning traffic.
12. **Wild Animal Crossings** – Installing over or underpasses could reduce the number of wild animals crossing the highway near Valley Road / Highline Drive and SR 260.
13. **Realign the side streets** – Aligning the two side streets opposite of each other simplifies intersection turning movements and is more consistent with driver expectations.

Figure 19: Looking from ditch on the south side of the road.

14. **Raise Valley Road** – Valley Road currently comes in on an incline. The roadway could be raised to be even with the mainline and a better sight distance could be achieved.

Figure 20: Looking east from Valley Road.

15. **Move or eliminate ditch on south side of SR 260** – On the south side of SR 260 there is a steep ditch. Moving this further from the travelway, would allow the drivers more time to recover. If the ditch is completely eliminated, it would provide a wider clear zone.

Figure 21: Ditch near Highland Drive.

Treatment #	Total Cost	B/C	CMF	Notes
1. Add Sign Post Delineators	$120.00	N/A	N/A	Found under the FHWA tried and accepted treatment for rural roadways. Currently does not have any CMF associated with it.
2. Increase STOP sign size	$3,360.00	N/A	N/A	Found within the High Risk Rural Roads guidance, FHWA approves and has seen that increasing the STOP sign size increases the safety.
3. Install Side Road Warning Signs with Distance Plaque	$480.00	67.6	0.99	N/A
4. Install Proper Signing for No Thru Road	$250.00	N/A	N/A	MUTCD Compliance
5. Cut Back Vegetation	*$2,000.00*	*192.3*	*0.27*	*N/A*
6. Modify Cattle Fencing	$150.00	0	N/A	Cattle fencing is currently cut short so there are areas where the cattle could get out. Modifying it so that it covers these gaps will help to reduce the chance of a vehicle – animal collision. Non-fatal and serious injury crashes occurred that were not included in the benefit/ cost analysis.
7. Install Safety Edge	$2,750.00	0	0.769	Non-fatal and serious injury crashes occurred that were not included in the benefit/ cost analysis.
8. Add Intersection Lighting	$55,580.00	0	0.41	Non-fatal and serious injury crashes occurred that were not included in the benefit/ cost analysis.
9. Add Wild Animal Fencing	$3,600.00	N/A	N/A	See ADOT's results.
10. Install Transverse rumbles	$7,200.44	299.2	0.785	N/A
11. Cut Back Embankment	$2,840.00	1884.8	0.53	N/A
12. Wild Animal Crossings	$2,500,000	N/A	N/A	See ADOT's current findings on wild animal crossings. They have seen a significant reduction in crashes with wild animals.
13. Realign Side Streets	$250,000.00	N/A	N/A	N/A
14. Raise Valley Road	$25,000.00	N/A	N/A	N/A
15. Move or eliminate ditch on south side of SR 260	$1,136.00	4712	0.53	N/A
Recommendation: 2, 3, 4, 9, 10	$14,890.44	126.5	0 .78	

*Calculated combined CMF using treatments 3 & 10.

Intersection 5: Broad Street & Oak Street

Located in Globe, AZ the intersection of Broad Street and Oak Street is a four-way stop controlled intersection. It is ranked fifth overall in the intersection network screening process. **Appendix E** contains all supporting documentation for this intersection including a crash map, **Figure E-1;** a crash diagram, **Figure E-2;** and the physical characteristics of the intersection, **Figure E-3**.

Figure 22: Broad Street and Oak Street Location Map

Intersection Characteristics

The four-way stop controlled intersection of Broad Street and Oak Street has one lane on each approach. On Oak Street, there is parallel parking and on Broad Street there is angled parking. The angled parking goes up to the intersection, whereas the parallel parking stops approximately 40 feet before the intersection. There are bulbouts provided for the pedestrians on all approaches. All four approaches have crosswalks and ramps for pedestrians as

well as stop bars. Also, behind the stop bar on each approach, the word STOP is painted. The STOP signs located at each of the intersections is 36" and in good condition.

Traffic at this intersection is primarily passenger vehicles and small trucks. The speed limit on both streets is 25 mph and most of the traffic observed was traveling at or near the speed limit. Along with the vehicular traffic, pedestrians and bicyclists were observed using the roadway and sidewalks. Lighting is provided for both pedestrians and vehicles, with three vehicle lights at the intersection and five pedestrian lights provided near the intersection.

Fixed objects can be found near the roadway at the intersection. Three of the STOP signs were on islands and the other STOP sign is located on the edge of the travelway, but can still be seen by moving vehicles since parking is to the right of the stop sign. Other fixed objects found near the roadway include a concrete bench on the edge of the northeast curb return, a fire hydrant, trash cans, decorative trees, and bench.

Crash Characteristics

Of the 21 total crashes, six involved an injury, one of which was a serious injury. **Table 5.1** shows crashes by severity. The intersection experiences eight percent of crashes during night-time, lighted conditions. **Table 5.2** shows the breakdown by first harmful event. The most common crash type was motor vehicle in transport, followed by other fixed object. A complete breakdown of crashes by first harmful event can be found in **Table 5.2**. The most common collision manner, shown in **Table 5.3**, is rear-to-side. This collision manner makes up thirty-three percent of all the crashes at the intersection. Other collision manners are single vehicle, rear end, and head on.

Table 5.1: Crashes By Severity	
Fatal	0
Serious Injury	1
Minor Injury	5
Property Damage Only (PDO)	15
Total	**21**

Table 5.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Other Non-Collision	0	0	1	0	**1**
Motor Vehicle in Transport	0	1	3	12	**16**
Curb	0	0	0	1	**1**
Other Fixed Object	0	0	1	2	**3**
Total	**0**	**1**	**5**	**15**	**21**

Table 5.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	0	0	2	3	**5**
Angle	0	0	0	3	**3**
Rear End	0	1	2	1	**4**
Head-On	0	0	1	0	**1**
Rear-To-Side	0	0	0	7	**7**
Other	0	0	0	1	**1**
Total	**0**	**1**	**5**	**15**	**21**

Recommendations

Recommendations for this intersection only apply to the low cost / quick implementation category.

Low Cost Solutions

1. **Parking Spots** – Currently the most common crash type is Rear-to-Side. This is indicative of sight distance problems with cars backing out of spots. Options to reduce these crashes include: eliminating angled parking, reducing the number of angled parking spots near the intersection, or changing the angled parking to parallel or back-in only street parking on Broad Street.

Figure 23: Parking on north leg of intersection.

2. **Provide Retroreflective Marking on Fixed Objects near Roadway** –The concrete bench used to delineate the pedestrian area should have a reflectorized sign to help it stand out at night.
3. **Inlet Hole Southeast Corner** – On the southeast corner there is an inlet hole that poses a risk to pedestrians, bicyclists, and vehicles.
4. **Restripe Intersection** – The intersection currently has striping but it is faded.
5. **Update Signing** –The Stop Signs have a 4-Way plaque underneath, but should be updated to say All-Way as this is the most up to date signing standard.

Figure 24: Inlet on southeast quadrant.

Figure 25: Crosswalk crossing south leg of intersection.

Treatment #	Total Cost	B/C	CMF	Notes
1a. Parking Spots-Change to Parallel	$2,167.50	21.2	0.65	N/A
1b. Parking Spots - Change to Back in	$3,468.00	13.6	0.65	N/A
1c. Eliminate angled parking	$1,734.00	26.1	0.65	N/A
2. Provide Retroreflective marking on Fixed Objects near Roadway	$250.00	0	N/A	PDO crashes related to fixed objects in the area.
3. Fix Inlet hole in southeast corner	$500.00	N/A	N/A	ADA Compliance, Trip Hazard.
4. Restripe Intersection	$9,792.00	N/A	N/A	Standard practice to restripe intersections as needed.
5. Update Signing	$1,092.00	45.6	0.85	Change signs to be MUTCD compliant
Recommendation: 1a, 3, 4, 5	$13,551.50	14.2	0.55	

*Calculated combined CMF using treatments 1a & 5.

Intersection 6: SR 87 & Bonita

Located in Payson, AZ the intersection of SR 87 & Bonita is a signalized, four leg intersection. This intersection was ranked sixth on the intersection network screening process. **Appendix F** contains all supporting documentation for this intersection including a crash map, **Figure F-1;** a crash diagram, **Figure F-2;** and the physical characteristics of the intersection, **Figure F-3**.

Figure 26: SR 87 & Bonita Location Map

Intersection Characteristics

Surrounding the intersection, the land use is commercial, which includes hotels, restaurants, a gas station, and a donut shop. The hotels and restaurants are on both sides of SR 87 so pedestrian traffic from the hotels to restaurants is expected.

The intersection's mainline road, SR 87, has two lanes in each direction with a two way left-turn lane that turns into left-turn lanes at the intersection. The left turns from SR 87 have protected/permissive signal phasing. The speed limit on the mainline is 35 mph, with the majority of the traffic doing the speed limit or slightly above. The side street has a one lane approach with permissive only left turns and a speed limit of 25 mph. Along the east leg, there is angle parking located near the intersection. The intersection has overhead vehicular lighting for three of the four quadrants; the northwest quadrant does not have lighting.

All modes of transportation were observed using this intersection: pedestrians, bicyclists, passenger vehicles, RV's, and large trucks. Pedestrian facilities include sidewalks, going south and north; ramps, on all quadrants; countdown pedestrian heads, on all quadrants; push buttons, on all quadrants; and crosswalks on all legs. There are no bicycle facilities.

Crash Characteristics

Of the 40 crashes, one was classified as a serious injury. **Table 6.1** shows crashes by severity. The majority of the crashes occurred during daylight hours and during clear weather. **Table 6.2** shows the breakdown by first harmful event. The most common crash type was motor vehicle in transport but notably, this intersection has two pedestrian crashes and one pedalcycle crash. The most common collision manner, shown in **Table 6.3**, was rear end, which is expected at an intersection.

Table 6.1: Crashes By Severity	
Fatal	0
Serious Injury	1
Minor Injury	17
Property Damage Only (PDO)	22
Total	**40**

Table 6.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Motor Vehicle in Transport	0	0	14	22	**36**
Pedestrian	0	0	2	0	**2**
Bicycle	0	1	0	0	**1**
Unknown	0	0	1	0	**1**
Total	**0**	**1**	**17**	**22**	**40**

Table 6.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Angle	0	0	5	3	**8**
Left Turn	0	0	3	2	**5**
Rear End	0	0	7	12	**19**
Head-On	0	0	0	1	**1**
Sideswipe (Same Direction)	0	0	0	1	**1**
Rear-To-Side	0	0	0	2	**2**
Other	0	1	2	1	**4**
Total	**0**	**1**	**17**	**22**	**40**

Recommendations

Recommendations are presented in three categories: low cost / quick implementation, moderate cost / moderate implementation timeline, and high cost / long range implementation.

Low Cost Solutions

Install Flashing Yellow Arrow – It has been shown that the flashing yellow arrow, for permissive lefts is easier for drivers to understand. This treatment will alleviate left-turn and angle crashes.

1. **Add Reflective Tape to Backplates** – Adding reflective tape around the outside of the signal heads on the backplate will increase the visibility of the signals during nighttime and dusk / dawn hours.
2. **Re-Stripe Intersection** The intersection has striping but needs to be restriped as it is fading. Stop bars and crosswalks were significantly faded. New striping would help drivers, pedestrians, and other road users understand where they should be in the intersection.

Figure 27: Looking from the northeast quadrant.

3. **Add Detectable Warnings** – Detectable warnings were not present at any of the ramps, but would help the pedestrians with disabilities better see the edge of the roadway.
4. **Initiate a Pedestrian Lead Time** – This allows the pedestrian to get out into the intersection, where vehicles can better see the pedestrian.

Moderate Cost Solutions

5. **Update Pedestrian Push Buttons** – The pedestrian push buttons are older designs. Adding audio to the push button will keep pedestrians safe at the intersection.
6. **Install Directional Pedestrian Ramps** – Installing pedestrian ramps will help pedestrians with disabilities navigate the intersection. It will also help drivers see which direction the pedestrian intends to travel.
7. **Access Control** –The gas station has access at the southwest quadrant of intersection. The start of the access begins at the curb return, which causes conflicts. The gas station has multiple entrances and exits, so removing the access closest to the intersection would be beneficial with little impact to the gas station. Another option is removing access from the gas station to SR 87 altogether, since the gas station also has access onto/from the side street.

Figure 28: Looking from northeast quadrant towards the west.

8. **Reduce Width of Driveways** – Reduce the width of the driveways on each side of the intersection. One of the driveways is the entire width of the lot.
9. **Eliminate Access on SR 87** – As there is access to all businesses from the side streets, eliminating access onto the SR 87 would improve safety as well as progression along the mainline.

Figure 29: Looking from northwest quadrant towards southwest quadrant.

10. **Move Utilities Further from Roadway** – A number of crashes were with fixed objects, primarily in the northwest quadrant, where multiple utilities and the signal controller cabinet is located. Moving the utilities further from the roadway would reduce the risk of hitting fixed objects and also help with sight distance, , going east on Bonita.
11. **Connect Sidewalks** – Connecting the sidewalks on the northeast quadrant will allow for the pedestrians to easily access the pushbuttons. Currently, not all push buttons are accessible via the sidewalk.
12. **Pedestrian Adaptive Signal Timing** – This treatment will extend pedestrian walk time across the intersection so they can make it across safely. These can also be used to cancel a pedestrian call, if a pedestrian walks away from the intersection, or shorten the walk time if the pedestrian walks faster than the given time.

Figure 30: Pedestrian and Bicyclist on NW quadrant unable to stay on sidewalk to push pushbutton.

13. **Initiate Bicycle Timing & Detection at Signals** –Bicycle timing and detection would provide bicyclists enough time to get through the intersection.
14. **Initiate Passive Pedestrian Detection** – Passive pedestrian detection can be used to detect pedestrians without needing a pushbutton.

High Cost Solutions

15. **Buffered Bike Lane** – One bicycle crash occurred at this intersection so adding a buffered bike lane along SR 87 could improve the safety of bikes along the roadway. Also, the site visit revealed most of the bicyclists were riding on the sidewalk.
16. **Create Bike / Ped Path** – Convert the sidewalk into a bicycle and pedestrian path by widening it. This will keep the pedestrian and bicyclists off the roadway and reduce the potential conflicts between vulnerable users and vehicles.
17. **Install Pedestrian Lighting** –Pedestrian level lighting alerts other road users that pedestrians are near the roadway.

Treatment #	Total Cost	B/C	CMF	Notes
1. Add Reflective Tape to Backplates	$1,725.00	8.7	0.97	N/A
2. Restripe Intersection	$9,576.00	N/A	N/A	Standard practice to restripe intersection as needed.
3. Add Detectable Warnings	Included in ramp cost.	N/A	N/A	ADA, included in ramp updates.
4. Initiate a Pedestrian Lead Time	$100.00	268.6	0.63	N/A
5. Update Pedestrian Push Buttons	$8,320.00	N/A	N/A	ADA compliance.
6. Install Directional Pedestrian Ramps	$7,500.00	N/A	N/A	ADA compliance.
7a. Access Control - Remove access onto SR 87 for gas stations	$5,600.00	N/A	N/A	HSM / common practice identifies the reduction in access points within intersection influence areas as a way to reduce conflict points and thus crashes.
7b. Access Control - Limit access for gas station	$7,600.00	N/A	N/A	HSM / common practice identifies the reduction in access points within intersection influence areas as a way to reduce conflict points and thus crashes
8. Reduce width of Driveways	$4,000.00	N/A	N/A	HSM / common practice identifies the reduction in access points within intersection influence areas as a way to reduce conflict points and thus crashes
9. Eliminate Access on SR 87	$14,280.00	N/A	N/A	HSM / common practice identifies the reduction in access points within intersection influence areas as a way to reduce conflict points and thus crashes
10. Move Utilities Further from Roadway	*$2,000.00*	*192.3*	*0.27*	*N/A*
11. Connect Sidewalks	$464.86	N/A	N/A	ADA compliance as well as intuitive that connecting sidewalks will keep pedestrians off of the roadway and make the area safer for pedestrians.
12. Pedestrian Adaptive Signal Timing	$100.00	268.6	0.63	N/A
13. Initiate Bicycle Timing and Detection	$100.00	268.6	0.63	Cost varies on existing equipment. May be able to add in detection with existing video/radar detection.

Treatment #	Total Cost	B/C	CMF	Notes
14. Initiate Passive Pedestrian Detection	$20,000.00	39.2	N/A	N/A
15. Buffered Bike Lane	$54,000.00	N/A	N/A	Safer as it takes bikes out of vehicular traffic.
16. Create Bike/Ped Path	$166,666.67	N/A	N/A	Safer as it takes vulnerable users out of vehicular traffic.
17. Install Pedestrian lighting	$55,580.00	8.1	0.41	N/A
Recommendation: 1, 2, 3, 4, 5 , 6, 11*	$27,685	9.3	0.61	

*Combined CMF used treatments 4 & 5.

Segment 1: SR 87 From Gila/Maricopa County Boundary to Indian Road / Green Valley Parkway

The 26 mile segment of SR 87 is a divided highway and classified as a rural principal. Between the years of 2008 and 2013, it experienced a total of 467 crashes. This segment is located in Gila County, AZ and starts at the Gila / Maricopa County Boundary and travels north to Green Valley Parkway, just south of Payson, AZ. This segment was ranked first by the segment network screening analysis. Figure G-1 in **Appendix G** shows the crash map.

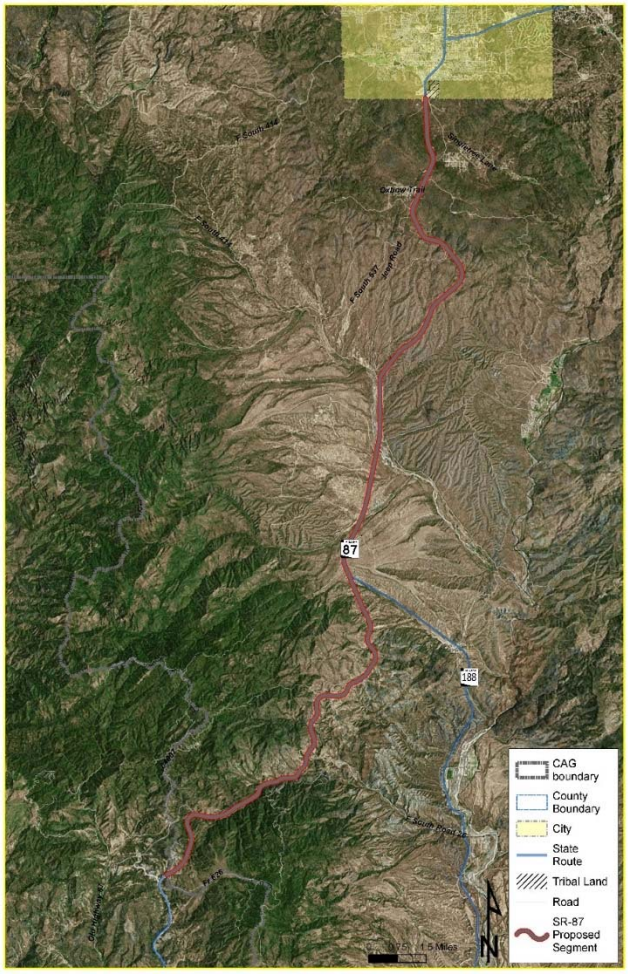

Figure 31: SR 87 Location Map

Roadway Characteristics

This segment of SR 87 begins at the Gila/Maricopa county boundary. At this point, the speed limit is 55 mph, and it is a four lane divided highway. Northbound, it has a two foot shoulder on the left hand side of the road and 6 foot shoulder on the right hand side. The speed limit increases to 65 mph leaving Payson near Lousey Saddle Trail. The northbound side has a number of areas with shoulders and rumble strips, while the southbound side has limited shoulders and no rumbles. Pull outs are located sporadically along the route with the first one, going eastbound, occurring approximately 1.5 miles from the SR 87 and Green Valley Parkway intersection. Most of the road, going southbound, provides very little room for driver error because of the lack of shoulders and either embankments or drop offs next to the roadway. The southbound side does have occasional earth shoulders, approximately 2 feet in width. Also located on the southbound side are break check point areas. These areas were being utilized while driving past and people were also pulled over past the break check points, in areas with very little shoulder, checking their vehicles, which presents a safety hazard.

Crash Characteristics

This segment was ranked 1st overall with a total of 467 crashes in the study period. Of these, a total of 11 were fatal crashes, and 25 serious injury crashes. **Tables 7.1** shows crashes by severity**.** Almost 40% of the crashes occurred during dark, unlighted conditions. Of the remaining crashes, approximately 3% occurred in dawn and dusk. The most common weather type, after clear conditions, for crashes was cloudy at approximately 13%. Rain is the next highest contributor to crashes at about 9%. The data shows that the over 50% of crashes happen on the weekend (Friday, Saturday, Sunday). Of those three days, Friday is the highest with approximately 21%. **Table 7.2** shows the breakdown by first harmful event. The most common crash type was animal wild game, with 92 total crashes, followed by overturn / rollover with 57 crashes. The most common collision manner, shown in **Table 7.3,** was single vehicle, making up 84% of all the crashes. The next most common type was sideswipe at approximately 5%. Another observation from data analysis reveals that road departure was present in all the fatal and serious injury crashes.

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Table 7.1: Number of Crashes By Severity	
Fatal	11
Serious Injury	25
Minor Injury	106
Property Damage Only (PDO)	325
Total	**467**

Table 7.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Overturn / Rollover	1	6	29	21	**57**
Fire / Explosion	0	0	0	20	**20**
Immersion	0	0	0	1	**1**
Jackknife	0	0	0	3	**3**
Cargo/Equipment Loss/Shift	0	0	2	7	**9**
Fell / Jumped From Vehicle	0	2	1	0	**3**
Thrown / Falling Object	0	0	0	2	**2**
Other Non-Collision	0	1	1	16	**18**
Equipment Failure	0	0	0	2	**2**
Ran Off Road Left	0	0	0	1	**1**
Motor Vehicle in Transport	3	3	14	40	**60**
Animal Wild Non-Game	0	0	1	2	**3**
Animal Wild-Game	0	0	9	83	**92**
Animal – Pet	0	0	0	1	**1**
Animal – Livestock	0	0	0	1	**1**
Parked Motor Vehicle	0	1	0	0	**1**
Work Zone / Maint. Equipment	0	0	0	1	**1**
Other Non-Fixed Object	0	0	4	14	**18**
Bridge Rail	0	0	0	2	**2**
Culvert	0	0	0	1	**1**
Ditch	1	1	8	16	**26**
Embankment	1	3	4	6	**14**
Guardrail Face	5	4	13	26	**48**
Guardrail End	0	1	3	5	**9**
Concrete Traffic Barrier	0	2	11	29	**42**
Tree, bush, stump (standing)	0	1	3	13	**17**
Traffic Sign Support	0	0	0	6	**6**
Other Post, Pole, or Support	0	0	1	2	**3**
Fence	0	0	0	1	**1**
Other Fixed Object	0	0	1	4	**5**
Total	**11**	**25**	**106**	**325**	**467**

Table 7.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	6	20	87	277	**390**
Angle	2	2	2	3	**9**
Left Turn	0	0	3	1	**4**
Rear End	0	1	7	14	**22**
Head-On	0	1	0	0	**1**
Sideswipe (Same Direction)	1	0	3	21	**25**
Sideswipe (Opposite Direction)	0	0	1	2	**3**
Rear-To-Side	0	0	0	0	**0**
Rear-To-Rear	0	0	0	0	**0**
Other	2	1	3	7	**13**
Total	**11**	**25**	**106**	**325**	**467**

Tabulating crash factors for this segment, the most prevalent factors in fatal and/or serious injury crashes are as follows: heavy vehicles, speeding, unbelted motorists, and motorcycles.

Recommendations

Recommendations are presented in three categories: low cost / quick implementation, moderate cost / moderate implementation timeline, high cost / long range implementation.

Figure 32: Intersection of SR 87 & SR 188.

Low Cost Solutions

1. **Add Yellow/Red Post Reflectors to Side-Road Stop Sign** – Many of the side-roads came in at odd angles and have existing side road warning signs. By adding post reflectors to the signs, attention can be focused on the hard to see side-road entrances.

2. **Add Safety Edge** – Portions of the roadway have edge drop offs that would benefit from a safety edge. A safety edge is used to provide an angle that is easily traversable by vehicles if they were to run off the road, and essentially making it easier to recover an errant vehicle. In coordination with a reconstruction project, the addition of safety edges could help eliminate some roll over crashes and single vehicle crashes.
3. **Add Animal Fencing** – Install fencing along the roadway to deter wild animals from crossing.
4. **Move Signs to 5 Feet Above Travelway** – Some signs seen along this route are not the required five feet off of the ground / above the travelway. This is a danger to motorists and does not meet design standards. By ensuring the signs are the proper height with the proper breakaway base, the signs would fall away from vehicles if hit and avoid injuring the occupants.
5. **Breakaway Post Base** – Install breakaway bases on all the signs. With the amount of run-off the road crashes and fixed object crashes it is important that signs have proper bases to help eliminate / reduce injuries when hit.

Figure 33: Eroding edge of roadway

Figure 34: Sign near intersection of SR 87& SR 188. Improper mounting height and breakaway base.

6. **Correct Yield Signs** – The shape of regulatory signs should not be modified. For instance if a DO NOT ENTER sign is located on the back of the YIELD sign, the YIELD sign's shape takes priority.
7. **Striping** – This road had been recently overlaid in areas and striping is missing. In the areas that had not been overlaid, the striping is faded. Re-striping the roadway will allow for better delineation of the road.
8. **Install Chevrons & Speed Plaques for Curve Signs** – Some curves along this route require chevrons, but do not have them. Installing chevrons will help reduce the number of crashes related to run off the road, and rollover/overturn. Although not required, chevrons are recommended on curves that currently have object marker delineation to enhance visibility. Adding speed plaques will help drivers understand the travel speed for curves.

Moderate Cost Solutions

9. **Speed Studies** – Conduct a speed study to understand the speeds that are being travelled on this road, the appropriate speeds to go around the curve, and speed differential. There appeared to be large speed differentials on multiple parts of the roadway. Based upon the results of the speed study, a decrease in speed limit may be warranted.

Figure 35: Curving Road Sign without a speed plaque.

10. **Create Clear Zone** – A high number of crashes occur when a vehicle collides with objects / vegetation / land formations on the side of the road.

High Cost Solutions

11. **Rumble Stripes** – Rumble Strips are currently found on some of the roadway segment. Installing strips along the entire segment, in both directions, would help address the single vehicle crashes, roll over crashes, and fixed object crashes.
12. **Install 2 Foot or Greater Shoulder** – Traveling southbound, the shoulder widths vary substantially from none to 6 foot shoulders. A minimum of two foot shoulders are recommended along the entire route to allow for areas where the driver can correct their errant vehicle. This will help with the run off the road, overturn/rollover, and fixed object crashes.
13. **Realign Roadway** – Realigning the roadway would help to eliminate some of the crashes due to the horizontal curves. Also, if some of the vertical curves could be eliminated or the grades reduced, that would help eliminate some of the crashes.
14. **Provide Animal Under or Overpasses** – Provide alternatives for animals to cross the road by using under and overpasses in conjunction with fencing.

Treatment #	Total Cost	B/C	CMF	Notes
1. Add Yellow/Red Post Reflectors to Side-Road Stop Signs	$1,820.00	N/A	N/A	Considered a tried safety measure by FHWA. It does not have an associated CMF.
2. Add Safety Edge	$2,904,000.00	14.3	0.77	N/A
3. Add Animal Fencing	$871,200.00	N/A	N/A	See ADOT's Results with animal fencing.
4. Move Signs to 5 feet above Travelway	$40.00	N/A	N/A	MUTCD Compliance, at the intersection of SR 87/SR 188
5. Breakaway Post Bases	$1,800.00	N/A	N/A	MUTCD Compliance
6. Correct Yield Signs	$40.00	N/A	N/A	MUTCD Compliance per 2B.10.08
7. Striping	$1,089,000.00	N/A	N/A	MUTCD Compliance
8. Install Chevrons & Speed Plaques for Curve Signs	$16,000.00	59.4	0.99	N/A
9. Speed Studies	$7,000.00	N/A	N/A	Included as the speed differential could cause an increase in safety problems. Also, the changes in speed limit on the route need to be evaluated to see if speed limits are placed appropriately.
10. Create Clear Zones	*$100,000.00*	*4.4*	*0.43*	*N/A*
11. Rumble Stripes	$13,305.60	4551.9	0.64	N/A
12. Install 2 foot or greater shoulder	$45,000,000.00	0.5	0.87	Paved Shoulder included in HSM.
13. Realign Roadway	$2,500,000.00	N/A	N/A	Standard, improved geometrics will help increase the safety of the roadway.
14. Provide Animal under or overpasses	$2,500,000.00	N/A	N/A	AZ has used these on routes with high crashes with animals and have seen significant reduction in crashes. At this time no CMF is published.
Recommendation: 4, 5, 6, 8, 9, 10, 11*	$138,185.60	916.4	0.27	

*Combined CMF used treatments 10 & 11.

Segment 2: SR 77 from Gila/Pinal County Boundary to US-70

The 33 mile segment of SR 77 is a rural minor arterial located in Gila County, AZ starting at the Gila/Pinal County Boundary and ending north of the start point at the intersection of SR 77 and SR 70 in Globe, AZ. It is ranked third[1] on the segment network screening process. **Appendix H** contains a crash map, **Figure H-1**.

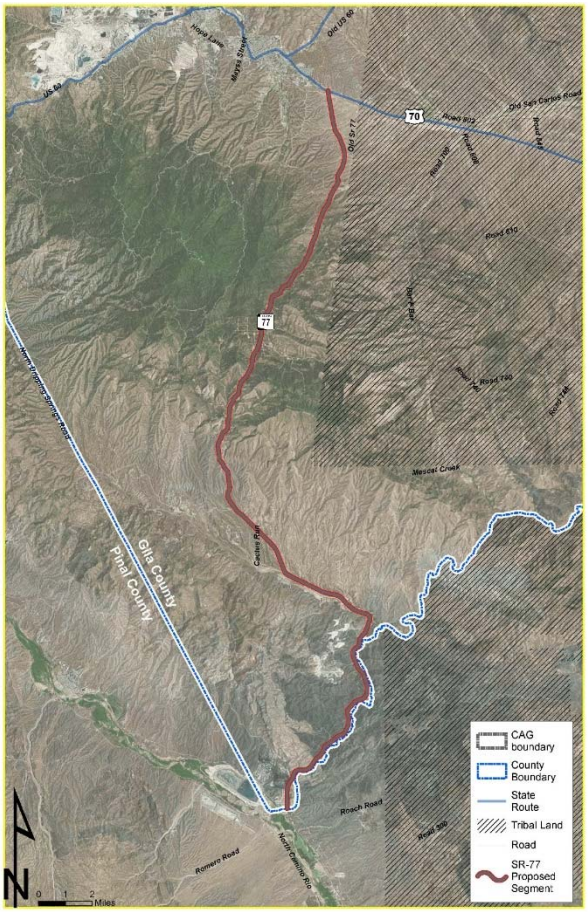


Figure 36: SR 77 Location Map

[1] *Ranking number two on the segment network screening process, SR 87 from 0.11 mi S of Private Drive to Strawberry Drive, is already being studied by the Arizona DOT and is not included as part of the CAG Safety Study.*

Roadway Characteristics

Starting at the Gila/Pinal County Boundary going north, the road starts in Winkleman just south of the SR 77 and W. Quarellie Street intersection. Within the town of Winkleman, the speed limit is 40 mph, the roadway has a left-turn lane, and a median. Once outside of the town of Winkleman, the speed limit increases to 55 mph and becomes an undivided roadway facility. From the point where the speed limit changes to the end of the segment, at SR 70 in Globe, AZ, the speed limit varies from 50 to 55 mph and the shoulder widths vary from not present to 10 feet wide. This segment travels through the mountains and grades reach a peak of 8%. Passing lanes are provided intermittently and striping to pass on the two-lane roadway is present. Pull-outs and runaway truck ramps are also available along the segment. When shoulders are present, a combination of continuous and non-continuous rumble strips are found.

Crash Characteristics

With a total of 133 crashes from 2009 to 2013, this segment had five fatal crashes, and ten classified as serious injury. **Tables 8.1** shows crashes by severity**.** Of the 133 crashes, approximately 35% occurred in dark conditions; 13% occurring during rain; and 14% occurring during cloudy weather. **Table 8.2** shows the breakdown by first harmful event. The most common crash type is motor vehicle in transport, followed closely by overturn / rollover, other non-fixed object, and embankment. The most common collision manner, shown in **Table 8.3,** is single vehicle. This collision manner makes up 81% of all the crashes on this segment. Other collision manners involved in fatal and serious injury crashes includes: head-on, sideswipe, and rear end.

Table 8.1: Crashes By Severity	
Fatal	5
Serious Injury	10
Minor Injury	31
Property Damage Only (PDO)	87
Total	**133**

Table 8.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Overturn / Rollover	1	3	7	6	**17**
Fire / Explosion	0	0	0	4	**4**
Jackknife	0	0	0	1	**1**
Cargo/Equipment Loss/Shift	0	0	0	2	**2**
Other Non-Collision	0	0	0	1	**1**
Motor Vehicle in Transport	2	3	6	11	**22**
Animal Wild-Game	0	0	3	7	**10**
Animal – Livestock	0	0	0	4	**4**
Parked Motor Vehicle	0	0	0	2	**2**
Other Non-Fixed Object	0	0	1	16	**17**
Culvert	0	0	0	1	**1**
Ditch	1	0	2	3	**6**
Embankment	0	2	5	8	**15**
Guardrail Face	0	1	3	6	**10**
Guardrail End	0	1	0	3	**4**
Other Traffic Barrier	0	0	0	1	**1**
Concrete Traffic Barrier	0	0	0	1	**1**
Tree, bush, stump (standing)	1	0	1	7	**9**
Utility Pole/Light Support	0	0	0	1	**1**
Other fixed Object	0	0	3	2	**5**
Total	**5**	**10**	**31**	**87**	**133**

Table 8.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	3	7	25	73	**108**
Angle	0	0	0	3	**3**
Rear End	0	1	3	2	**6**
Head-On	2	0	1	0	**3**
Sideswipe (Same Direction)	0	1	1	4	**6**
Sideswipe (Opposite Direction)	0	1	0	2	**3**
Rear-To-Side	0	0	0	1	**1**
Rear-To-Rear	0	0	0	1	**1**
Other	0	0	1	1	**2**
Total	**5**	**10**	**31**	**87**	**133**

Tabulating crash contributing factors, the most common for this segment include the following: speeding, heavy vehicles, and motorcyclists.

Recommendations

Recommendations are presented in two categories: low cost / quick implementation and moderate cost / moderate implementation timeline.

Low Cost Solutions

1. **Rock Netting** – While performing the site evaluation, rocks from the surrounding rock faces were seen on the shoulder and roadway. Several of these rocks were large enough to cause damage to a vehicle if driven over. Crashes with other non-fixed objects is one of the top three first harmful events.

2. **Add Distance Plaques to Side-Road Signs** – Though the majority of the crashes are single vehicle, adding distance plaques to the existing side-road signs allows for drivers to better understand where the upcoming side road is located.

3. **Add Yellow/Red Post Reflectors to Side-Road Stop Sign** – Adding the appropriately colored side post delineators helps vehicles traveling on the mainline see where the side road is located. Adding the delineator to the front of the stop sign, located on the post beneath the stop sign, calls attention to the driver of the upcoming stop sign.

Figure 37: Side Road Left Sign.

4. **Add Distance Plaque to the Stop Ahead Sign** – The Stop Ahead sign, located prior to the SR 77 and US 70 intersection, could be supplemented with a distance plaque.

5. **Add Beacon to Stop Ahead Sign** – The Stop Ahead sign, located prior to the SR 77 and US 70 intersection could be supplemented with a flashing beacon to call attention to the fact that the driver needs to stop soon. This would help with the crashes near the intersection.


Figure 38: Eroding edge of travelway.

6. **Fix Eroding Edge of Roadway** – Portions of the roadway are eroding. Fixing these would help drivers recover if they run off the road.

Moderate Cost

7. **Evaluate Passing / No Passing Zones** – During the field investigation, some passing zones appeared to be too short for the speed limit. The passing zones could be re-evaluated to confirm appropriate location and length and updated as needed.

8. **Stripes** – Rumble Strips are currently found on some of the roadway. Expanding to cover the entire segment would help address some of the single vehicle crashes, roll over crashes, and fixed object crashes.


Figure 39: Narrow shoulders, faded centerline striping.

9. **Centerline Rumble Strips** – Currently the entire segment does not have centerline rumble strips. Installing them along the entire segment would help address head-on and sideswipe crashes.

10. **Change Rumble Strips to Continuous Rumble Stripes** – Currently all the rumbles on this roadway are rumble strips, some continuous and some not. Converting them to stripes, located on the edge striping, makes them is easier to see during rain events, and there is more time for the driver to correct an errant vehicle.

11. **Trim Overgrowth** – Along the route many areas have overgrown foliage that is starting to creep onto the shoulders and roadway, and obstruct sign faces. This limits sight distance, but also encourages people to drive closer to the centerline.
12. **Install 2-foot or Wider Shoulders** – This route has varying shoulder widths—from no shoulder to 10-foot shoulders. Creating at least a 2-foot shoulder along the entire route, on both sides, would provide a recovery area, reducing some of the single vehicle, fixed object, and roll over crashes.

Figure 40: Vegetation encroachment.

13. **Evaluate Speeds** – Speed limits range from 40 to 55 mph along the segment. The speeds on the roadway should be evaluated to determine if the speed limits posted are appropriate and used in the appropriate manner. Many vehicles were traveling above the posted speed limit, which may cause conflicts.
14. **Striping** – Striping along the route is visible during daylight hours but is fading. Re-striping the route would enhance visibility of the roadway.
15. **Chevrons** – Add chevrons on curves where advisory speed is 10 MPH less than posted speed limits. Chevrons may also be added to curves where object markers are in place.

Figure 41: Slight curve delineated with object markers.

Treatment #	Total Cost	B/C	CMF	Notes
1. Rock Netting	$12,000.00	N/A	N/A	Need netting between MM 139-143. The safety benefit is unknown but removing objects from within the roadway or near the sides of the roadway decreases the likelihood of a conflict between vehicles and rocks.
2. Add Distance Plaques to Side-Road Signs	$20,000.00	21.4	0.99	N/A
3. Add Yellow/Red Post Reflectors to Side-Road Stop Sign	$2,800.00	N/A	N/A	Considered a tried safety measure by FHWA. It does not have an associated CMF.
4. Add Distance Plaques to Stop Sign Ahead Sign	$30.00	631.7	0.99	Project should be at beginning of route near US 70.
5. Add Beacon to Stop Ahead Sign	$8,423.00	0	0.84	Found at beginning of Route near US 70. No fatal or serious injury crashes related to this countermeasure but lesser severity crashes were related.
6. Fix Eroding Edge of Roadway	$1,742,400.00	1.5	0.77	N/A
7. Evaluate Passing / No Passing Zones	$10,000.00	N/A	N/A	Noticed NPZ looks short 2 miles from US 70. No Passing Zones indicate to drivers that it is an acceptable place to pass other vehicles.
8. Rumble Stripes	$68,006.40	59.4	0.64	N/A
9. Centerline Rumble Strips	$51,744.00	207.8	0.55	N/A
10. Change Rumble strips to Continuous Rumble Stripes	$5,913.60	594.6	0.64	N/A
11. Trim Overgrowth	*$10,000.00*	*40.8*	*0.43*	*N/A*
12. Install 2 foot or wider shoulders	$160,000,000.00	0	0.13	Paved Shoulder included in HSM. B/C is 0 due to the high cost of implementing shoulders in this area.
13. Evaluate Speeds	$10,000.00	N/A	N/A	The speed differential on this route seemed large. Studying this difference in more depth may lead to more insight and better managing of the vehicle speeds.
14. Striping	$784,080.00	N/A	N/A	Standard practice to restripe.
15. Chevrons	$15,000.00	367.3	0.87	Curve at MM 159 needs chevrons.
Recommendation: 1, 2, 3, 4, 8, 9, 11*	$154,580.40	5.4	.15	

*Combined CMF used treatments 8, 9, and 11.

Segment 3: SR 79 From SR 77 to Deep Well Ranch Road

The 27 mile long segment of SR 79 is a rural minor arterial located in Gila County, AZ with a starting point at SR 77 and ending point at Deep Well Ranch Road. Ranking fifth[2] overall on the segment network screening process this segment had 164 crashes from 2008 to 2013. **Appendix I** contains a crash map, **Figure I-1**.

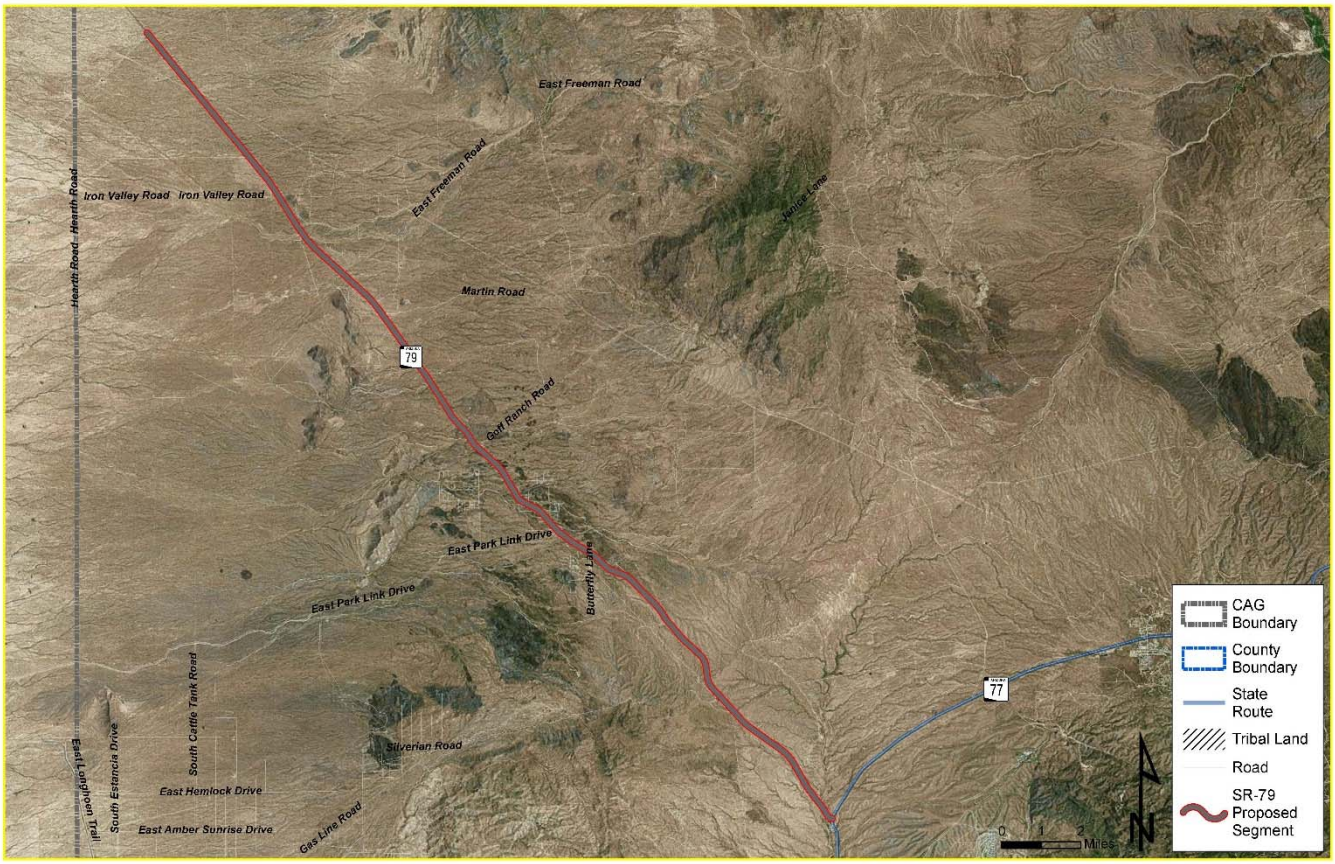


Figure 42: SR 789 Location Map

[2] *Ranking number four on the segment network screening process, SR 260 from Tonto National Forest to Coconino/Gila County Boundary, is already being studied by the Arizona DOT and is not included as part of the CAG Safety Study.*

Roadway Characteristics

Starting at Deep Well Ranch Road, the speed limit is 65 mph with 12 foot lanes and 2 foot shoulders. It is a two-lane road with one lane in each direction. The roadway does not have any rumble stripes or strips or centerline rumbles. There are many pull-offs along the roadway providing for opportunities to rest but also contributing to safety problems as sometimes these are hard to see when approaching. Another safety concern is the vegetation comes to the edges of the road and could be an issue for run off the road crashes. The road is primarily straight, but does have slight curves that could prove problematic due to the change in roadway demand. Also, along the roadway are washes, which carry water, but typically only have water in them for brief periods of times. The washes are typically covered by a box culvert and many of the box culverts have edges that are falling in.

Crash Characteristics

With a total of 164 crashes from 2009 to 2013 had 3 fatal crashes, and 20 classified as serious injury. **Tables 9.1** shows crashes by severity**.** The majority of the crashes occurred during daylight hours but approximately 30% occurred during dark, not lighted conditions and another 9% occurred during dawn. The most prevalent weather type, during crashes was clear, followed by cloudy, which was a factor in 13% of the crashes. Rain and snow also contributed to a small percentage of the crashes at 7% and 3% respectively. **Table 9.2** shows the breakdown by first harmful event. The most common crash type is animal wild—game, followed by tree, bush, and stump (standing) then overturn / rollover. The most common collision manner, shown in **Table 9.3,** is single vehicle at 83% of all the crashes, followed by rear end.

Table 9.1: Crashes By Severity	
Fatal	3
Serious Injury	20
Minor Injury	32
Property Damage Only (PDO)	109
Total	**164**

Table 9.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Overturn / Rollover	2	8	8	8	**26**
Fire / Explosion	0	0	0	2	**2**
Jackknife	0	0	0	1	**1**
Cargo/Equipment Loss/Shift	0	0	1	0	**1**
Other Non-Collision	0	0	0	1	**1**
Motor Vehicle in Transport	0	4	5	16	**25**
Animal Wild Non-Game	0	0	0	1	**1**
Animal Wild-Game	0	0	4	46	**50**
Animal – Livestock	0	0	0	3	**3**
Culvert	0	1	0	0	**1**
Ditch	0	0	1	1	**2**
Embankment	0	0	5	4	**9**
Guardrail Face	0	0	0	1	**1**
Guardrail End	1	0	0	2	**3**
Other Traffic Barrier	0	0	0	1	**1**
Tree, bush, stump (standing)	0	4	6	18	**28**
Traffic Sign Support	0	2	2	2	**6**
Other Post, Pole, or Support	0	1	0	0	**1**
Other fixed Object	0	0	0	1	**1**
Total	**3**	**20**	**32**	**109**	**164**

Table 9.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	2	16	27	91	**136**
Angle	0	1	2	1	**4**
Rear End	0	1	2	9	**12**
Head-On	1	1	0	0	**2**
Sideswipe (Same Direction)	0	1	1	6	**8**
Other	0	0	0	2	**2**
Total	**3**	**20**	**32**	**109**	**164**

Tabulating the crash characteristics, the most common factors in fatal and / or serious injury crashes on the segment include the following: speeding, unbelted drivers, impaired drivers, distracted driving, and young drivers.

Recommendations

Recommendations are presented in two categories: low cost / quick implementation and moderate cost / moderate implementation timeline.

Low Cost Solutions

1. **Add Yellow/Red Post Reflectors to Side-Road Stop Sign** – Many of the side-roads came in at odd angles and have existing side road warning signs. Adding the post reflectors to the warning signs, calls attention to the hard to see driveways.
2. **Add Safety Edge** – Portions of the roadway have edge drop offs that would benefit from a safety edge. This would help eliminate roll over crashes and single vehicle crashes by providing drivers an opportunity to correct their errant vehicle.
3. **Add Advanced Warning of Pull-Off Areas / Picnic Area's** – There are many areas where motorists can pull off the side of the road for recreational purposes. These areas are hard to see while traveling on the roadway. Adding signage or clearing brush in advance of the pull-off area would help driver's better see the pull-off. It would also help drivers trying to pull out from the areas see on-coming traffic.
4. **Trim Overgrowth** – Overgrowth should be trimmed along the route areas where overgrowth of vegetation started to advance onto the shoulders, roadway, and obstruct sign faces. This poses a risk for limiting sight distance and also encourages people to drive closer to, or on, the centerline.
5. **Evaluate Passing / No Passing Zones** – During the field investigation, some passing zones appeared to be too short for the speed limit. The passing zones could be re-evaluated to confirm appropriate location and length and updated as needed.
6. **Striping** – Striping along the route is visible during daylight hours but is faded. Re-striping the route would enhance visibility of the roadway.
7. **Install Chevrons** – Crashes are clustered on the curves, adding chevrons will notify the driver of an upcoming geometric change would. This could prevent run off the road, single vehicle, rollover, and fixed object crashes

Moderate Cost Solutions

8. **Replace / Move / Fix Box Culverts** – Many of the culverts are eroding on the edges and are also located right at the edge of the roadway and delineated by type 3 object markers. It is recommended to move the edges of the culverts out of the clear zone.
9. **Create Clear Zone** – The segment has vegetation that advances to the shoulder of the road. One of the primary crash types is collisions with bush, tree, or stump. By creating the clear zone, the driver should be able to recover without impacting fixed objects.
10. **Rumble Stripes** – Rumble Strips are currently found on some of the roadway. Installing strips throughout the entire segment would address the single vehicle crashes, roll over crashes, and fixed object crashes.

Figure 43: Edge of roadway eroding.

11. **Centerline Rumble Strips** – The segment does not have centerline rumble strips, but. Installing them along the entire segment would help address sideswipe crashes and head-on crashes.
12. **Install 2 Foot or Greater Shoulder** – This route has varying shoulder widths—from no shoulder to the most common 2 foot shoulder. Installing at least a 2 foot shoulder along the entire route will allow for a recovery area.

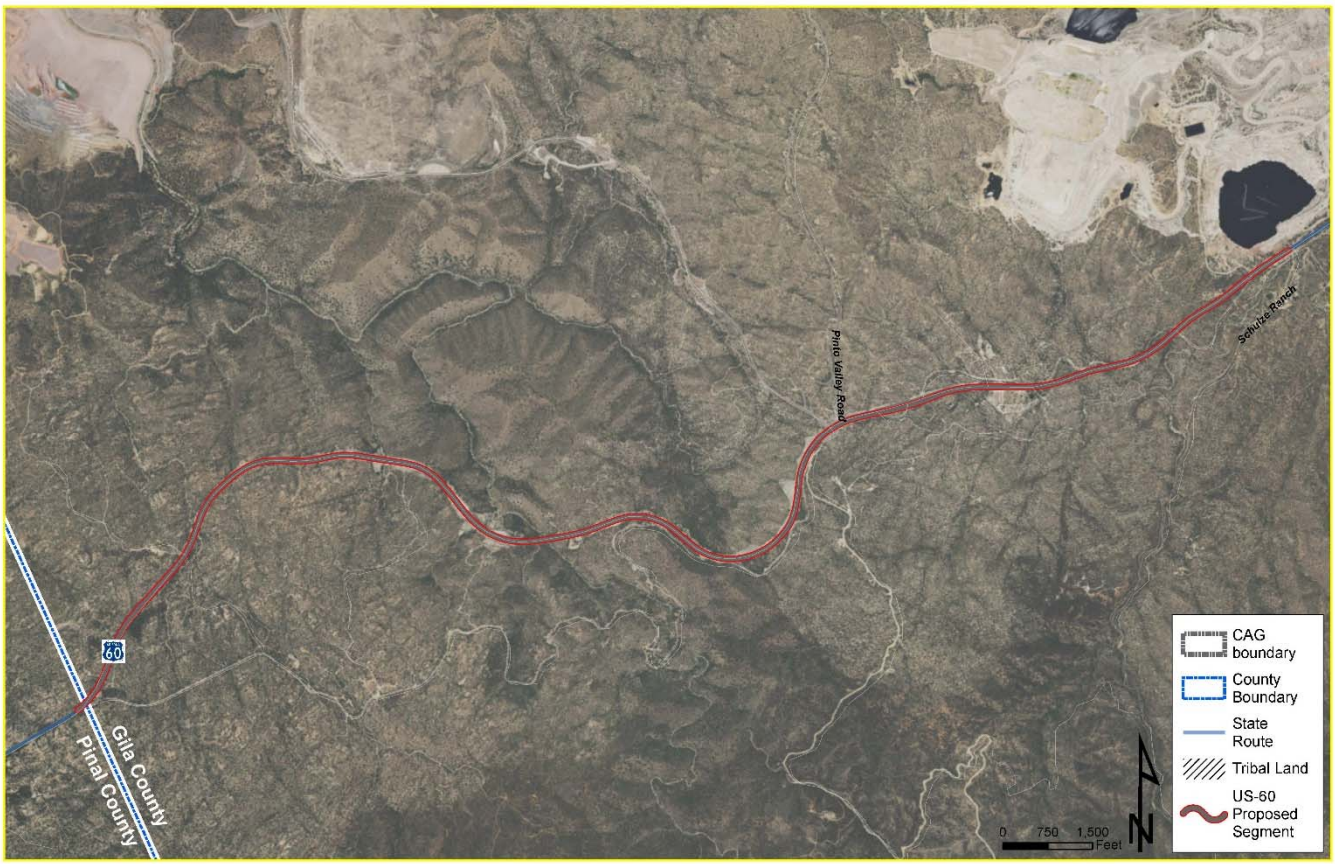
Figure 44: Vegetation close to roadway. Near a pullout.

Treatment #	Total Cost	B/C	CMF	Notes
1. Add Yellow/Red Post Reflectors to Side Road Stop Sign	$500.00	N/A	N/A	Considered a tried safety measure by FHWA. It does not have an associated CMF.
2. Add Safety Edge	$167,225.00	1	0.769	N/A
3. Add Advance Warning of Pull-Off Areas/Picnic Area's	$840.00	225.5	0.99	N/A
4. Trim Overgrowth	Varies	Varies	0.43	See HSM for different CMF factors.
5. Evaluate Passing/No Passing Zones	$15,000.00	N/A	N/A	Passing and No Passing Zones indicate to drivers where it is safe for them to attempt to pass. Some passing zones on this route seemed shorter than the required length for passing.
6. Striping	$213,840.00	N/A	N/A	Standard practice.
7. Install Chevrons	$5,240.00	436.8	0.87	N/A
8. Replace/Move/Fixe Box Culverts	*$2,000.00*	*229.8*	*0.13*	*N/A*
9. Create Clear Zone	*$2,000.00*	*150.5*	*0.43*	*N/A*
10. Rumble Stripes	$79,242.24	3.5	0.64	N/A
11. Centerline Rumbles	$3,252.48	1377.3	0.55	N/A
12. Install 2 foot or Greater shoulder	$268,000,000.00	0	0.2	Paved Shoulder included in HSM. Cost of countermeasure too high for a b/c greater than 0.
Recommendation: 1, 2, 3, 4, 6, 7, 10, 11*	$470,139.72	1.9	0.23	

*Combined CMF calculated using treatments 10, 7, and 4.

Segment 4: US-60 From Gila/Pinal County Boundary to Globe Urban Boundary

The five mile segment of US-60 is a rural principal located in Gila County, AZ with a starting point at the Gila/Pinal County Boundary and ending at the Urban Boundary of Globe, AZ. From the segment network screening, this segment was ranked 6th overall with a total of 93 crashes from 2008 to 2013. **Appendix J** provides **Figure J-1**, crash locations.



Roadway Characteristics

Starting at the Gila/Pinal Boundary going north-east along the route (approximately mile marker 236), the route has one lane each direction, one foot to two foot shoulders on either side, and a speed limit of 55 mph. Along the route, the shoulders vary in width from none to eight foot. As this rural roadway goes through the mountains, the grades are steep, reaching 8 percent at some points. The steep grades become more problematic at horizontal

curves. Most of the curves have advisory speeds of 5-10 mph under the posted speed limit. Along this segment, many side roads come into the mainline at the end or beginning of curves. To address this, many of the side roads have advisory signs. The roadway includes rumble strips for approximately two miles near the eastern starting point and has no centerline rumbles. Along this route, passing / climbing lanes are provided as well as passing zones. At the end of the segment, near the urban boundary, the speeds reduce to 35 mph.

Crash Characteristics

With a total of 93 crashes from 2009 to 2013, this segment ranked 6th through the network screening process. Of the total crashes, 1 was fatal, and 6 classified as serious injury. **Tables 10.1** shows crashes by severity**.** The majority of the crashes occurred during daylight hours, but 26% of all the crashes occurring during dark, unlit conditions and 18% of crashes occurred when the weather was classified as cloudy. A total of eight crashes that occurred during inclement weather, which includes rain and snow. **Table 10.2** shows the breakdown by first harmful event. The most common crash type is motor vehicle in transport followed by guardrail face. The most common collision manner, shown in **Table 10.3,** is single vehicle, followed by side-swipe.

Table 10.1: Crashes By Severity	
Fatal	1
Serious Injury	6
Minor Injury	22
Property Damage Only (PDO)	64
Total	**93**

Table 10.2: Crashes By First Harmful Event					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Overturn / Rollover	0	0	2	3	**5**
Fire / Explosion	0	0	0	3	**3**
Jackknife	0	0	0	2	**2**
Cargo/Equipment Loss/Shift	0	0	0	1	**1**
Thrown or Falling Object	0	0	1	0	**1**
Other Non-Collision	0	0	0	1	**1**
Equipment Failure	0	0	0	1	**1**
Motor Vehicle in Transport	0	3	3	17	**23**
Animal Wild-Game	0	0	0	3	**3**
Animal – Pet	0	0	0	1	**1**
Animal – Livestock	0	0	0	1	**1**
Other Non-Fixed Object	0	0	0	4	**4**
Bridge Rail	0	0	0	2	**2**
Ditch	0	0	1	0	**1**
Embankment	0	0	4	5	**9**
Guardrail Face	0	2	2	10	**14**
Guardrail End	0	0	1	5	**6**
Other Traffic Barrier	0	1	0	0	**1**
Tree, bush, stump (standing)	0	0	0	3	**3**
Traffic Sign Support	1	0	0	0	**1**
Other Post, Pole, or Support	0	0	0	1	**1**
Other fixed Object	0	0	8	1	**9**
Total	**1**	**6**	**22**	**64**	**93**

Table 10.3: Crashes by Collision Manner					
	Fatal	**Serious Injury**	**Minor Injury**	**PDO**	**Total**
Single Vehicle	1	3	18	45	**67**
Angle	0	2	0	0	**2**
Left Turn	0	0	0	1	**1**
Rear End	0	0	0	7	**7**
Head-On	0	1	1	0	**2**
Sideswipe (Same Direction)	0	0	1	7	**8**
Sideswipe (Opposite Direction)	0	0	1	1	**2**
Rear-To-Rear	0	0	0	1	**1**
Other	0	0	1	2	**3**
Total	**1**	**6**	**22**	**64**	**93**

Tabulating the crash contributing factors for fatal and / or serious injury crashes the following were the top factors: speeding, heavy vehicles, motorcycle.

Recommendations

Recommendations are presented in three categories: low cost / quick implementation, moderate cost / moderate implementation timeline, and high cost/longer term implementation.

Low Cost Solutions

1. **Add Distance Plaques to Side-Road Signs** –Adding distance plaques to the existing side-road signs helps drivers better understand where the upcoming side road is located.

2. **Add Yellow/Red Post Reflectors to Side-Road Stop Sign** – Many of the side-roads came in at odd angles and have existing side road warning signs. Adding the post reflectors to the warning signs calls more attention to the hard to see side-roads.
3. **Evaluate Passing / No Passing Zones** – During the field investigation, some passing zones appeared to be too short for the speed limit. The passing zones could be re-evaluated to confirm appropriate location and length and updated as needed.
4. **Trim Overgrowth** – Overgrowth should be trimmed along the route areas where overgrowth of vegetation started to advance onto the shoulders, roadway, and obstruct sign faces. This poses a risk for limiting sight distance and also encourages people to drive closer to, or on, the centerline.
5. **Evaluate Speeds** – Speed limits ranged from 40 to 55 mph along the segment. The speeds on the roadway should be evaluated to determine if the speed limits posted are appropriate. Many vehicles were traveling

above the posted speed limit, and many of the large trucks could not travel at, or close to, the speed limit due to the steep inclines. The speed differential may cause conflicts.

6. **Add Safety Edge** – Some portions of the road had edges that are starting to erode. Providing safety edge at those locations, will help drivers correct an errant vehicle.
7. **Striping** – Striping along the route is visible during daylight hours but is faded. Re-striping the route would enhance visibility of the roadway.

Moderate Cost Solutions

8. **Rumble Stripes** – Rumble Strips are currently found on some of the roadway. Installing rumble strips throughout the entire segment would help address the single vehicle crashes, roll over crashes, and fixed object crashes.

Figure 45: Faded Striping & Small Shoulder

9. **Centerline Rumble Strips** –The entire segment does not have centerline rumble strips. Installing them along the entire segment would help address sideswipe crashes and head on crashes.
10. **Change Rumble Strips to Continuous Rumble Stripes** –All the rumbles on this roadway are rumble strips, some continuous some not. Converting the strips to stripes, located on the edge striping, makes them easier to see during rain events and provides more time for the driver to correct an errant vehicle.
11. **Install Two Foot or Greater Shoulder** – This route has varying shoulder widths—from no shoulder to 10 foot shoulders. Creating at least a 2 foot shoulder along the entire route, on both sides of the road, would provide a recovery area to address the single vehicle, fixed object, and roll over crashes.

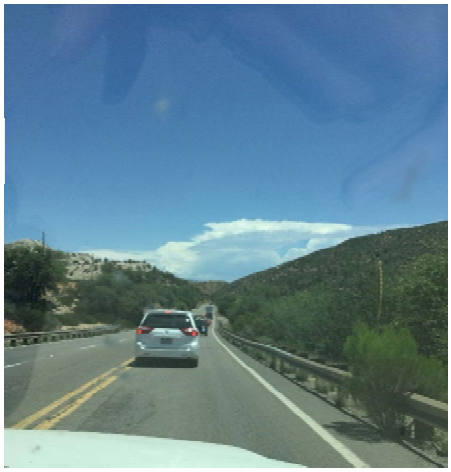


Figure 46: Vegetation Encroaching

High Cost Solutions

Figure 47: Passing Lane

12. Passing / Climbing Lanes – Though some passing/climbing lanes are provided, adding additional lanes would help to reduce the number of sideswipe collisions.

Treatment #	Total Cost	B/C	CMF	Notes
1. Add distance plaques to side-road signs	$30.00	22.9	0.99	N/A
2. Add yellow/red post reflectors to side-road stop sign	$360.00	N/A	N/A	Considered a tried safety measure by FHWA. It does not have an associated CMF.
3. Evaluate passing/no passing zones	$15,000.00	N/A	N/A	No Passing Zones indicate to drivers where it is safe to pass. If a NPZ is not correct it gives the wrong message to the driver.
4. Trim Overgrowth	*$2,000.00*	*150.5*	*0.43*	*N/A*
5. Evaluate Speeds	$10,000.00	N/A	N/A	Speed limits along route are inconsistent and speed differential between vehicles was noticeable
6. Add Safety Edge	$528,000.00	0	0.769	B/C of 0 due to lack of fatal / serious injury crashes mitigated by this countermeasure but some PDO and Minor Injury crashes are mitigated by this countermeasure.
7. Restripe	$237,600.00	N/A	N/A	Standard practice.
8. Rumble Stripes	$12,862.08	395.7	0.55	N/A
9. Centerline Rumble Stripes	$14,931.84	0	0.64	B/C of 0 due to lack of fatal/serious injury crashes mitigated by this countermeasure but there are some PDO / Minor Injury crashes mitigated by this countermeasure.
10. Change Rumble Strips to Continuous Rumble Stripes	$2,069.76	0	0.64	B/C of 0 due to lack of fatal/serious injury crashes mitigated by this countermeasure but there are some PDO / Minor Injury crashes mitigated by this countermeasure.
11. Install 2 foot or greater shoulder	$40,000,000.00	0.2	0.2	Paved Shoulder included in HSM.
12. Passing/Climbing Lanes	$1,250,000.00	0.4	0.65	N/A
Recommendation: 1,2,4,6,8,9*	$558,1893.92	14	.352	

*Combined CMF calculated using treatments 8 & 9